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SAMeCiPP: An Ever-growing Society Thanks to its Members

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It is a great pride for the 2023–2024 Board of Directors of the *Sociedad Argentina de Medicina y Cirugía del Pie y Pierna* to present, for the second consecutive year, a special issue of the Journal of the *Asociación Argentina de Ortopedia y Traumatología* focused on the pathology of this region.

This edition, composed mainly of scientific contributions from our members, reaffirms the commitment to research and publication of a community of subspecialists that continues to grow, despite the socioeconomic challenges we are currently facing. The XXV Annual Conference, held in April 2024 in the city of Mendoza, with more than 400 attendees and 415 active members, are figures that reflect the growth of a Society that has already passed five decades of life—and is still going strong.

In these pages, readers will find original articles reflecting the experience of our colleagues in the fields of sports-related injuries, trauma, reconstructive surgery, and degenerative foot disease, as well as a thorough update on one of the most studied conditions in the region in recent years: progressive collapsing foot deformity.

This new issue, the result of a joint effort between the AAOT Editorial Committee and SAMeCiPP, reinforces the importance of interdisciplinary collaboration and the continuous development of medical knowledge for the benefit of our patients. We are deeply grateful to all those who have contributed their work and dedication to making this possible, and we hope it will be a source of inspiration for future research and developments to be featured in upcoming editions.

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Case Presentation

Juan Manuel Trebino Molteni, Leticia I. Rodríguez
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Case Resolution on page 197.

Pain in the Hindfoot

ABSTRACT
We present the case of a 20-year-old male football player who consulted for medial hindfoot pain in his left foot, lasting for a few months, with no identifiable history of trauma and unresponsive to analgesics. On physical examination, pes planovalgus was observed, more pronounced on the affected side. Radiographs and magnetic resonance imaging (MRI) revealed an expansile, eccentric, well-defined, multilobulated lesion with internal fluid-fluid levels.
Keywords: Bone cysts; calcaneus
Level of Evidence: IV

Dolor en el retropié

RESUMEN
Se presenta a un varón de 20 años, que practica fútbol habitualmente y consulta por dolor interno del retropié izquierdo, de un par de meses de evolución, sin poder determinar un antecedente traumático y que no calma con analgésicos. En el examen físico, se constata pie plano valgo, más acentuado del lado del dolor. Se solicitan radiografías y una resonancia magnética que muestran una lesión expansiva, excéntrica, de contornos bien definidos, polilobulada, con niveles líquido-líquido en su interior.
Palabras clave: Quistes óseos; calcáneo.
Nivel de Evidencia: IV

INTRODUCTION

A 20-year-old male, a regular soccer player, presented with pain in the medial hindfoot of his left foot, with no history of trauma to the region. Physical examination revealed pes planovalgus, more pronounced on the affected side (Figure 1). Weight-bearing foot and ankle radiographs and a non-contrast magnetic resonance imaging (MRI) scan were requested.

FINDINGS AND INTERPRETATION OF IMAGING STUDIES

The lateral weight-bearing radiograph of the foot revealed a multilobulated, polycystic lesion confined within the cortices of the left calcaneus (Figure 2). Non-contrast MRI showed an expansile, eccentric lesion with well-defined margins, multilobulated morphology, and internal fluid-fluid levels, measuring 3.3 cm in anteroposterior and transverse dimensions and 2.7 cm in cephalocaudal extension (Figure 3).

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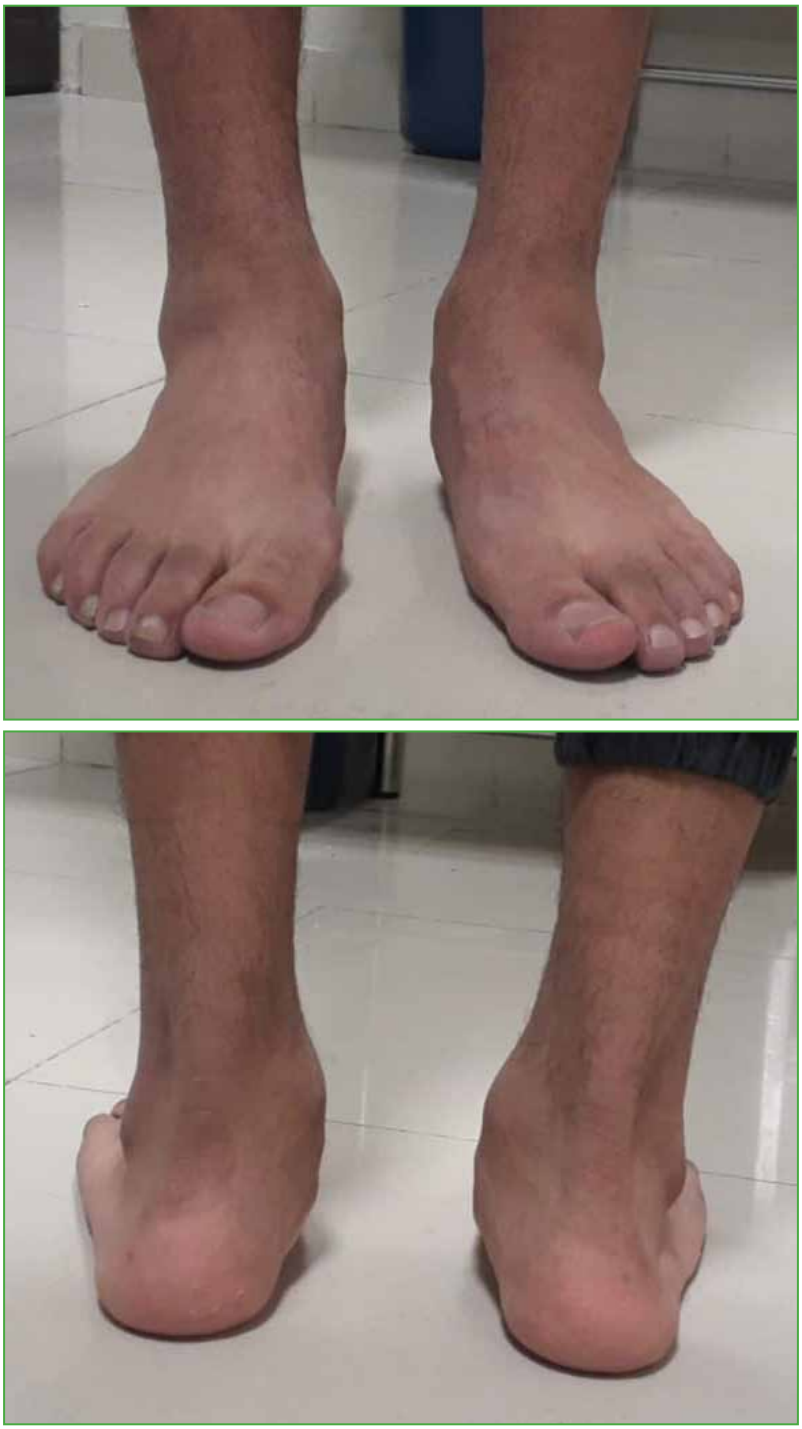

Figure 1. Pes planovalgus, more pronounced on the painful left side.

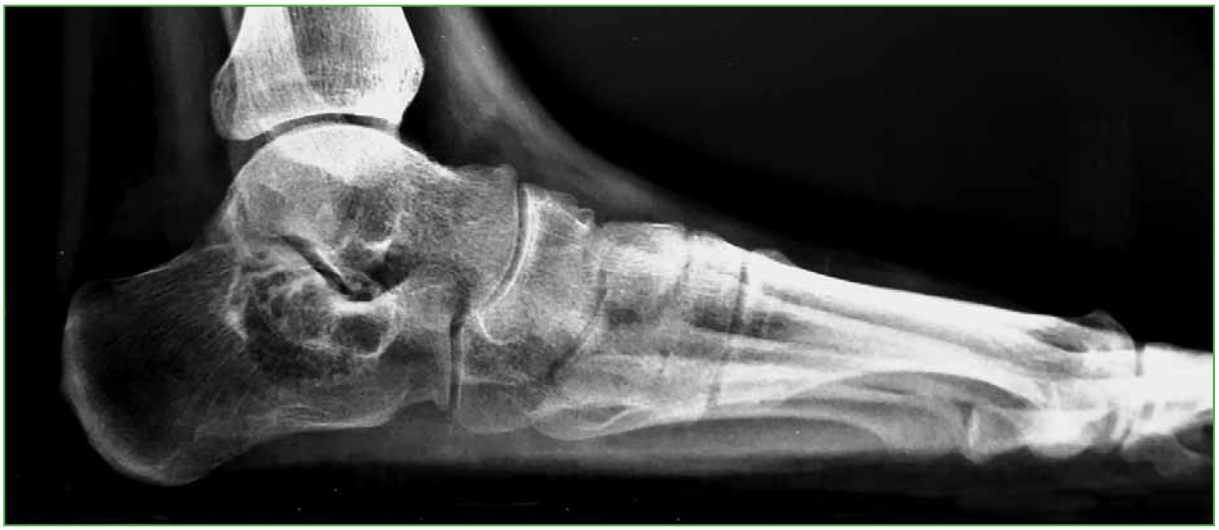

Figure 2. Lateral weight-bearing radiograph of the left foot. A polycystic, multilobulated lesion is observed in the calcaneus, without cortical breach.

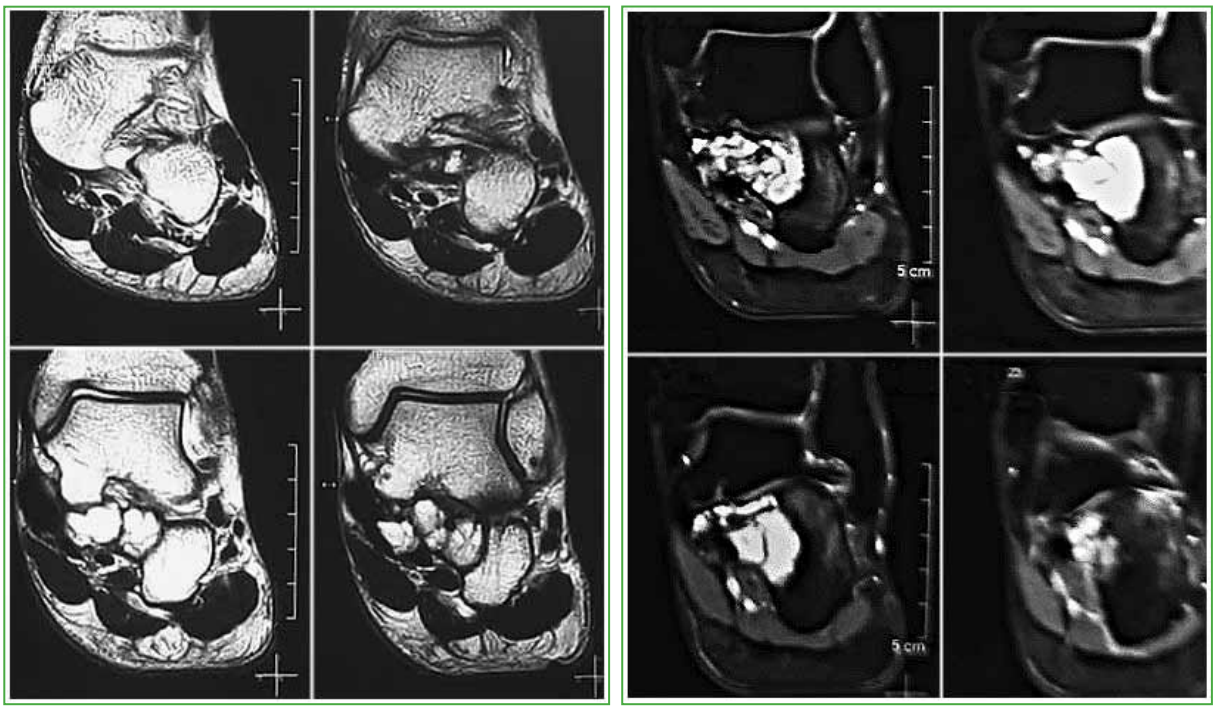

Figure 3. Coronal non-contrast MRI of the left foot. A multilobulated, polycystic lesion with fluid-fluid levels is seen, confined within the cortices of the left calcaneus.

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Early Surgical Treatment for Severe Idiopathic Compression of the Common Peroneal Nerve: A Case Series

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ABSTRACT

Introduction: Compression of the common peroneal nerve (CPN) is a common condition in the lower limb and can be either idiopathic or secondary. While secondary compressions have been extensively studied and show good outcomes with microsurgical decompression, evidence regarding idiopathic compressions remains limited. This study aims to report cases of severe idiopathic CPN compression treated surgically, evaluate clinical outcomes, and assess the need for a standardized treatment protocol. **Materials and Methods:** A retrospective review was conducted on patients diagnosed with idiopathic CPN palsy over the past 10 years. Inclusion criteria comprised cases with a positive electromyogram, no history of trauma, negative MRI findings, and normal intraoperative findings. Patients with secondary nerve entrapment, spinal pathology, psychiatric disorders, or pregnancy were excluded. Severe cases were defined as those presenting with a dorsiflexion motor deficit of ≤2/5. Preoperative, intraoperative, and postoperative variables were analyzed. **Results:** Eight patients met the inclusion criteria (2 women, 6 men). The mean time from diagnosis to surgery was 30 days, with an average follow-up of 959 days. All patients regained at least 4/5 dorsiflexion strength. Six patients achieved full recovery of both strength and sensation. No complications were reported. **Conclusions:** Early decompression of the CPN is a safe and effective procedure for severe idiopathic compression. The establishment of a standardized treatment protocol is recommended.

Keywords: Common peroneal nerve; club foot; peripheral nerve compression.

Level of Evidence: IV

Tratamiento quirúrgico precoz para la compresión severa idiopática del nervio peroneo común. Serie de casos

RESUMEN

Introducción: La compresión del nervio peroneo común es frecuente en el miembro inferior y puede ser idiopática o secundaria. Las compresiones secundarias se han estudiado ampliamente y la descompresión microquirúrgica logra buenos resultados. Sin embargo, la evidencia sobre las compresiones idiopáticas es limitada. Este estudio busca comunicar casos de compresión idiopática severa del nervio peroneo común tratada con cirugía, evaluar los resultados y analizar la necesidad de un protocolo terapéutico estandarizado. **Materiales y Métodos:** Se realizó una revisión retrospectiva de pacientes con diagnóstico de parálisis idiopática del nervio peroneo común en los últimos 10 años. Se incluyeron casos con electromiograma positivo y sin antecedentes de trauma, con resonancia magnética negativa y hallazgos intraoperatorios normales. Se excluyó a pacientes con atrapamiento secundario, problemas raquídeos, alteraciones psiquiátricas o embarazo. Se definió como caso severo cuando el déficit motor de dorsiflexión era ≤2/5. Se evaluaron variables preoperatorias, intraoperatorias y posoperatorias. **Resultados:** Ocho pacientes cumplieron los criterios de inclusión (2 mujeres y 6 hombres). El tiempo medio desde el diagnóstico hasta la cirugía fue de 30 días, el seguimiento promedio fue de 959 días. Todos recuperaron, al menos, 4/5 de fuerza en dorsiflexión. Seis pacientes recuperaron la fuerza y la sensibilidad completamente. No se observaron complicaciones. **Conclusiones:** La descompresión precoz del nervio peroneo común es un procedimiento seguro para la compresión idiopática severa. Se sugiere la creación de un protocolo estandarizado para su tratamiento.

Palabras clave: Nervio peroneo común; pie equino; compresión neurológica periférica.

Nivel de Evidencia: IV

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INTRODUCTION

Compression of the common peroneal nerve (CPN) is the most frequent focal neuropathy of the lower limb.[1,2] It is the third most common compressive neuropathy overall, surpassed only by compression of the median and ulnar nerves.[3] It is also the leading cause of numbness associated with pain and muscle weakness. CPN compression may present with sensory symptoms or motor deficits, including impairment of dorsiflexion and eversion of the foot. This condition is broadly classified into two groups: idiopathic compressions and secondary lesions.[4] Secondary lesions of the CPN encompass a wide variety of causes, most of which have been reported as isolated cases or small series.[5,6] Idiopathic compressions may affect individuals across all age groups.[7]

The clinical outcomes of microsurgical decompression of the CPN in cases of secondary compression (post-traumatic, iatrogenic, tumor-related) have been studied, with mixed results in most series.[1,8,9] However, the literature is limited to heterogeneous case series from various specialties. There are reports from orthopedic surgeons, plastic surgeons, neurosurgeons, and sports medicine specialists.[4,10] Treatment guidelines are inconsistent and poorly standardized.[11] Moreover, there is no consensus on how to evaluate the outcomes of either conservative or surgical treatment.[12,13]

Available data on idiopathic CPN compression are scarce. It is a poorly defined entity in terms of severity and timing of treatment. Therefore, the aim of this article is to present a series of patients with severe idiopathic CPN compression treated surgically, evaluate the outcomes, and propose a standardized therapeutic protocol for the orthopedic surgeon.

MATERIALS AND METHODS

A retrospective review was conducted over a 10-year period on patients diagnosed with idiopathic CPN palsy at our institution. Idiopathic was defined as the absence of trauma or external compression, with negative MRI findings, no intraoperative pathology, and a positive electromyogram. Significant weight loss was also assessed as a potential contributing factor.

We excluded patients with secondary CPN entrapment—i.e., those with imaging or preoperative findings consistent with nerve compression—as well as those with CPN neuropraxia following knee surgery or symptoms of CPN compression secondary to spinal disease. Patients with a history of psychiatric disorders or who were pregnant at the time of symptom onset were also excluded.

Severe was defined as a case presenting with an initial dorsiflexion motor deficit ≤ 2/5 on the Medical Research Council (MRC) Scale for muscle strength.

Preoperative Protocol

At the first medical consultation, patients were evaluated by a fellow trained in peripheral nerve disease and subsequently re-evaluated by the surgeon responsible for the procedure. The standardized anamnesis for patients with clubfoot included questions about abrupt changes in body mass index (notably marked weight loss), history of bariatric surgery, history of direct trauma to the knee or upper third of the affected leg (including the use of immobilizers at that level), history of knee surgery (arthroscopic or open), engagement in contact sports or postures that may favor nerve compression, history of metabolic disorders, and occupational postures (e.g., rural work, repetitive bending while bearing weight).

Motor function was evaluated by assessing the muscles innervated by the common peroneal nerve (CPN): tibialis anterior, extensor digitorum longus, fibularis tertius, extensor hallucis longus, extensor digitorum brevis, fibularis longus, and fibularis brevis. It is important to note that the fibular muscles are innervated by the superficial branch of the CPN, whereas the remaining muscles are innervated by the deep branch.

Muscle strength was assessed using the Medical Research Council (MRC) scale: 0, no contraction; 1, minimal muscle contraction; 2, active movement in the absence of gravity; 3, active movement against gravity; 4, active movement against gravity and resistance; and 5, normal strength.[14] The CPN is not associated with any reflex, and there is no specific provocation maneuver linked to it.

Sensory function was assessed through manual stimulation of the dermal regions innervated by the nerve. The CPN proper innervates the proximal lateral aspect of the leg. The superficial branch innervates the dorsum of the foot and the distal anterolateral third of the leg, while the deep branch provides sensation to the first dorsal web space. Tinel's sign was routinely assessed along the nerve pathway.

As for complementary studies, patients with clinical symptoms suggestive of CPN compression were systematically referred for electromyography, including motor and sensory conduction studies of the lower limb. They were referred to the Neurology Department for this evaluation. Additionally, standard anteroposterior and lateral knee radiographs were obtained, as well as a dedicated MRI to detect peripheral nerve lesions (high-resolution MR neurography with intravenous contrast).

Patients presenting with severe clinical compression (clubfoot and MRC ≤ 2) and a positive electromyogram, but without imaging findings, were considered to have severe idiopathic CPN compression and were indicated for surgical exploration and possible decompression. All patients completed the American Orthopaedic Foot and Ankle Society (AOFAS) questionnaire prior to surgery and at the latest available postoperative follow-up.

Surgical Protocol

The patient was positioned supine with the lower limb slightly flexed. A 5 cm oblique incision was made just below the head of the fibula, following the course of the CPN. The subcutaneous tissue was dissected to expose the superficial fascia overlying the nerve. The nerve is typically identified distally in its course medial and posterior to the fibular head. The fascia was incised parallel to the nerve, which was then decompressed using microsurgical techniques by releasing the surrounding ligaments and fascia until it was completely freed.

Dissection was extended to the nerve trifurcation, with particular attention to the articular branches to rule out the presence of intraneural ganglion cysts. The motor branches often perforate the intermuscular septa. It is essential to release the posterior crural intermuscular septum, located deep to the anterior border of the fibularis longus muscle. The anterior crural intermuscular septum and the surrounding fascia enveloping the CPN over the deep fascia were also identified and systematically released to ensure decompression at the fibular head.

The nerve is protected by perineural fat, which should be preserved as much as possible because it provides vascular support and facilitates gliding motion during joint movement. Hemostasis is critical to prevent hematomas that could compromise the decompressed nerve. The wound was closed with absorbable sutures for the subcutaneous tissue, while the skin was closed with either biological glue (tissue adhesive) or an intradermal nylon suture (Figure).

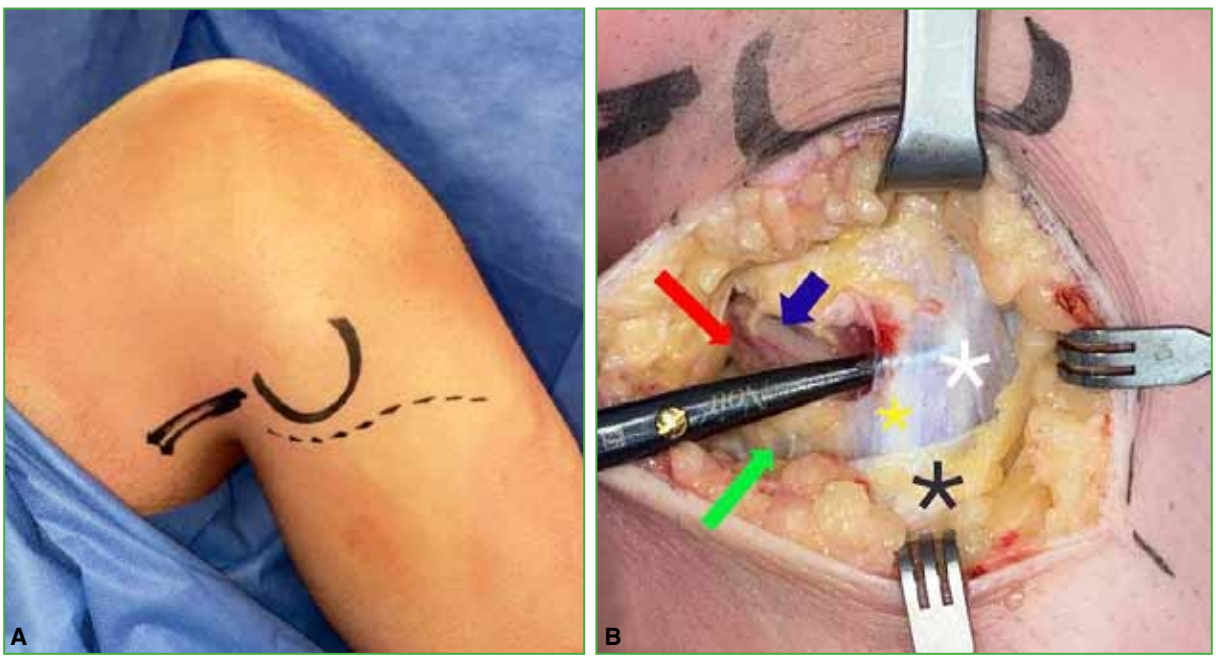

Figure. A. Preoperative skin marking of the surgical approach using the fibular head and nerve orientation as landmarks. **B.** Soleus muscle (red arrow), common peroneal nerve (blue arrow), anterior septum (green arrow), extensor digitorum longus (yellow asterisk), fibular muscles (white asterisk), anterior fascia (black asterisk).

Postoperative Protocol

Postoperatively, patients were discharged with the ankle and foot positioned at 90° in a protective orthosis (Walker boot). Due to the severity of the condition, many patients had already been advised to use the boot preoperatively to maintain appropriate ankle positioning. Although weight-bearing was not contraindicated, patients were instructed to keep the limb elevated during the initial postoperative days to reduce edema and promote healing. If edema was present, compression stockings were recommended. Physical therapy began five days postsurgery and followed a neuromuscular rehabilitation protocol focused on gait training, management of residual edema and scar tissue, maintenance of ankle range of motion, and strength recovery.

Motor and sensory recovery was evaluated monthly, beginning 30 days after surgery, and continued until full recovery or until the maximum available follow-up was reached. The AOFAS score was used to assess outcomes at the final follow-up.

All patients provided informed consent and agreed to participate in the study. This research was conducted in accordance with the Declaration of Helsinki.

RESULTS

Over a 10-year period (2013–2023), 16 decompression procedures of the CPN were performed. Eight patients met the inclusion criteria (2 women and 6 men). The mean time from diagnosis to surgery was 30 days. The average follow-up duration was 959 days. All patients recovered at least grade 4/5 dorsiflexion motor strength of the affected foot. Six of the eight patients recovered full motor strength and normal sensation. None experienced abrupt weight loss. No relevant medical history associated with the condition under study was reported, and none of the patients were smokers. Demographic data are detailed in Table 1.

Table 1. Demographic and preoperative data.

Patient	Age	Sex	Laterality	Smoker	Time from diagnosis to surgery (days)	Electromyogram	MRI	Sensitivity	TA	EHL	EDL	Fibularis	AOFAS Score
1	16	M	R	No	30	Positive	No findings	Total paresthesia	M0	M0	M0	M0	38
2	78	M	R	No	20	Positive	No findings	Hyperesthesia in the lateral aspect of the leg plus hypoesthesia in the dorsum of the foot.	M2	M0	M2	M2	24
3	78	F	L	No	15	Positive	No findings	Hypoesthesia in the dorsum of the foot	M0	M1	M2	M2	44
4	63	F	L	No	40	Positive	No findings	Hypoesthesia in the dorsum of the foot	M0	M0	M0	M0	24
5	60	M	R	No	35	Positive	No findings	Hypoesthesia in the dorsum of the foot	M2	M2	M1	M1	40
6	47	M	R	No	40	Positive	No findings	Hypoesthesia in the lateral aspect of the leg plus hypoesthesia in the dorsum of the foot.	M0	M2	M0	M2	24
7	41	M	R	No	40	Positive	No findings	Hypoesthesia in the lateral aspect of the leg plus hypoesthesia in the dorsum of the foot.	M1	M2	M1	M2	24
8	16	M	L	No	20	Positive	No findings	Hypoesthesia in the lateral aspect of the leg plus hypoesthesia in the dorsum of the foot.	M0	M0	M1	M1	24

M = male; F = female; R = right; L = left; MRI = magnetic resonance imaging; TA = tibialis anterior; EHL = extensor hallucis longus; EDL = extensor digitorum longus; AOFAS = *American Orthopaedic Foot and Ankle Society*.

There were no intraoperative or postoperative complications. In all cases, the nerve injury was classified as neurapraxia according to Seddon's classification,[15] with no evidence of axonotmesis or neurotmesis; all cases corresponded to Sunderland type I lesions.[16] All electromyographic studies demonstrated acute neurogenic compromise, with ongoing denervation activity, absence of reinnervation at the time of evaluation, and topography consistent with a lesion at the level of the CPN in the knee, showing conduction block. The mean AOFAS score was 30 prior to surgery (range, 24–44) and 97 at the end of follow-up (range, 93–100). Table 2 summarizes the results at the final follow-up.

Table 2. Postoperative evaluation

Patient	Intraoperative findings	Follow-up (days)	TA	EHL	EDL	Fibularis	AOFAS score
1	Negative	465	M5	M5	M5	M5	93
2	Negative	755	M4	M4	M4	M$	95
3	Negative	2550	M4	M5	M5	M5	93
4	Negative	435	M5	M5	M5	M5	100
5	Negative	395	M4	M4	M4	M4	100
6	Negative	1850	M5	M5	M5	M5	95
7	Negative	730	M5	M5	M5	M5	100
8	Negative	495	M5	M5	M5	M5	100

TA = tibialis anterior; EHL = extensor hallucis longus; EDL = extensor digitorum longus; AOFAS = American Orthopaedic Foot and Ankle Society.

DISCUSSION

We present a case series of early decompression of the CPN in patients with idiopathic and severe involvement. The mean time from diagnosis to surgical intervention was 30 days. Functional outcomes were favorable in all patients following CPN decompression. Our findings are comparable to those of the most significant published series to date, which included 14 patients diagnosed with severe idiopathic compression. Notably, that study was conducted and published in the field of Neurosurgery rather than Orthopedics.[13] Although it was a prospective study, one patient underwent surgery more than 100 days after diagnosis; in contrast, all patients in our series were operated on within the first month. That study concluded that earlier decompression is associated with better outcomes. Although the precise time frame for defining "early" decompression remains unclear, we believe that the success observed in our series is partly attributable to the short interval between diagnosis and surgery. There is currently no consensus on the ideal timing, and it would be ethically unfeasible to conduct a prospective trial involving a watch-and-wait strategy in patients with severe presentations to evaluate the differential response to decompression. Similarly, a control group was not feasible in our study, as we believe—based on theoretical and clinical grounds—that severe cases warrant prompt surgical intervention.

The fibers of the CPN originate from the L4–S1 spinal nerve roots and descend as part of the sciatic nerve before diverging into the fibular division. The nerve is particularly vulnerable to compression as it winds superficially around the fibular neck on the lateral aspect of the knee, where it is protected only by skin and subcutaneous adipose tissue.[17] The anatomical course of the CPN exhibits considerable variability. Although certain "safe zones" have been described, the high interindividual variation precludes the recommendation of standardized decompression approaches.

The most frequent sites of CPN compression include the intermuscular septum, the convergence of the proximal insertions of the soleus and fibularis longus muscles, the entrance of the fibrous tunnel, the fibrous band of the deep head of the fibularis longus, and the fascia of the fibular muscles.[18,19] Currently, PCN compression is considered a dynamic condition. Intraoperative pressure measurements have shown that nerve pressure progressively decreases as the most common sites of compression are sequentially released.[20]

The diagnosis of idiopathic compression of the CPN is not straightforward, and several aspects must be taken into account. The clinical presentation may initially resemble that of other conditions, such as chronic compartment syndrome. The etiology of clubfoot can be highly diverse. A thorough clinical examination and a detailed patient history are essential to determine the cause and, most importantly, to assess the likelihood of recovery without surgical decompression.

Patients presenting with acute, rapidly progressive CPN palsy and no early signs of motor recovery are candidates for nerve exploration and possible decompression.[21] In general, surgical decompression of lower limb nerves significantly improves patients' quality of life.[21] However, there are currently no prospective randomized studies available to establish standardized recommendations on the timing of nerve decompression.[11]

Once compression has been diagnosed, the tendency to prescribe a series of poorly standardized conservative treatments may hinder the patient's recovery. These may include activity modification, physiotherapy, stretching exercises, massage, nerve blocks, or iontophoresis. In severe cases, however, recovery is often incomplete.[20]

In 2023, Oosterbos et al.[22] conducted a survey and concluded that there are not only substantial differences in therapeutic approaches among physicians within the same specialty but also between different specialties trained to manage this condition and potentially perform surgery. Furthermore, no studies have evaluated the cost-effectiveness of non-invasive treatment compared to surgical management.

Another issue is the lack of standardization in the evaluation of outcomes after both surgical and conservative treatment. A systematic review of 31 articles published in 2023 found that only 83.9% reported motor strength outcomes, 38.7% reported sensory findings, 25.8% assessed pain, 12.9% used validated foot and ankle functional scores, 9.7% used electrodiagnostic studies, and only 3.2% included imaging results. In total, 29 different outcome measures were used.[23]

As described in our preoperative protocol, all patients underwent electromyography (EMG) as part of the diagnostic process. The sensitivity and specificity of EMG are generally high. However, as previously reported in the literature, the absence of abnormal findings in patients with severe symptoms—as in this series—is usually due to technical limitations, given that EMG is operator-dependent. For this reason, our protocol mandates that all studies be performed in our institution by the same experienced team of neurologists. Additionally, the absence of sensory findings on EMG should not preclude the decision to proceed with early decompression. In this patient group, early surgical intervention has been shown to yield better outcomes than conservative treatment.[19]

In 2013, Maalla et al.[19] reported that clinical outcomes were worse when surgery was delayed by more than 12 months. Similar results were seen in patients who presented with sensory symptoms and underwent surgery after more than 6 months. The authors also emphasized that advanced age should not be considered a contraindication to decompression. In our series, two patients were 78 years old.

The use of MRI for preoperative evaluation of the CPN has also been explored. While MRI has high specificity (>90%), its sensitivity barely exceeds 50%.[24] Certain advanced sequences, such as high-resolution MR neurography with intravenous contrast, are believed to provide more detailed information. Although the absence of imaging abnormalities does not preclude surgery (it simply classifies the case as idiopathic), we believe that imaging is important to rule out more serious secondary conditions, such as neoplastic lesions. The use of complementary studies, such as compartment pressure measurements to exclude other pathologies—such as chronic compartment syndrome—has also been debated.[10]

This study has several limitations. First, its retrospective design. Second, the absence of a control group, which is not feasible due to the small number of patients and ethical considerations. Third, the overall sample size is limited. However, considering the existing literature and the narrow focus on severe idiopathic compression, we believe this series is consistent with the rarity and specificity of the condition.

CONCLUSIONS

Early decompression of the common peroneal nerve is a safe procedure that should be considered in cases of severe idiopathic compression. This is a rare condition, and conservative treatment may delay decision-making and compromise prognosis. Orthopedic surgeons trained in peripheral nerve surgery should be familiar with this disease and able to manage it without referral. We believe it is important to establish standardized preoperative, intraoperative, and postoperative protocols to optimize outcomes.

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

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Tibial Stress Fractures: Specificity of Focal Tenderness to Palpation

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ABSTRACT

Introduction: Stress fractures are common among military recruits and athletes. When involving the leg, they are typically characterized by tenderness in the medial tibial region. The inconsistency and imprecision of previously described clinical examination maneuvers highlight the need for this study, which aims to evaluate the sensitivity and specificity of tibial palpatory pain patterns. **Materials and Methods:** A series of 19 patients presenting with 31 painful episodes in the leg between 2012 and 2014 was analyzed. Patients experiencing tibial pain during military training were included, while those with a history of trauma were excluded. A physical examination was performed, mapping painful tibial points using a grid divided into nine zones and classifying them into three patterns: vertical, transverse, and focal (single point). All patients underwent radiographic and scintigraphic imaging. **Results:** Of the total patients, 63% were women and 36.8% were men. A total of 31 lesions were identified (64.5% in women, 35.5% in men). Radiographs were negative in all cases, whereas scintigraphy confirmed 22 (71%) stress fractures and 9 (29%) cases of periostitis. The transverse and focal pain patterns were the most sensitive (40.91%). The focal pattern was observed in 29% of cases and was exclusively associated with stress fractures. **Conclusions:** Focal tenderness to palpation was present in 100% of cases with stress fractures, demonstrating its high specificity as a clinical sign. This finding highlights its diagnostic value in evaluating tibial stress fractures.

Keywords: Stress fractures; physical examination; tibial fractures; tibial stress.

Level of Evidence: IIIB

Fracturas de tibia por estrés: especificidad del signo de dolor puntual palpatorio

RESUMEN

Introducción: Las fracturas por estrés son comunes en reclutas y deportistas. Se caracterizan, en los casos que involucran a la pierna, por dolor en la región tibial medial. La inconsistencia e imprecisión de las maniobras semiológicas publicadas destaca la necesidad de este estudio, que busca evaluar la sensibilidad y especificidad de patrones dolorosos palpatorios en la tibia. **Materiales y Métodos:** Se presenta una serie de 19 pacientes con 31 cuadros dolorosos en la pierna, entre 2012 y 2014. Se incluyó a pacientes con dolor tibial durante el entrenamiento militar, y se excluyó a aquellos con antecedentes traumáticos. Se realizó un examen físico y se registraron los puntos dolorosos tibiales en una grilla con 9 zonas, estableciendo 3 patrones: vertical, transversal y único. A todos se les realizaron radiografías y centellografía. **Resultados:** El 63% eran mujeres y el 36,8%, hombres. Se identificaron 31 lesiones (64,5% en mujeres y 35,5% en hombres). Las radiografías fueron negativas, mientras que la centellografía mostró 22 (71%) fracturas por estrés y 9 (29%) periostitis. Los patrones transversal y único fueron los más sensibles (40,91%). El 29% de los casos tenía un patrón único, siempre asociado a fracturas. **Conclusiones:** El dolor puntual palpatorio como signo clínico estuvo asociado, en todos los casos, a fracturas por estrés, lo que demuestra su alta especificidad. Se destaca la importancia de este hallazgo en la evaluación diagnóstica de las fracturas por estrés.

Palabras clave: Fracturas por estrés; semiología; fracturas de tibia; estrés tibial.

Nivel de Evidencia: IIIB

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INTRODUCTION

Stress fracture, also known as fatigue or overuse fracture, was first described by Breithaupt[1] in 1855. Although rare, its prevalence has increased with the growth of impact sports and the intensification of training. These fractures typically occur in individuals who engage in or initiate high-impact activities without gradual progression or under inadequate conditions.

In the military field, stress fractures have a high incidence among newly recruited personnel,[1,2] often leading to prolonged periods of inactivity. The available literature indicates that physical maneuvers for diagnostic presumption are inconsistent and imprecise.

The aim of this study was to evaluate the sensitivity and specificity of palpatory pain patterns in the clinical diagnosis of stress fractures.

MATERIALS AND METHODS

This study presents a series of patients evaluated for painful leg syndromes at the health section of a recruitment center of the Argentine Army between February 2012 and December 2014. The sample consisted of 19 patients presenting with 31 episodes of acute leg pain.

The inclusion criteria were: patients in military service experiencing acute tibial pain, assessed in the health section. All underwent the same training regimen and were evaluated by the same specialist in Orthopedics and Traumatology. The exclusion criteria included any history of trauma, with or without clear signs of fracture on radiographic examination.

All patients underwent a thorough physical examination following this methodology: a complete anamnesis, evaluation of footwear, and assessment of associated lower limb deformities. Patients were asked to indicate the exact location of their pain, and a targeted palpation of the tibia was performed, documenting pain areas using a grid system consisting of three transverse and three vertical regions, establishing nine zones for pain localization (Figure 1).

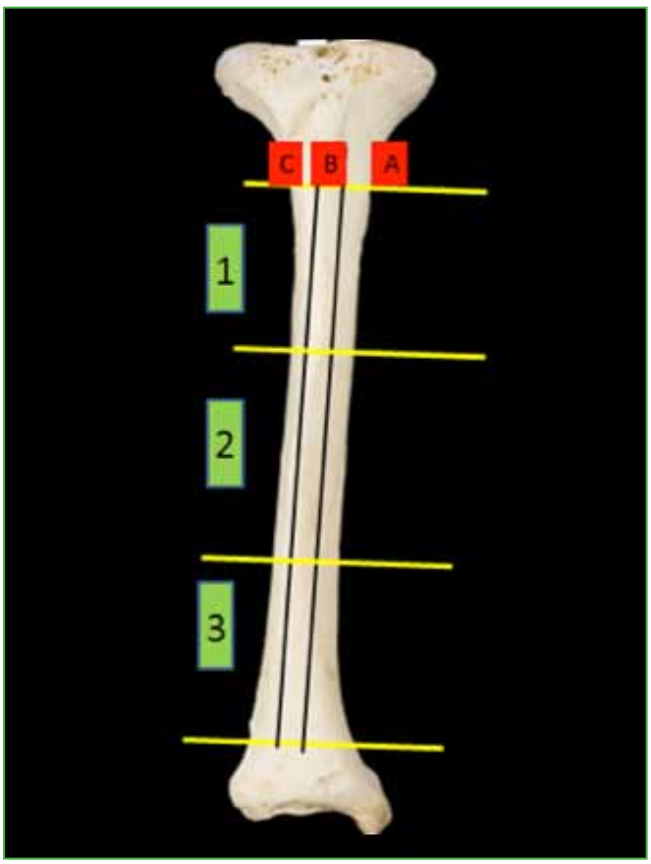

Figure 1. Grid used to locate areas and patterns of pain in the affected tibia.

The distribution of pain areas was analyzed, identifying three predominant patterns: vertical, transverse, and single (Figure 2). The transverse pattern was defined as pain affecting two or three contiguous zones in the horizontal plane. The vertical pattern was defined as pain affecting two or three zones in any of the grid columns. The single pattern was defined as pain localized to a single zone within the grid.

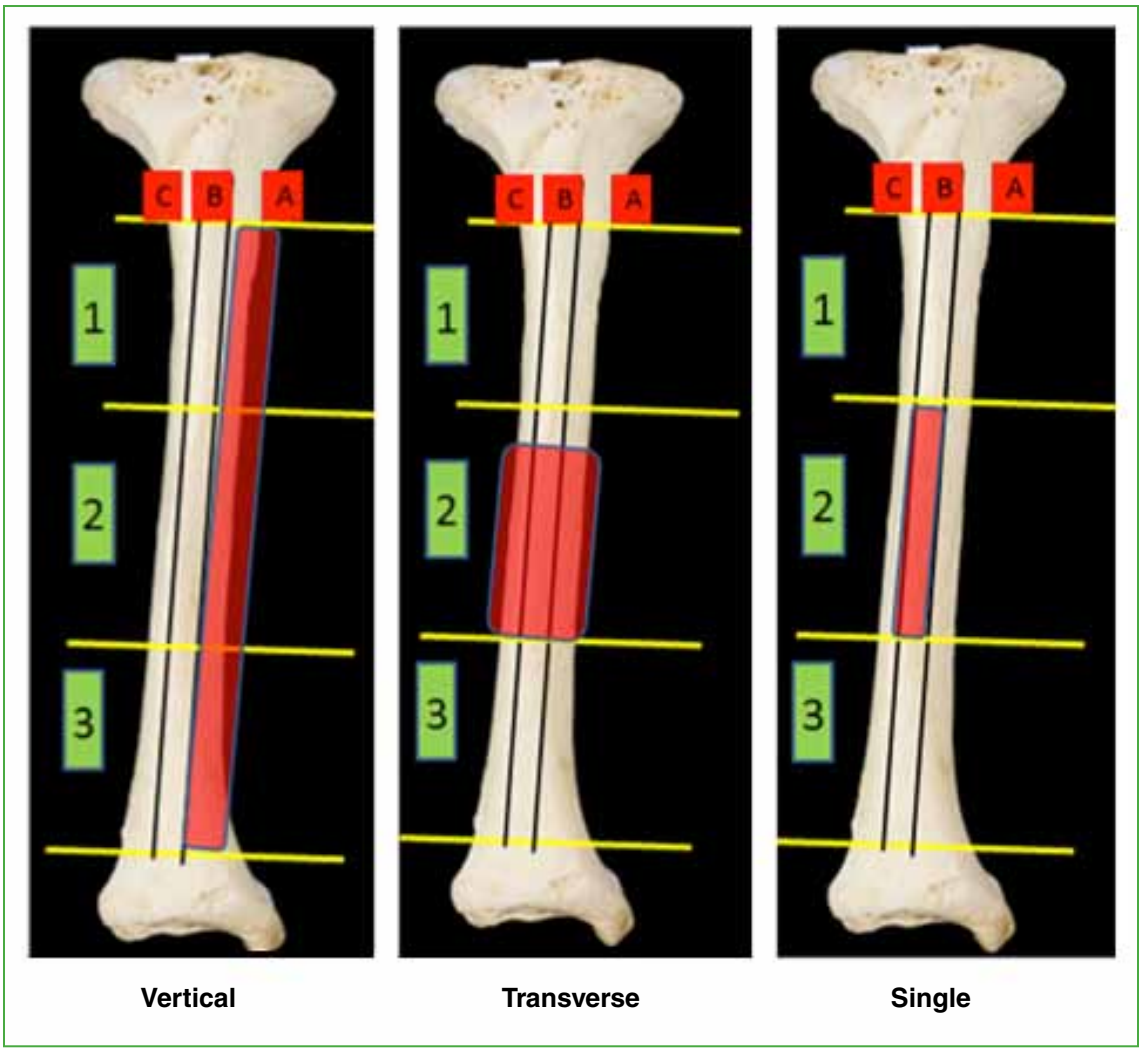

Figure 2. Pain patterns according to patient symptoms.

Initial complementary imaging included anteroposterior and lateral radiographs of the leg. Once other conditions, such as fractures or tumor lesions, were ruled out, a bone scintigraphy with Tc-99 was performed to confirm the diagnosis. The results were documented and later analyzed statistically, both manually and using the OpenEpi program. IRB approval was obtained for this study.

RESULTS

Twelve (63%) patients were female, and seven (36.8%) were male. A total of 31 lesions were identified: 20 (64.5%) in women and 11 (35.5%) in men. Pain was detected in 16 (51.6%) left legs and 15 (48.4%) right legs. All initial radiographic studies were negative. Diagnosis was confirmed by scintigraphy, identifying 22 (71%) cases of stress fractures and 9 (29%) cases of periostitis. Among the stress fracture cases, 63.8% were bilateral, while 80% of the periostitis cases also affected both legs.

Sensitivity

The transverse and single patterns were the most sensitive, with a sensitivity of 40.91% (95% confidence interval [95% CI]: 23.26–61.27). When considering only focal tenderness to palpation, sensitivity was 100%, as all patients tested positive for this maneuver, with no false-negative results.

When analyzing the test across all patterns, the diagnostic sensitivity was 70%, indicating that at least 7 out of 10 patients with tibial stress fractures would test positive in the physical maneuver (Table, Figure 3).

Table. Positive predictive value (PPV) of sensitivity, specificity and negative predictive value (NPV) according to pain pattern.

Pattern	Sensitivity	95%CI	Specificity	95%CI	PPV	95%CI	NPV	95%CI	Test accuracy	95%CI
Single	40.91	23.26-61.27	100	70-100	100	70-100	40.91	23.26-61.27	58.06	40.77-73.58
Transverse	40.91	23.26-61.28	33.33	12.01-64.68	60	35.75-80.18	18.65	6.59-43.01	38.64	23.73-56.18
Vertical	18.18	7.31-38.52	66.67	35.42-87.94	57.14	05.25-84.18	25	12-44.9	32.26	18.57-49.86

95%CI = 95% confidence interval.

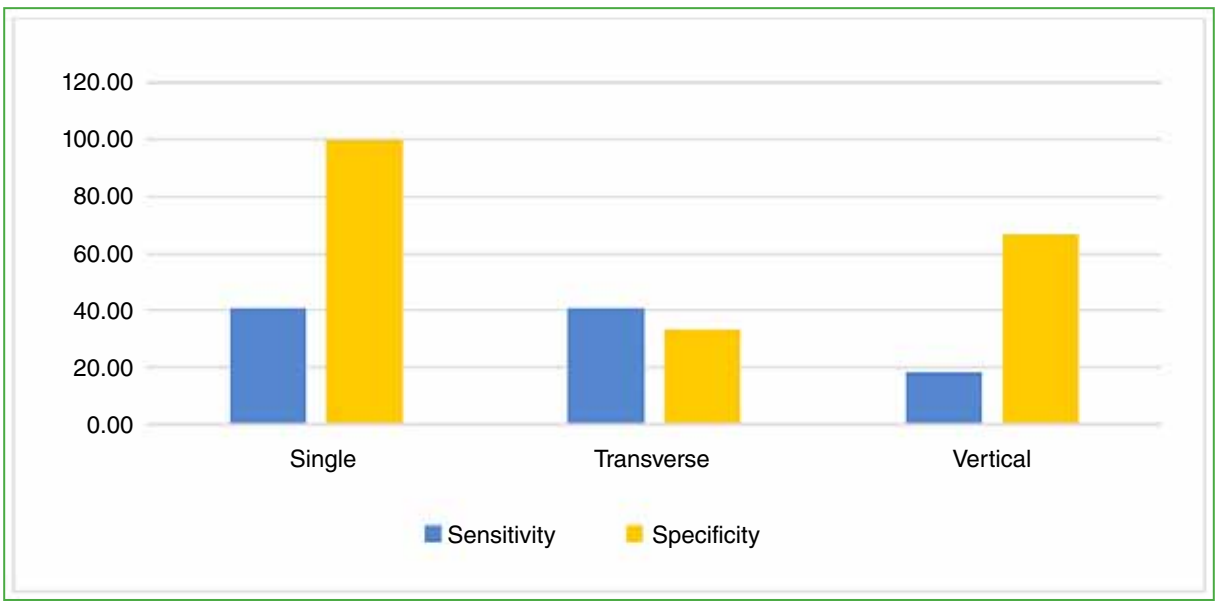

Figure 3. Comparison of sensitivity and specificity according to pain pattern.

Specificity

The single pattern was the most specific for stress fractures, with a specificity of 100% (95% CI: 70–100), as all patients exhibiting this pattern had stress fractures. The vertical pattern had a specificity of 66.67% (95% CI: 35.42–87.94), while the transverse pattern had a specificity of 33.33% (95% CI: 12.01–64.68).

This implies that the probability of a stress fracture in a patient with a negative test for the single pattern (i.e., no pain on palpation or compression in any part of the tibia) is close to 0%. However, a negative result in the other patterns does not rule out the condition; to definitively exclude a stress fracture, all patterns must yield negative results (Table, Figure 3).

Positive Predictive Value (PPV) and Negative Predictive Value (NPV)

The single pattern had a PPV of 100% (95% CI: 70–100) and an NPV of 40.91% (95% CI: 23.26–61.27), indicating that it is a strong predictor for diagnosing stress fractures. However, its absence does not provide a high degree of certainty that the patient does not have the condition.

The remaining patterns had PPVs close to 60%, with an overall PPV for the maneuver of 70.97% (95% CI: 53.41–83.9), representing a high predictive value (Table, Figure 4).

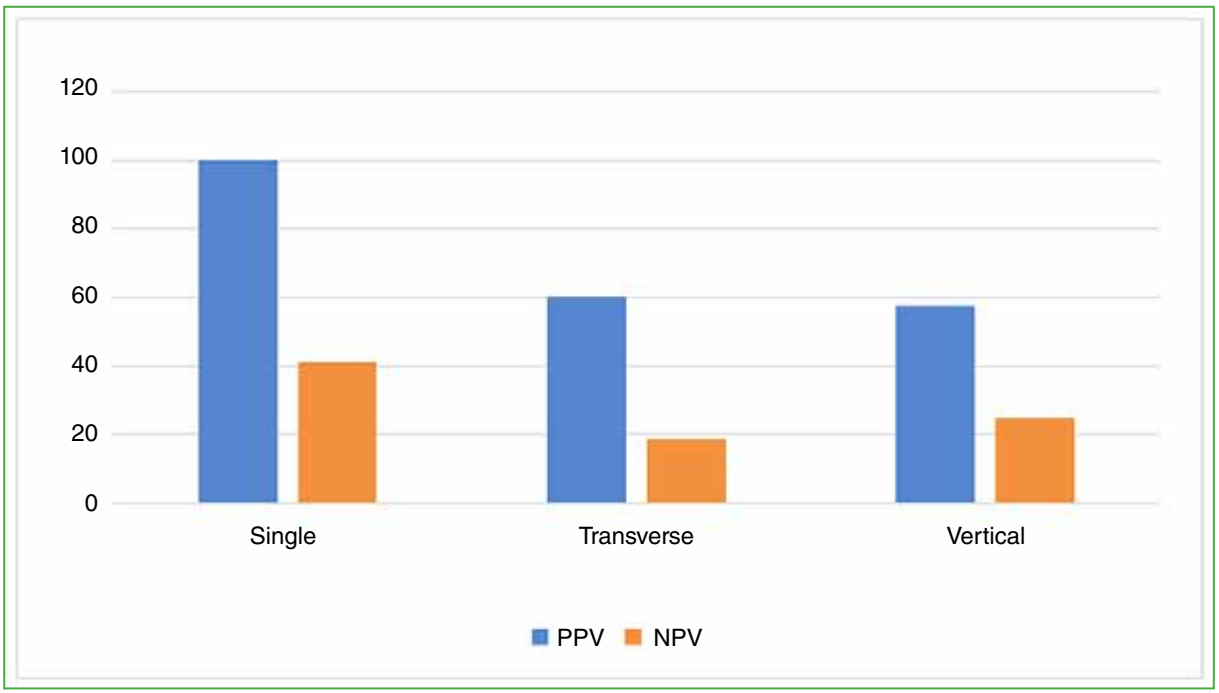

Figure 4. Positive and negative predictive values according to pain pattern.

Pattern Distribution

Seven cases (22.6%) presented with a vertical pain pattern, associated with 4 (12.9%) stress fractures and 3 (9.7%) periostitis cases confirmed by scintigraphy. Fifteen cases (48.4%) exhibited a transverse pain pattern, associated with 9 (29%) stress fractures and 6 (19.35%) periostitis cases. The single, focal palpatory pain pattern was found in 9 (29%) cases, always associated with stress fractures (Figure 5).

None of the periostitis cases confirmed by scintigraphy were associated with focal pain in a specific area of the grid or "one-finger pain."

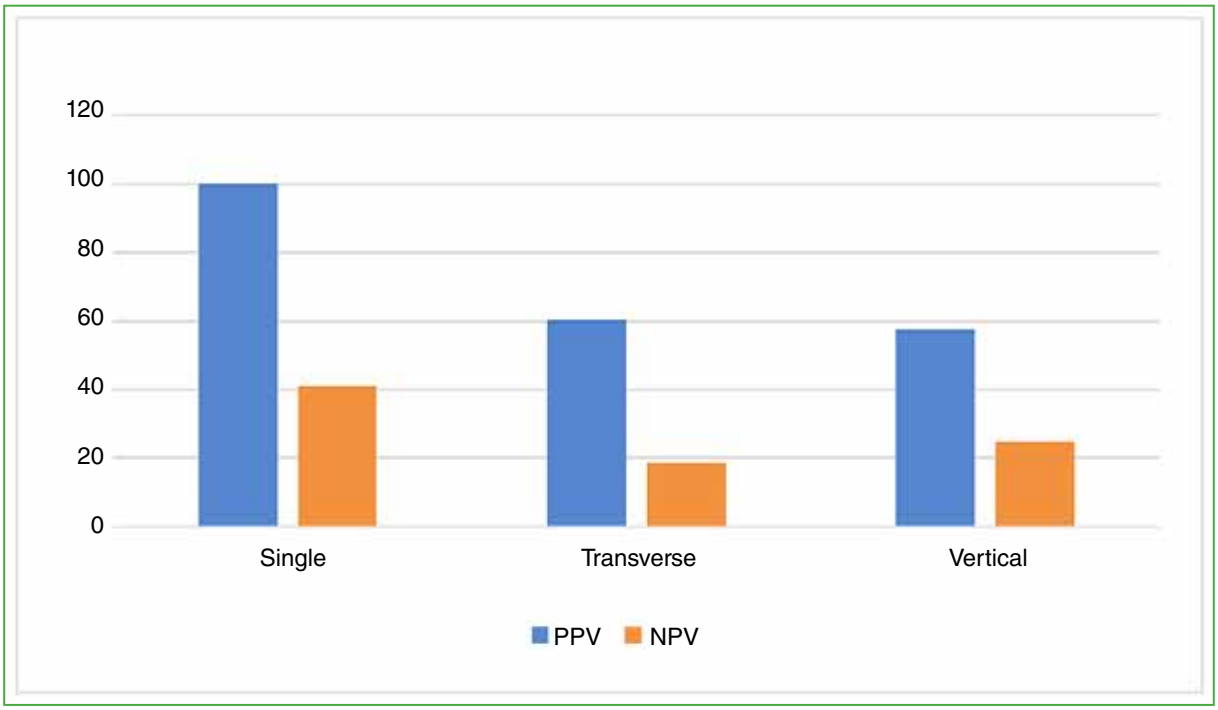

Figure 5. Number of patients according to pattern and condition.

DISCUSSION

It is well known that running promotes good health,[3] but under certain circumstances, it can predispose individuals to injuries,[3] particularly when running more than 65 km per week,[4] training on inadequate surfaces or footwear,[3,5,6] or abruptly increasing the intensity of training.

Leg pain syndromes are among these issues. The differential diagnoses of these conditions include tibial periostitis, stress fractures, painful myotendinous insertion syndromes, and chronic exertional compartment syndrome, among the most common.[4]

There are very few published studies on the clinical presentation of stress fractures, and those available are not highly specific. In general, they report only pain localized to the anteromedial aspect of the tibia.[7,8]

Periostitis is the most challenging condition to differentiate from stress fractures, as both share a sudden onset triggered by high-impact activities or sustained physical exertion over time, without a history of trauma. The underlying cause of periostitis is abnormal traction of the flexor digitorum longus and soleus muscles, which generates excessive stress on the medial tibial cortex. In contrast, stress fractures result from repetitive overload on bone tissue, surpassing its regenerative capacity. Cancellous bone is typically the first to be affected.[3] According to the literature, stress fractures are significantly more prevalent in females, with a reported 2:1 female-to-male ratio,[9,10] a finding that aligns with our study results.

Diagnosis

The diagnosis is initially clinical. The most common reason for consultation is nonspecific pain in the anterointernal aspect of the tibia. If the patient does not rest or continues engaging in high-impact activities, the symptoms progress. Initially, the pain is felt at the end of physical activity, but as the condition worsens, it persists throughout the activity and, in severe cases, continues even at rest.

Additionally, hormonal disorders, sleep deprivation, psychological stress, vitamin D deficiency,[11] and associated limb disease should be investigated, as they are linked to a higher incidence of stress fractures in recruits.[10] Progressive weight loss during training, with a decrease in tibial mineral mass but no loss in other locations, is considered another predisposing factor.[12]

Physical Examination

Currently, there are few descriptions of physical examination maneuvers for this condition and limited data on their validity. Different authors mention that pain, edema, or erythema may be present in the affected area.[3,7] Milgrom et al. base the differential diagnosis on palpation of the medial border of the tibia, establishing that pain localized within a longitudinal strip no greater than one-third of the tibia's length is suggestive of a stress fracture.[13] Thus, the presumptive diagnosis is based on physical examination and clinical history.[2,13]

Devas[14] describes edema (present in 16–44% of patients) and pain on ambulation (reported in 81% of patients) as signs of a stress fracture. All patients in our study experienced pain upon impact.

It is important to note that some authors consider localized pain a pathognomonic sign of stress fractures.[7,15-17] Their studies report that 65–100% of patients experienced pain, a finding that aligns with our results. However, these studies do not specify how the patient or examiner localizes the pain, nor do they evaluate the diagnostic value of this sign.

Authors such as Harrast et al. describe the "single hop test" as a diagnostic tool,[3] while Milgrom et al. combine it with the "fulcrum test," which elicits pain by applying tension to the affected bone surface.[13] However, these authors do not mention other maneuvers or signs, such as those assessed in our study. They do emphasize the importance of evaluating intrinsic predisposing factors, such as lower limb imbalances and muscle shortening.

Complementary Studies

The first step is always to request radiographs of the leg, including anteroposterior and lateral views, to rule out differential diagnoses such as fractures or tumors. However, stress fractures typically do not show radiographic findings until the tenth week.[15]

Once other conditions have been excluded, additional imaging studies with greater sensitivity and specificity should be performed to diagnose stress fractures. The most sensitive and specific modality is MRI (100% sensitivity and 85% specificity), compared to scintigraphy, which has a sensitivity of 74–100% but lower specificity. Despite this, both MRI and scintigraphy provide high diagnostic accuracy when combined with clinical examination.

MRI is preferable due to its higher sensitivity, its ability to differentiate stress fractures from other conditions, and its capacity to detect small or asymptomatic lesions.[8]

Tc-99 scintigraphy shows localized hyperenhancement in all three phases. During healing, the first phase normalizes first, but the later phases may take longer, making this modality unsuitable for monitoring disease progression. Scintigraphy should be used when a stress fracture is suspected, but it cannot reliably distinguish between a fracture and other conditions, such as infection or neoplasia.

Early recognition of a stress fracture should prompt evaluation of the contralateral limb, even if asymptomatic. Milgrom et al. reported that 60% of patients with a diagnosed stress fracture had asymptomatic contralateral fractures, suggesting that scintigraphy should be performed even in cases with positive radiographic findings to assess bilaterality.[18]

In our study, 63.8% of stress fractures were bilateral. However, unlike Milgrom et al.'s findings,[18] our patients were symptomatic. Additionally, 80% of cases of periostitis were bilateral.

CONCLUSIONS

Stress fractures and tibial periostitis often present with similar symptoms, and patient history frequently provides overlapping information, making differential diagnosis challenging. However, focal tenderness to palpation was consistently a specific clinical sign associated with stress fractures.

In our study, this clinical sign and the proposed palpation maneuver demonstrated high sensitivity and specificity. While a positive maneuver strongly indicates the presence of a stress fracture, we recommend confirming the diagnosis with MRI or bone scintigraphy for greater precision.

No published studies were found that evaluated both the sensitivity and specificity of commonly used physical maneuvers. A limitation of this study is the small sample size. We believe that further comparative, prospective, and randomized studies are necessary to confirm our findings and enhance the diagnostic accuracy of these conditions.

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

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Acute Lateral Ankle Instability: A Comparative Study of Minimally Invasive Surgical Treatment vs. Functional Treatment

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ABSTRACT

Introduction: Lateral ankle instability is a frequently underdiagnosed condition. The objective of this study was to evaluate two treatment approaches: functional and surgical. We hypothesized that ligament reconstruction using peripheral tissue promotes scar formation, stabilizing the joint and leading to better recovery outcomes compared to functional treatment. **Materials and Methods:** Between 2021 and 2023, 48 patients with lateral ankle instability were treated. Stress radiographs were performed by applying a varus force to the hindfoot while stabilizing the distal leg and comparing the affected ankle with the contralateral healthy ankle. Patients were divided into two groups according to the treatment received: Group A (minimally invasive surgical technique) and Group B (functional treatment). **Results:** The comparative results were as follows: Visual Analog Scale scores: Group A: 9.6, Group B: 7.26. American Orthopaedic Foot & Ankle Society (AOFAS) scores: Group A: 99.7, Group B: 85.3. Additional outcomes assessed included residual instability, time to return to previous activities, and complications. **Conclusions:** This study suggests that minimally invasive surgical treatment for lateral ankle instability is an effective option, providing faster recovery and better clinical outcomes compared to functional treatment, with a low complication rate.

Keywords: Lateral ankle instability; stress radiography; ankle sprain; functional treatment; surgical treatment.
Level of Evidence: IV

Inestabilidad lateral aguda de tobillo. Estudio comparativo entre el tratamiento quirúrgico mínimamente invasivo y el tratamiento funcional

RESUMEN

Introducción: La inestabilidad lateral de tobillo es una afección que, muchas veces, no se diagnostica. El objetivo de este estudio fue evaluar dos tipos de tratamiento (funcional y quirúrgico). Se plantea la hipótesis de que la plástica ligamentaria con tejido periférico genera una cicatriz que estabiliza la articulación y mejora la recuperación comparada con el tratamiento funcional. **Materiales y Métodos:** Entre 2021 y 2023, se trató a 48 pacientes con inestabilidad lateral de tobillo. Se tomaron radiografías en estrés ejerciendo varo del retropié y manteniendo firme la región distal de la pierna, y en forma comparativa con el tobillo sano. Se dividió a los pacientes en 2 grupos según el tratamiento recibido: grupo A: cirugía con técnica mínimamente invasiva; grupo B: tratamiento funcional. **Resultados:** Los resultados comparativos fueron: grupo A: 9,6 y grupo B: 7,26 en la escala analógica visual; grupo A: 99,7 y grupo B: 85,3, en la escala AOFAS. Otros resultados evaluados fueron: inestabilidad residual, tiempo hasta retornar a las actividades previas y complicaciones. **Conclusiones:** Se desprende de este estudio que la técnica quirúrgica mínimamente invasiva para el tratamiento de las inestabilidades laterales de tobillo es una buena opción, los pacientes tienen una evolución y una recuperación más rápidas que con el tratamiento funcional y la tasa de complicaciones es baja.

Palabras clave: Inestabilidad lateral de tobillo; radiografía en estrés; esguince de tobillo; tratamiento funcional; cirugía.
Nivel de Evidencia: IV

Received on September 18th, 2024. Accepted after evaluation on February 6th, 2025 • Dr. IGNACIO ARZAC ULLA • ignacioarzac@hotmail.com https://orcid.org/0000-0002-5038-7720

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INTRODUCTION

Ankle instability is defined as the inability to maintain the normal relationship between the bones that make up this joint, as well as the varus inclination of the talus with respect to the tibial plateau on stress radiographs.[1]

The literature regarding ankle sprains is controversial. Some authors report that they resolve with rest and rehabilitation without resulting in limiting sequelae, while others describe that more than 40% may develop recurrent functional or mechanical instability.[2,3]

Functional instability is defined as the subjective sensation of loss of ankle balance due to proprioceptive and neuromuscular deficits, resulting in decreased functional performance, pain, and edema. Mechanical instability is characterized by laxity of the ankle joint due to structural damage to the ligaments.[1]

Poorly treated acute sprains often lead to chronic ankle instability, which is characterized by repeated episodes of sprains or the perception of the ankle giving way; persistent but non-disabling pain; weakness; or reduced range of motion of the ankle joint.[4,5]

Hamilton[6] classifies lateral ankle sprains into three grades. Grade I is characterized by partial tear of the anterior talofibular ligament, an inconclusive anterior drawer test, and a negative talar tilt test. Grade II presents with complete tear of the anterior talofibular ligament, sprain of the calcaneofibular ligament, a positive anterior drawer test, and a normal talar tilt test. Grade III indicates complete tear of the three lateral ankle ligaments, a significantly positive anterior drawer test and talar tilt test, and ankle instability.

Between 10% and 70% of patients treated conservatively may progress to chronic instability.[7-10]

The most commonly used surgical procedure for ankle sprains with lateral instability is the Broström procedure. Described in 1966, it was designed to repair both the anterior talofibular ligament and the calcaneofibular ligament using an anatomical technique through a curved anterior approach to the lateral malleolus. The anterior talofibular and calcaneofibular ligaments are dissected from the remaining capsule and repaired in an end-to-end fashion.[2]

In 1980, Gould et al.[11] described a modification of the Broström technique in which the repair of the lateral ankle ligaments is reinforced by attaching the inferior extensor retinaculum to the periosteum of the distal fibula using sutures. This modification has been shown to increase the strength of the repair by 50%.

The hypothesis of this study is that ligamentoplasty with peripheral tissue generates a scar that stabilizes the joint and improves recovery compared to functional treatment.

The aim of the study was to compare two types of treatment (functional and surgical) for lateral ankle instability and to evaluate the mid-term clinical and functional outcomes.

MATERIALS AND METHODS

A prospective, correlational, quantitative (non-experimental), longitudinal cohort study was conducted. Between October 2021 and December 2023, 58 cases of lateral ankle instability were diagnosed.

Lateral ankle instability was defined as a talar tilt greater than 10° with respect to the tibial plateau, or more than 5° compared to the contralateral extremity on stress radiographs.[9]

Patients with ankle trauma were evaluated with conventional radiographs. Once fractures were ruled out, a clinical examination for lateral instability of the tibiotalar joint through varus stress was performed. When clinical suspicion arose, the diagnosis was confirmed with stress radiographs, taken with the patient fully relaxed and with no more than 10° of dorsiflexion to reduce tension on the calcaneofibular ligament. Rearfoot varus stress was applied while stabilizing the distal leg and comparing it to the contralateral, healthy ankle (Figure 1).

All stress radiographs were performed by a single traumatologist specializing in leg, ankle, and foot surgery. The X-ray equipment used was a Pimax model Micro HF 601-33.

Forty-eight patients were followed and thus included in the study; ten were excluded due to loss to follow-up.

Patients were divided into two groups based on the treatment they received, and the outcomes were then analyzed comparatively. Treatment selection was made by the patients after being informed of the advantages and disadvantages of each approach.

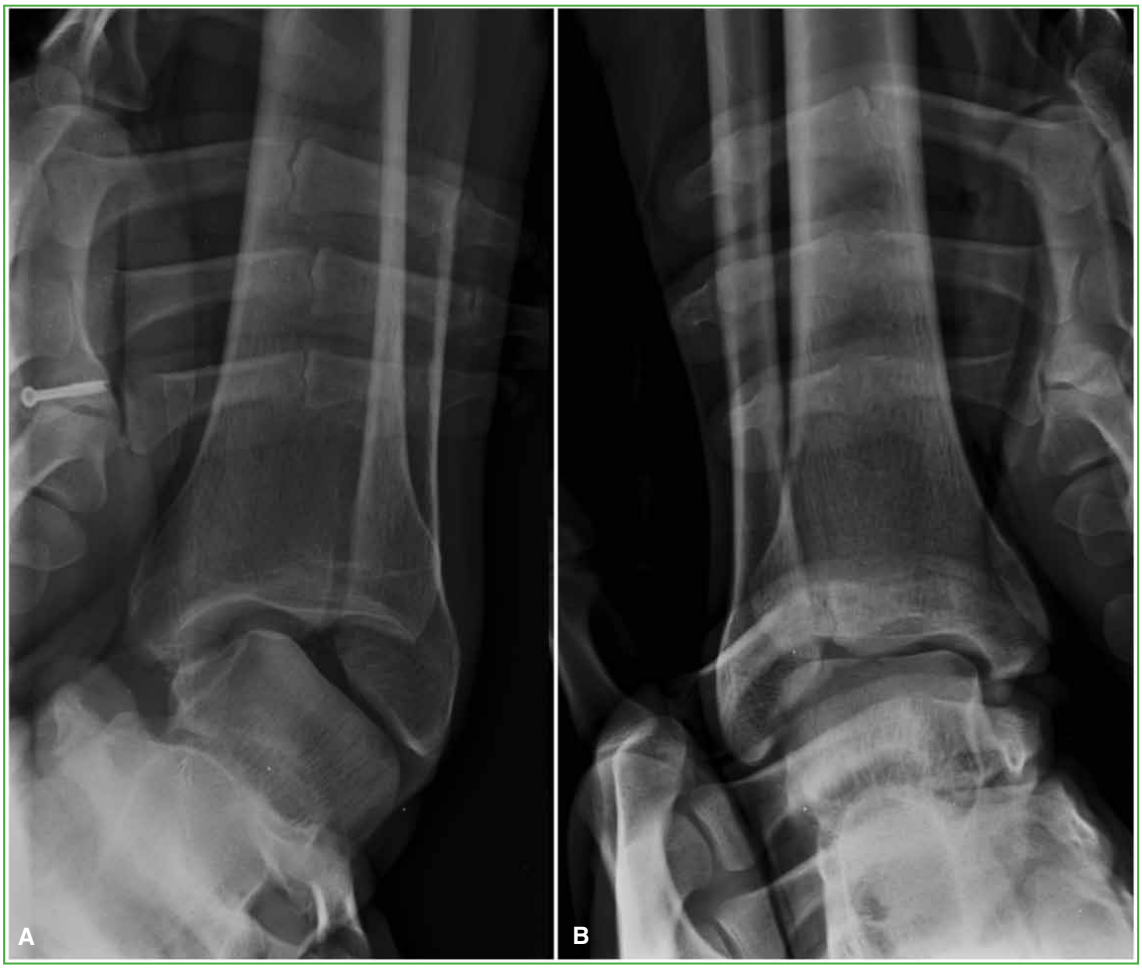

Figure 1. Stress ankle radiograph. **A.** Affected ankle. **B.** Healthy ankle.

Group A: 25 surgically treated patients. The procedure was performed with the patient in a supine position, slightly lateralized, to expose the lateral malleolus. Two small punctiform incisions were made over the distal region of the lateral malleolus (one anterodistal and the other directly over the tip of the fibula) to access and repair the lateral ligament complex of the ankle. Through these incisions, two 3.5 mm double-row suture anchors were inserted (one per incision). Using a curved needle, and avoiding the superficial peroneal nerve and peroneal tendons, the retinaculum was repaired by passing the sutures through the subcutaneous tissue.

The ankle was then placed in valgus, and the sutures were tied. Finally, dynamic maneuvers were performed and radiographic stability was verified (Figure 2, Video).

The postoperative protocol included immediate ankle mobilization and weight-bearing as tolerated, with a Walker boot, worn for 15 days.

Group B: 23 patients treated conservatively. This consisted of immobilization with a Walker plastic boot for 21 days, compressive bandaging, joint rest, and cryotherapy, followed by a rehabilitation and exercise program.

Weight-bearing was permitted from day 5 onward, according to tolerance, with the Walker boot.

Inclusion criteria were 1) acute ankle instability, 2) age >18 years and <60 years, 3) minimum follow-up of 18 months, and 4) surgical or conservative treatment of lateral ankle instability.

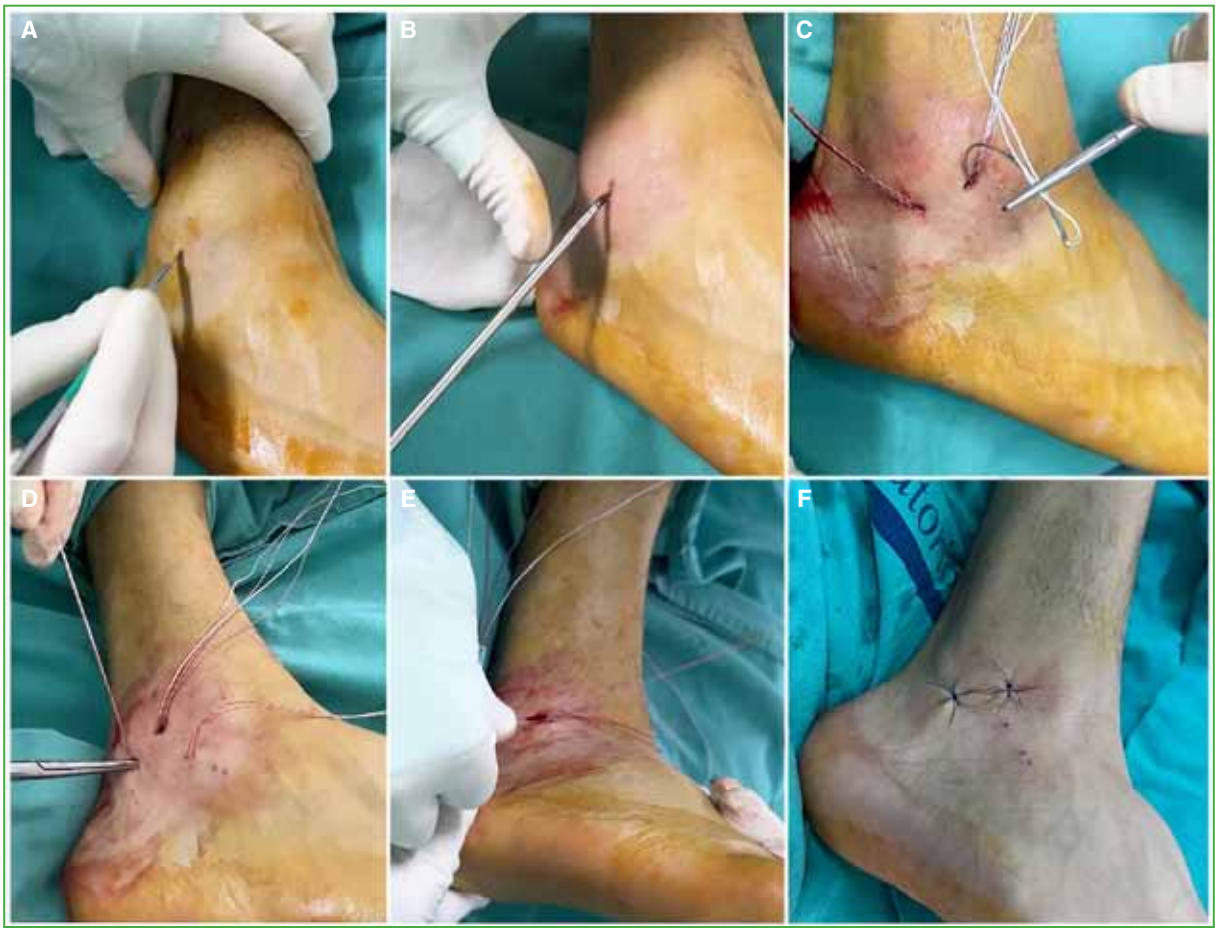

Figure 2. Description of the percutaneous surgical technique for the repair of lateral ankle instabilities. **A.** Incisions over the distal fibula. **B.** Placement of a 3.5 mm harpoon. **C.** Suture passage through the inferior extensor retinaculum. **D.** Using a hemostatic forceps, the thread is retrieved after passing through the inferior extensor retinaculum in the subcutaneous tissue. **E.** Sutures are tied with the ankle in slight valgus. **F.** Images of the incision sites at the end of surgery.

Exclusion criteria were 1) instability treated after 15 days of injury, 2) syndesmotic sprains, 3) associated ankle fractures, 4) prior surgical treatment for ankle instability, 5) loss to follow-up, and 6) local or systemic therapies potentially affecting tendon strength (e.g., local anesthetic or corticosteroid injections in the region, immunosuppressive treatment in transplant or autoimmune patients).

To assess repair of the lateral ligament complex, a stress radiograph was obtained six months after surgery (Figure 3). For clinical-functional evaluation, the AOFAS scale (American Orthopaedic Foot and Ankle Score) and the Visual Analog Scale (VAS) were used.

Follow-up continued until 18 months after the traumatic event.

The AOFAS scale assigns up to 50 points for function, 40 points for pain, and 10 points for alignment. A perfect score of 100 indicates the patient has no pain, full ankle and hindfoot range of motion, no instability, proper alignment, ability to walk more than 6 blocks (600 m) on any surface, no limp, no limitations in daily or recreational activities, and no need for assistive devices.[12]

The following parameters were evaluated in both groups: a) mechanism of injury, b) history of prior sprains, c) body mass index, d) Visual Analog Scale (VAS) score, e) AOFAS score, f) residual instability, g) time to return to previous activities, and h) complications.

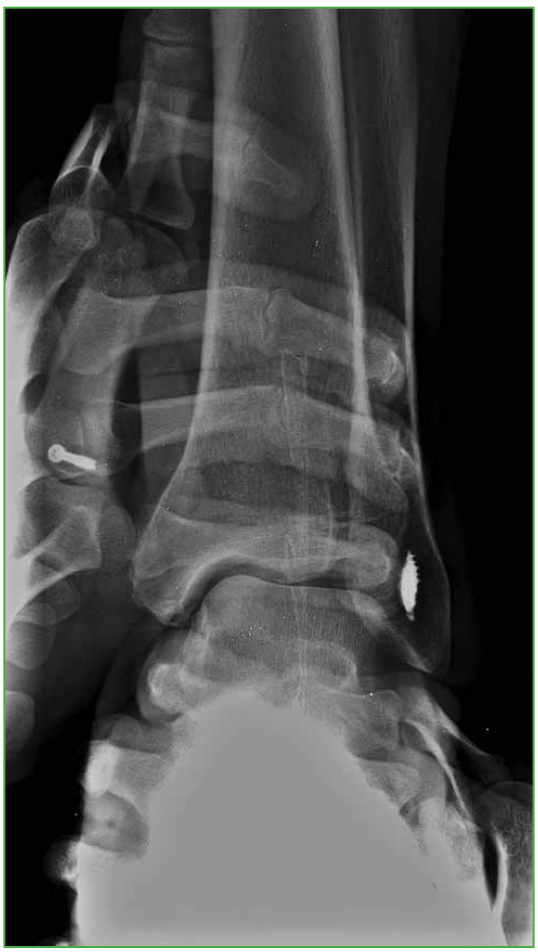

Figure 3. Stress radiograph of the ankle, six months postoperatively.

Statistical Analysis

Statistical analysis was based on group comparisons using the Student's t-test for samples with equal or unequal variances, as appropriate, and by analyzing proportions and percentages. A p-value <0.05 was considered statistically significant. For qualitative variables, unpaired sample analysis was used.

To assess the association between the type of treatment (surgical vs. conservative) and the occurrence of complications, the χ^2 test was applied. The calculated χ^2 value was 13.13, and the p-value obtained was <0.05 (p = 0.0003). Since the p-value was significantly lower than the pre-specified significance level of 0.05, the null hypothesis was rejected. This indicates a statistically significant association between the type of treatment and the incidence of complications (Tables 1 and 2).

Table 1. Statistical analysis.

Classification	Variable	Group 1	Group 2	n (1)	n (2)
Treatment	AOFAS score	Non-operated	Operated	23	25

Student's t-test - AOFAS
Independent samples t-test. Bilateral test

Classification	VAR (1)	VAR (2)	pHom VAR	T	gl	P value
Treatment	1.38	0,04	<0.0001	-4.67	23	0.0001

Classification	Mean (1)	Mean (2)	Mean (1)	Mean (2)	LL (95)	UL (95)
Treatment	85.30	99.72		-14.42	-20.81	-8.02

Classification	Variable	Group 1	Group 2	n (1)	n (2)
Treatment	VAS	Non-operated	Operated	23	25

Student's t-test – Visual analog scale
Independent samples t-test. Bilateral test

Classification	VAR (1)	VAR (2)	pHom VAR	T	gl	p
Treatment	5.02	0.83	<0.0001	-4.66	20	0.0001

Classification	Mean (1)	Mean (2)	Mean (1)	Mean (2)	LL (95)	UL (95)
Treatment	7.26	9.60		-2.34	-3.36	-1.31

Student's t-test – Return to previous activities
Independent samples t-test. Bilateral test

Classification	Variable		Group 1	Group 2	n (1)	n (2)
Treatment	Return to previous activities		Non-operated	Operated	23	25
Classification	VAR (1)	VAR (2)	pHom VAR	T	gl	p
Treatment	1,38	0.04	<0.0001	3.14	23	0.0046
Classification	Mean (1)	Mean (2)	Mean (1)	Mean (2)	LL (95)	UL (95)
Treatment	2.74	1.96		0.78	0.27	1.29

Table 2. Comparison of groups A and B

	Group A	Group B	p
Body mass index	26.33	26.18	>0.05
Previous sprains	1.44	1.39	0.9264
VAS	9.6	7.26	>0.05
AOFAS	99.72	85.30	>0.05
Return to work (months)	1.96	2.74	>0.05
Residual instability	0	8 patients	>0.05
Complications	2 patients	13 patients	>0.05

VAS = visual analog scale; AOFAS = *American Orthopaedic Foot and Ankle Score.*

RESULTS

Description of the groups

Group A: 25 patients (13 male, 12 female). The mean age was 30.92 years (range: 15–52). Right ankle involvement occurred in 15 patients, and left ankle involvement in 10. Mechanisms of injury included sports activity (14 cases, 56%), fall from height (6 cases, 24%), going up or down stairs (4 cases, 16%), and motorcycle accident (1 case, 4%). All patients underwent minimally invasive surgery.

Group B: 23 patients (12 male, 13 female). The mean age was 31.34 years (range: 15–49). Right ankle involvement occurred in 10 patients, and left ankle involvement in 13. Mechanisms of injury included physical activity (14 cases, 61%), fall from standing height (7 cases, 30%), and fall down stairs (2 cases, 9%). All patients received conservative treatment.

Comparison between both groups (Table 3)

- Previous sprains: Group A: 1.44 (range: 0–6); Group B: 1.39 (range: 0–7)
- Body mass index: Group A: 26.33 (range: 20.8–34.5); Group B: 26.18 (range: 21.5–39.2)
- Visual analog scale: Group A: 9.6 (range: 7–10); Group B: 7.26 (range: 2–10)
- AOFAS score at 6 months: Group A: 99.74 (range: 98–100); Group B: 85.30 (range: 60–100)
- Residual instability: 0 patients in Group A; 8 patients in Group B
- Return to previous activities: Group A: 1.96 months (range: 1–2); Group B: 2.73 months (range: 1–4)
- Complications: Group A: 2 patients developed infections.

Table 3. Contingency tables. Statistical analysis

Absolute frequencies
In columns: TREATMENT

Post-surgical complications	Non-operated	Operated	Total
No	10	23	33
Sí	13	2	15
Total	23	25	48

Statistic	Value	gl	p
χ^2 Pearson	13.13	1	0.0003
χ^2 MV-G2	14.19	1	0.0002
Irwin - Fisher bilateral	-0.56		0.0004
Cramer's contingency coefficient	0.37		
Kappa (Cohen)	-0.48		
Pearson's contingency coefficient	0.46		
Phi Coefficient	-0.52		

Odds ratio

Statistic	Estim.	LL 95%	UL 95%
Odds ratio 1/2	0.07	0.01	0.31
Odds ratio 2/1	14.95	3.23	69.26

One was superficial and managed with oral antibiotics. The other presented with serosanguineous drainage two months post-surgery, requiring culture and targeted antibiotic therapy. Both cases resolved successfully.

Group B: 7 patients reported persistent instability, 3 experienced recurrent sprains, 3 had joint pain and locking, and 2 reported ankle stiffness.

The type of treatment significantly affected the incidence of complications. These findings suggest that conservative treatment increases the risk of complications and should be carefully considered when determining the optimal clinical management of lateral ankle instability. Surgical intervention is recommended.

DISCUSSION

Currently, ankle instabilities often go undiagnosed or are diagnosed late.

Traumatologists generally request static imaging studies—such as radiographs, MRI, or CT scans—to look for fractures or bone lesions, while frequently omitting dynamic studies, such as stress radiographs, which are more effective in revealing ligamentous imbalances.

The clinical assessment of ankle instability is based on two tests: the anterior drawer test and the forced varus test. The anterior drawer test remains controversial and is considered to have limited diagnostic value, including in its radiographic reproduction.[1,13]

Kim et al.[14] concluded that muscle contracture can reduce stress radiographic measurements and result in false-negative outcomes.

When ligamentous instability is suspected and the patient cannot tolerate radiographic maneuvers, an anesthetic infiltration can be performed prior to the stress radiograph, or the test can be conducted in the operating room under sedation.

Sarcon et al.[15] recommend the use of semi-rigid orthoses, which provide both proprioceptive feedback and mechanical stability.

Initial rest reduces the metabolic demand at the injured site. The application of mild tension to the joint appears to facilitate the proper alignment of ligament fibers.

Cryotherapy also helps decrease metabolic demand, vasodilation, and nerve conduction velocity, thereby increasing the pain threshold.

Research studies, such as that of Hao et al.[16] —a meta-analysis of prospective studies comparing surgical and functional treatment for ankle sprains involving 1,268 patients (580 surgically treated and 688 treated functionally)—showed better outcomes for ankle stability in the surgically treated group.

In our series, although the number of patients was smaller, we also obtained better results in the surgically treated patients.

According to the literature, surgical morbidity associated with older techniques has maintained functional treatment as the first-line therapy for acute ankle sprains.[16] However, in our study, better outcomes were observed in the group treated with percutaneous surgery. This technique minimizes complications and enables patients to return to normal activities more quickly than with conservative treatment, thereby avoiding long-term sequelae.

Doherty et al.[17] conducted a prospective study on patients with ankle sprains and found that 40% developed chronic instability at 12-month follow-up.

In our study, 13 patients who received conservative treatment evolved with sequelae, whereas no sequelae were observed in the group that underwent surgery.

Cao et al.[18] reported an AOFAS score of 93.7 in patients treated with a percutaneous technique using the inferior extensor retinaculum. In our series, which also employed a percutaneous surgical technique, the AOFAS score reached 99.7.

Their postoperative protocol included a cast boot for three weeks followed by weight-bearing. In contrast, we allowed immediate weight-bearing, protected with a Walker boot, which was removed 15 days after surgery.

The number of complications in the surgically treated group was low, consistent with findings in the literature.[19]

The limitations of this study include the small sample size, which affected our ability to stratify the results, and the lack of randomization.

Among its strengths are the novelty of the topic, the contribution of a percutaneous surgical technique for this type of lesion, and the medium-term follow-up.

We are currently developing a new classification system for lateral ankle instabilities—*Hourly Classification*—which will provide a simple treatment framework without requiring angular measurements.

CONCLUSIONS

The originality of this proposal lies in its challenge to the current model of diagnosing and treating lateral ankle sprains/instabilities.

Stress radiographs are valuable tools for assessing this condition. Patients treated with the minimally invasive technique showed better outcomes and faster recovery.

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

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Insertional Achilles Tendinopathy: Surgical Treatment with Double-Row Suture Anchors. Case Series

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ABSTRACT

Introduction: Insertional Achilles tendinopathy (IAT) that fails to improve with conservative management often requires surgical intervention. One surgical approach consists of resecting the retrocalcaneal exostosis, debriding intratendinous calcifications, and reattaching the Achilles tendon. The use of a double-row suture anchor system has been proposed to increase the tendon–bone contact area at the insertion site and enhance biomechanical stability. The purpose of this study is to report the clinical and functional outcomes of patients treated with this technique. **Materials and Methods:** A retrospective study was conducted on consecutive adult patients who underwent surgical treatment for IAT using a double-row suture anchor system. Demographic data, time to return to work and sports, visual analog scale (VAS) scores, patient satisfaction, and complications were recorded. **Results:** Twenty-one patients were included, with a mean age of 55 years (range, 45–63). Of these, 76.14% reported being very satisfied with the outcome. The average time to return to daily activities was 2.96 months, and the time to return to sports was 5 months. The mean VAS score decreased from 9.26 preoperatively to 2.5 postoperatively ($p < 0.05$). **Conclusion:** Surgical treatment of insertional Achilles tendinopathy with a double-row suture anchor technique is an effective option. It is associated with high patient satisfaction, early return to daily activities, full return to sports, and a low complication rate.

Keywords: Insertional Achilles tendinopathy; Haglund deformity; Achilles tendon reattachment; double-row suture anchors; SpeedBridge™.

Level of Evidence: IV

Tendinopatía insercional del tendón de Aquiles: tratamiento quirúrgico con anclajes en doble hilera. Serie de casos

RESUMEN

Introducción: La tendinopatía insercional del tendón de Aquiles que no mejora con un tratamiento conservador requiere cirugía. Uno de los tratamientos quirúrgicos es la resección de la exostosis retrocalcánea, el desbridamiento de las calcificaciones intratendinosas y la reinserción del tendón de Aquiles. Para ello, hay un sistema de anclajes de doble hilera que permitiría una mayor área de contacto con el área de inserción y generaría más estabilidad biomecánica. El propósito de este artículo es comunicar los resultados clínicos y funcionales en pacientes operados con esta técnica. **Materiales y Métodos:** Se realizó un estudio retrospectivo en pacientes adultos consecutivos operados por tendinopatía insercional del tendón de Aquiles mediante un sistema de anclajes de doble hilera. Se registraron los datos demográficos, el tiempo hasta el retorno al trabajo y al deporte, el puntaje de la escala analógica visual, el nivel de satisfacción y las complicaciones. **Resultados:** Se incluyó a 21 pacientes (edad media 55 años; rango 45-63). El 76,14% estaba muy satisfecho. El tiempo medio hasta el retorno a las actividades habituales fue de 2.96 meses y hasta el retorno al deporte, de 5 meses. El puntaje de la escala analógica visual fue de 9,26 antes de la cirugía y de 2,5 después ($p <0,05$). **Conclusiones:** El tratamiento con anclaje de doble hilera para la tendinopatía insercional del tendón de Aquiles es una opción eficaz, permite un retorno temprano a las actividades habituales y el retorno completo al deporte. Las complicaciones son limitadas y el nivel de satisfacción es alto.

Palabras clave: Tendinopatía insercional del tendón de Aquiles; Haglund; reinserción; doble hilera; SpeedBridge™.

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INTRODUCTION

Between 2% and 6% of the population will experience some form of Achilles tendon pain during their lifetime.[1,2] One third of these patients will suffer from insertional Achilles tendinopathy (IAT).[3,4] IAT is commonly diagnosed in competitive or recreational athletes but can affect people of all activity levels, with the most common age of presentation being in the 40s.[5,6]

IAT includes three entities that can appear either in isolation or simultaneously: insertional tendinosis of the Achilles tendon with intratendinous calcifications, retrocalcaneal bursitis, and exostosis of the posterior calcaneal tuberosity, also known as Haglund's deformity.[7,8] When these conditions occur together, they are referred to as "Haglund's triad" or "Haglund's syndrome," in recognition of Patrick Haglund, who first described the condition in 1928.[9]

Clinically, it presents with pain and a palpable prominence in the posterolateral region of the heel, accompanied by localized erythema and edema that limits both work and sports activities and causes discomfort with footwear.[8-10]

The initial treatment of choice is conservative and may include non-steroidal anti-inflammatory drugs (NSAIDs), activity and footwear modification, orthoses, immobilization, eccentric exercises, extracorporeal shockwave therapy, nitroglycerin patches, corticosteroid infiltrations, or sclerosing agents.[11-13] Even when appropriately applied, this type of treatment has a reported success rate of less than 50%.[14] After six months of failed conservative treatment, surgical intervention is indicated.[1,2,5,6,10-15]

The surgical procedure consists of resection of the retrocalcaneal exostosis, excision of the bursa, debridement of the diseased tendon and intratendinous calcifications, and reattachment of the Achilles tendon to the calcaneus.[1,2,5,8] This can be achieved through various approaches, including open, endoscopic, and percutaneous. The endoscopic and percutaneous techniques allow for decompression of the retrocalcaneal space; however, they present challenges in adequately debriding degenerative tissue and intratendinous calcifications.[1,2,13] The open approach allows for complete access to the triad due to greater exposure and can be performed through a posterolateral, posteromedial, or central incision.[3] Debridement of the Achilles tendon may involve a partial, complete, or central split of the tendon. It has been shown that the risk of postoperative tendon tear is lower if less than 50% of the tendon is detached. If more than 50% of the tendon must be detached, reinsertion with suture anchors is necessary.[15] Compared to a single-row anchor technique, a double-row configuration provides a larger contact area at the insertion site and greater biomechanical stability, allowing for earlier rehabilitation and reduced immobilization and non-weight-bearing time.[12,13,15]

The purpose of this study was to evaluate the clinical and functional outcomes in patients diagnosed with IAT who underwent surgery in our department using an open approach with tendon detachment, resection of the retrocalcaneal exostosis, excision of the bursa, debridement of the diseased tendon and intratendinous calcifications, and reinsertion of the Achilles tendon to the calcaneus using a double-row anchor system.

MATERIALS AND METHODS

An observational, retrospective, descriptive case series study was conducted. The population consisted of consecutive adult male and female patients operated on by the same team from the Sector of Ankle and Foot Medicine and Surgery, treated for TIA using the Achilles SpeedBridge™ Repair double-row anchor system (Arthrex Inc., FL, USA) between March 2015 and March 2021.

Data were obtained systematically from the patients' digital medical records during preoperative and postoperative consultations and were supplemented by a personal patient questionnaire. Data collection and measurements were performed by a fellow and a junior surgeon from the team, who did not participate as surgeons in these procedures.

This research received prior approval from the institution's Ethics Committee and complies with the regulations of the Declaration of Helsinki and Good Clinical Practices. Data confidentiality is guaranteed in accordance with the Personal Data Protection Law No. 25,326.

Patients over 18 years old with a diagnosis of TIA with Haglund's triad, who had failed conservative treatment—including footwear adaptations, orthoses, physical therapy, posterior muscle chain elongation exercises, and oral non-steroidal anti-inflammatory drugs—for a minimum of 6 months, and who had a minimum postoperative follow-up of 12 months, were included.

Patients were excluded if they required associated procedures such as flexor hallucis longus muscle transfer, Achilles tendon lengthening or V-Y advancement, or had traumatic tendon disinsertion, previous Achilles tendon surgery, or incomplete electronic medical records.

The variables recorded were: sex and age, affected side, duration in months from symptom onset to surgery, and comorbidities such as diabetes, smoking, obesity, overweight, and dyslipidemia. Body mass index (BMI) was also recorded and used as an indicator of nutritional status, classifying patients as underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), or obese (≥30).

The visual analog scale (VAS) was used to assess pain intensity before and after surgery. This scale consists of a 10-cm horizontal line, with endpoints representing no pain (0) and maximum pain intensity (10). Patients marked the perceived pain intensity, which was then measured with a millimeter ruler and classified as mild (<3), moderate (4–7), or severe (≥8).

In addition, postoperative satisfaction was assessed through a subjective survey in which patients rated the clinical and functional outcomes as "very good" (favorable evolution without pain or discomfort), "good" (satisfaction with mild discomfort and no difficulty walking), "moderate" (moderate pain with some difficulty walking), or "poor" (persistent pain, little improvement, and regret undergoing this technique).

Post-surgical complications were also recorded, including superficial or deep infections, pain, wound dehiscence, nerve or vascular injuries, tendon disinsertion, and limited range of motion. The severity of complications was assessed using the Clavien-Dindo classification modified for foot and ankle surgery.[16]

Surgical Technique

The patient is placed in the prone position with both legs on the operating table, and regional anesthesia is administered. A hemostatic cuff is placed on the thigh. An inverted T-approach to the Achilles tendon is performed, releasing the diseased insertion of the tendon, and, if necessary, it is completely detached.

The retrocalcaneal bursa is resected, the diseased portion of the tendon is debrided, and Haglund's deformity is resected using an oscillating saw (Figure 1). The healthy remnant of the Achilles tendon is then reinserted at the insertion site using the Achilles SpeedBridge™ double-row suture system. Finally, layered closure is performed (Figures 2 and 3).

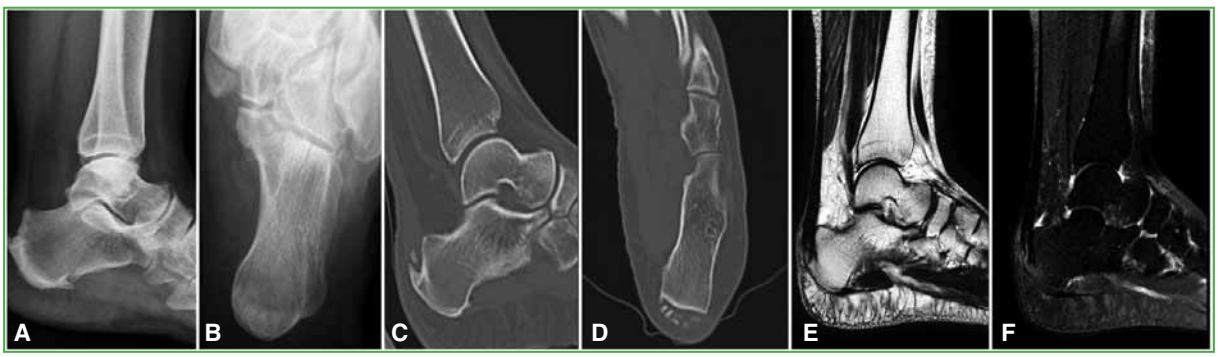

Figure 1. A and B. Preoperative radiographs of the calcaneus, lateral and axial views. **C and D.** Preoperative computed tomography of the calcaneus, sagittal and axial slices. **E and F.** Preoperative MRI of the calcaneus, sagittal T1 and T2 slices.

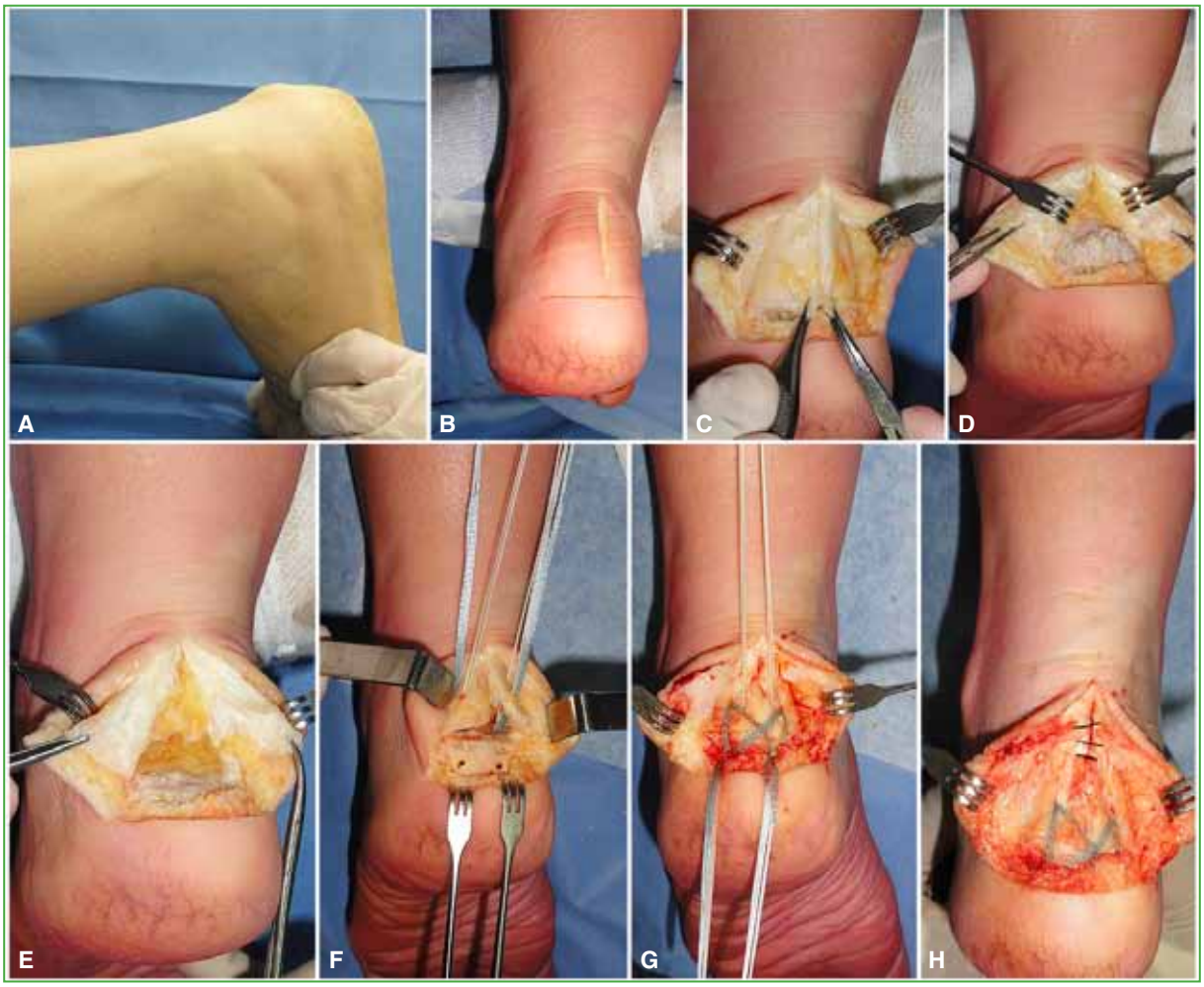

Figure 2. Surgical technique. **A**. Exostosis at the insertion of the Achilles tendon. **B-D.** Inverted "T" approach for visualization of the prominence at the posterosuperior border of the calcaneus. **E.** Image after resection. **F.** Placement of the first row of anchors. **G.** Placement of the second row of anchors. **H.** Tendon reinsertion.

Post-surgical Protocol

The immediate post-surgical protocol consists of antibiotic prophylaxis with cephalexin 1 g every 12 hours for 48 hours, and an analgesia plan according to the patient's needs.

Patients are monitored at 7 and 15 days, and at 1, 2, 3, and 6 months, and at 1 year. All patients are checked weekly during the first 2 weeks for wound healing and cast monitoring.

A short plaster boot is maintained in equinus for 2 weeks, non-weight-bearing. After that, a Walker boot with a 4 cm heel lift is used to maintain the equinus. Weight-bearing is initiated according to tolerance, and ankle mobility exercises are allowed, without exceeding neutral dorsiflexion. From the fourth week, walking in slippers is allowed, with full weight-bearing as tolerated. Muscle strengthening exercises are initiated and gradually progressed, with gentle stretching introduced in the third month. Progressive and impact sports activities may begin from the fifth month.

Clinical, Functional and Satisfaction Assessment

At follow-up visits, the time in months to return to normal and sports activities, as well as post-surgical complications, were recorded.

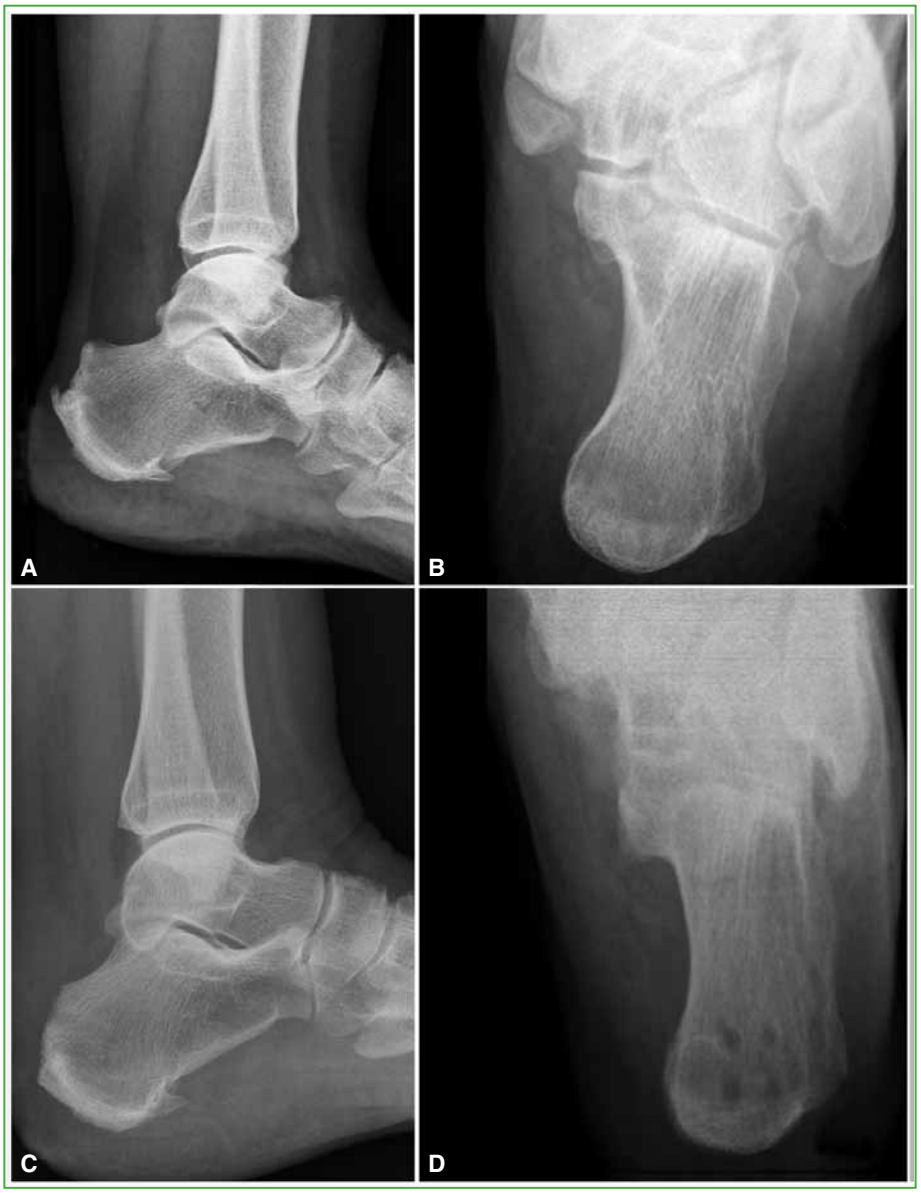

Figure 3. Preoperative radiographs of the calcaneus, lateral view (**A**) and axial view (**B**). Postoperative radiographs of the calcaneus, lateral view (**C**) and axial view (**D**).

At the 1-year follow-up, VAS scores and satisfaction with surgery were documented.

Statistical Analysis

A descriptive analysis of the variables was performed using mean and standard deviation (SD), or median and interquartile range (IQR) for numerical variables, according to their distribution. Categorical variables are expressed as absolute values and proportions. For objectives requiring comparison between continuous variables in different groups, Student's t test for paired samples was used. A p value <0.05 was considered statistically significant.

Statistical analysis was performed using Stata 17©, Version 2021, StataCorp LLC.

RESULTS

The study population consisted of 21 consecutive adult male and female patients diagnosed with TIA, operated on by the same surgical team using an open technique for reinsertion with a double-row suture system, between March 2015 and March 2021.

Demographic and Clinical Characteristics

The median (IQR) age at surgery was 55 years (range 45–63), with 11 patients (52.3%) being male. Eleven (52.3%) of the operated Achilles tendons were on the right side. The median (IQR) follow-up was 16 months (range 6–24). The median (IQR) time to surgery from symptom onset was 12 months (range 12–18).

Among the comorbidities recorded, the mean BMI was 31.3 (SD 5.8): 9 patients (42.8%) were classified as obese, one (4%) had controlled diabetes, 5 (23.8%) were smokers, and 4 (19%) had dyslipidemia.

The demographic and clinical characteristics of the patients are detailed in Table 1.

Table 1. Demographic and clinical characteristics of the patients

Variable	
Age, median (IQR)	55 (45-63)
Sex, n (%) Male	11 (52.3)
Achilles tendon affected, n (%) Right	11 (52.3)
Follow-up time (months), median (IQR)	16 (6-24)
Time from onset of symptoms to surgery (months), median (IQR)	12 (12-18)
Comorbidities	
Diabetes, n (%)	1 (4)
Smoking, n (%)	5 (23.8)
Dyslipidemia, n (%)	4 (19)
Obesity, n (%)	9 (42.8)
Body mass index, mean (SD)	31.1 (5.8)

SD = standard deviation.

Functional and Clinical Outcomes

A total of 76.14% of patients reported being "very satisfied" with the results of this surgical technique. None considered their outcome unsatisfactory.

The mean VAS score was 9.26 (SD 1.6) preoperatively and 2.5 (SD 1.62) postoperatively, showing a statistically significant difference ($p<0.05$). Functional outcomes are shown in Table 2.

Table 2. Clinical and functional outcomes.

Satisfaction scale, n (%) Very satisfied Satisfied Not satisfied	 16 (76.14) 5 (23.9) 0 (0)

Time Until Return to Normal and Sporting Activities

The mean time to return to usual activities was 2.96 months (SD 1.65), while the mean time to return to sports was 5 months (SD 2.19).

Complications

Five complications were recorded (23.8%). Three patients experienced discomfort due to the anchors, which required removal one year postoperatively. One patient developed a deep infection secondary to wound dehiscence, requiring surgical debridement, and another experienced deep vein thrombosis. Table 3 shows the modified Clavien-Dindo classification for foot and ankle surgery.

Table 3. Clavien-Dindo classification of complications.

Clavien-Dindo	Complications	n (%)
IIIB	Deep infection	1 (4.7)
IIIA	Anchor discomfort	3 (14.28)
IIA	Deep vein thrombosis	1 (4.7)

DISCUSSION

This study demonstrates that the combination of debridement of the diseased tendon, calcaneoplasty, reconstruction of the insertion area, and tendon reattachment with double-row anchorage for the treatment of TIA significantly relieves pain, enables rapid recovery for resumption of daily and sporting activities, and yields a high level of patient satisfaction.

Achilles tendinopathy has a multifactorial etiology. Hindfoot alignment, type of footwear, and heel height can influence its development, as can overuse in sports activities. In addition, there is evidence that genetic and medical factors, such as diabetes, advanced age, hypertension, obesity, and the use of corticosteroids and fluoroquinolones, are associated with Achilles tendinopathies.[6,11] In our population, the rate of comorbidities was high; overweight predominated, with an average BMI of 31.3 (SD 5.8). Nine patients (42.8%) had obesity, and one (4%) had controlled diabetes. These findings reinforce the importance of considering comorbidities in the evaluation and treatment of Achilles tendinopathies.

Our results show a significant improvement in functional scores and a high level of satisfaction after surgery. The mean VAS score was 9.26 (SD 1.6) in the pre-surgical evaluation and 2.5 (SD 1.62) postoperatively, a statistically significant difference ($p < 0.05$). In addition, 76.14% reported being "very satisfied" with the outcomes of this surgical technique. These findings are comparable with those published on this same technique. In a study of 13 patients, Abarquero-Diezhandino et al.[17] reported a preoperative VAS score of 8.8 and 1.3 after surgery. In addition, the American Orthopaedic Foot and Ankle Society (AOFAS) score improved from 34.8 to 90.9, with an average increase of 56.1 points, which was statistically significant. In the most recent series, published by Stumpner et al.,[18] sports capacity and ankle function were evaluated in 25 patients who underwent the same surgical technique. The results showed a significant reduction in the VAS score for pain during sports activity from 7.4 (SD 2.5) to 1.2 (SD 2.0) after surgery ($p < 0.001$). Moreover, sports ability and subjective perception of physical fitness improved significantly, from 3.6 (SD 3.0) and 3.5 (SD 2.2) to 8.8 (SD 2.4) and 8.8 (SD 2.2), respectively ($p < 0.001$). There was also a trend toward a transition from high-impact sports to lower-impact sports after surgery. Ninety-six percent of patients rated the surgical outcome as good or excellent, which aligns with the findings of our study.

These results support the efficacy of the double-row anchor technique for TIA, resulting in marked improvement in pain and function, with high levels of satisfaction and return to activity.

There are several techniques for Achilles tendon reattachment, and the optimal method remains a matter of debate.[18] In a cadaveric study, Achilles tendon reattachment using single-row versus double-row anchors was compared in 18 specimens.[13] Half of the specimens were fixed with a single row of anchors, while the other half were

fixed with double-row anchors. According to the results, the double-row technique provided greater coverage of the insertion area and greater load resistance, suggesting a more robust fixation and potentially earlier rehabilitation. Rigby et al.[5] published a series of 43 cases in which they used a double row of anchors for reinsertion in patients with TIA, and 81% had an associated procedure (gastrocnemius resection [33 cases] and flexor hallucis longus transfers [2 cases]). Weight-bearing was initiated at an average of 10 days (range 0–28). These results are consistent with those of our postoperative protocol, which allows partial weight-bearing from the second week according to tolerance.

Our approach of choice is the central inverted T incision, as it allows complete exposure of the insertion, preserving the medial and lateral insertions, if necessary. This facilitates wide debridement of the diseased tissue without risk of vascular or nerve injury. In addition, this approach has been shown to achieve good clinical outcomes and to result in few complicatThe complication rate for this procedure ranges from 6% to more than 30%, with the most frequent complications being wound healing problems, pain in the scar area, and sural nerve injury.[1] In our study, the overall complication rate was 23.8%, with only one serious complication: a deep infection (4.7%). Additionally, three patients reported discomfort from the anchors and required reoperation to remove them—a complication already reported by Vega et al.—[12] who described discomfort from subcutaneous knots in 2 of 12 patients, both of whom also required revision surgery. Despite this, all our patients remained satisfied with the final surgical outcome. It is important to note that no cases of disinsertion or vascular or nerve injuries were reported.

A strength of this study is that it analyzes a surgical technique performed by the same team, providing consistency in the procedure and follow-up. This is likely the first study on this technique conducted in our region, offering valuable information to the local literature. However, its limitations include its retrospective design and the small sample size. To obtain stronger evidence, comparative and randomized studies are needed.

CONCLUSIONS

Surgical treatment with double-row anchorage for TIA unresponsive to conservative management represents an effective intervention. This surgery allows for a full return to daily and sports activities, high levels of satisfaction, significant pain reduction, and a low incidence of serious complications. These findings support its consideration as a valid therapeutic option in selected cases.

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

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Percutaneous Treatment of Grade I/II Hallux Rigidus in Active Patients: Surgical Technique and Outcomes

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ABSTRACT

Introduction: Hallux rigidus is the most common degenerative condition affecting the foot. This study aims to present the outcomes of a percutaneous surgical technique designed to improve range of motion and relieve pain in active patients. **Materials and Methods**: We conducted a retrospective review of all patients diagnosed with mild to moderate hallux rigidus who underwent minimally invasive/percutaneous surgery, involving dorsal cheilectomy of the first metatarsal combined with a dorsal wedge osteotomy of the first metatarsal and proximal phalanx of the hallux, between June 2019 and June 2022. The minimum follow-up period was 12 months, with a maximum of 36 months. **Results:** A total of 15 patients (19 feet) were included, with a mean age of 54 years (range: 38–71). The visual analog scale (VAS) score decreased from 7 preoperatively to 0.7 postoperatively ($p < 0.05$). Mean dorsiflexion increased from 30° to 49° ($p < 0.05$), while plantarflexion improved from 14° to 20° ($p < 0.05$). The mean AOFAS score increased from 60 (range: 52–68) preoperatively to 85 (range: 81–89) at the final follow-up ($p < 0.001$). **Conclusions**: The minimally invasive approach—dorsal cheilectomy combined with dorsiflexion osteotomy of the distal metatarsal and proximal phalanx—appears to be a reliable long-term treatment for grade I/II hallux rigidus. This technique offers a safe and effective alternative for active patients, achieving optimal functional outcomes with minimal pain and only minor, common complications.

Keywords: Hallux rigidus; minimally invasive surgery; percutaneous surgery; cheilectomy; dorsal wedge osteotomy.
Level of Evidence: IV

Tratamiento percutáneo del hallux rigidus grado I/II en pacientes activos. Técnica quirúrgica y resultados

RESUMEN

Introducción: El hallux rigidus es la enfermedad degenerativa más frecuente del pie. El objetivo de este artículo es comunicar los resultados de una técnica quirúrgica percutánea para mejorar el rango de movilidad y eliminar el dolor en pacientes activos. **Materiales y Métodos:** Se realizó una revisión retrospectiva de todos los pacientes con diagnóstico de hallux rigidus leve o moderado que se habían sometido a una cirugía mínimamente invasiva/percutánea: queilectomía dorsal del primer metatarsiano más osteotomía en cuña dorsal del primer metatarsiano y la falange proximal del hallux, entre junio de 2019 y junio de 2022, con un seguimiento mínimo de 12 meses y máximo de 36 meses. **Resultados:** Se incluyó a 15 pacientes (19 pies) con una edad promedio de 54 años (rango 38-71). El puntaje en la escala analógica visual era 7 antes de la cirugía y 0,7 después ($p <0,05$). La dorsiflexión promedio aumentó de 30° a 49° ($p <0,05$) y la flexión plantar, de 14° a 20° ($p <0,05$). El puntaje promedio de la AOFAS aumentó de 60 (rango 52-68) antes de la operación a 85 (rango 81-89) en el último control ($p <0,001$). **Conclusiones:** La técnica mínimamente invasiva: queilectomía dorsal asociada a osteotomía dorsiflexora en el metatarsiano distal y la falange proximal puede ser un tratamiento confiable a largo plazo para el hallux rigidus grado I/II, es una alternativa segura y efectiva en pacientes activos; se logran resultados funcionales óptimos, con escaso dolor y complicaciones leves habituales.

Palabras clave: Hallux rigidus; cirugía mínimamente invasiva; cirugía percutánea; queilectomía; osteotomía en cuña dorsal.
Nivel de Evidencia: IV

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INTRODUCTION

Hallux rigidus is defined as a degenerative condition affecting the first metatarsophalangeal (MTP) joint and the sesamoid complex. It is characterized by pain, restricted range of motion, and periarticular osteophytosis.[1,2] It is the second most common disease of the first MTP joint after hallux valgus and represents the most frequent form of osteoarthritis in the foot and ankle. It affects 2.5% of the population over 50 years of age,[2,3] is more prevalent in women, and in two-thirds of cases, there is a family history. Additionally, 95% of patients present with bilateral involvement.[2]

Several etiologies have been proposed, though no definitive cause has been established. These include trauma (the most frequently cited in the literature), elevation of the first metatarsal (metatarsus primus elevatus), muscle-tendon imbalance, inflammatory and infectious causes, metabolic conditions, iatrogenic factors, and osteochondritis of the first metatarsal head in adolescents, among others.

Currently, no demonstrable relationship has been found with hypermobility of the first ray, metatarsal length, contracture of the Achilles tendon or gastrocnemius, structural foot deformities (e.g., pes planus), hallux valgus, elevation of the first metatarsal, adolescent onset, occupation, or type of footwear.[1] However, there do appear to be several documented factors associated with hallux rigidus, such as female sex, interphalangeal hallux valgus, metatarsus adductus, flat or chevron morphology of the first tarsometatarsal joint,[2] bilateral symptoms in patients with a family history, and unilateral symptoms in those with a history of trauma.[1]

In adults, the most commonly diagnosed condition is degenerative arthropathy, which causes mechanical joint pain, decreased maximum dorsiflexion, and increased pain during toe-off while walking.[1,2] Pain typically occurs with forced dorsiflexion and lateral deviation of the hallux. Initially, pain presents only at the end of dorsiflexion, but as the condition progresses, it may appear mid-range, indicating more extensive joint involvement and complicating conservative treatment.[2] As it advances, plantarflexion also becomes compromised, eventually leading to complete joint immobility, ankylosis, and persistent pain.[4]

The primary objective of this article is to present a percutaneous surgical technique for treating hallux rigidus with mild to moderate symptoms in patients classified as grade I/II according to the Coughlin and Shurnas classification (Table). The technique involves a combination of cheilectomy and dorsal wedge osteotomy of the first metatarsal, along with a dorsal wedge osteotomy of the proximal phalanx, combining percutaneous dorsiflexion-inducing techniques.[5] The secondary objective was to evaluate the long-term clinical outcomes of this joint-preserving approach, with a minimum follow-up of 36 months.[6]

Table. Coughlin and Shurnas Classification.

Grade	Dorsiflexion	Radiographic findings	Clinical findings
0	40-60°	Normal	- No pain - Moderate stiffness
1	30-40°	Mild dorsal osteophyte, normal joint space	- Intermittent pain at extremes of dorsiflexion - Mild stiffness
2	10-30°	Moderate dorsal osteophyte,<50% joint space narrowing	- Moderate to intense pain and stiffness - Pain at extremes of dorsal and plantar flexion
3	<10°	Severe dorsal osteophyte, >50% joint space narrowing	- Near constant pain - Stiffness at extreme ROM
4	<10°	Same as grade III	- Constant pain and stiffness - Pain at mid-range of motion of passive dorsiflexion

MATERIALS AND METHODS

A retrospective review was conducted of all patients diagnosed with mild to moderate hallux rigidus who underwent minimally invasive/percutaneous surgery—specifically, dorsal cheilectomy of the first metatarsal combined with dorsal wedge osteotomy of the first metatarsal and proximal phalanx of the hallux—between June 2019 and June 2022. All patients had a minimum follow-up of 12 months and a maximum of 36 months.

Clinical assessments included preoperative and postoperative evaluation of the range of motion according to the Coughlin and Shurnas classification, as well as the visual analog scale (VAS) for pain.

Surgical Technique

The patient is placed in the dorsal decubitus position under sedation. A local anesthetic block of the forefoot is administered, and a tourniquet is applied at the ankle.

Dorsal cheilectomy. A 4 mm medial incision is made approximately 2 cm proximal to the first MTP joint of the hallux. The capsule is then detached from the exostosis both medially and dorsally. An aggressive cheilectomy is performed using a Wedge Burr.

Distal osteotomy of the first metatarsal. Through the same percutaneous portal, a dorsal wedge osteotomy is performed using a long Shannon burr. Osteoclasis is then performed to close the osteotomy, followed by fixation with a compression screw, placed from proximal to distal and from medial to lateral through the head of the first metatarsal, without breaching the articular surface (Figure 1).

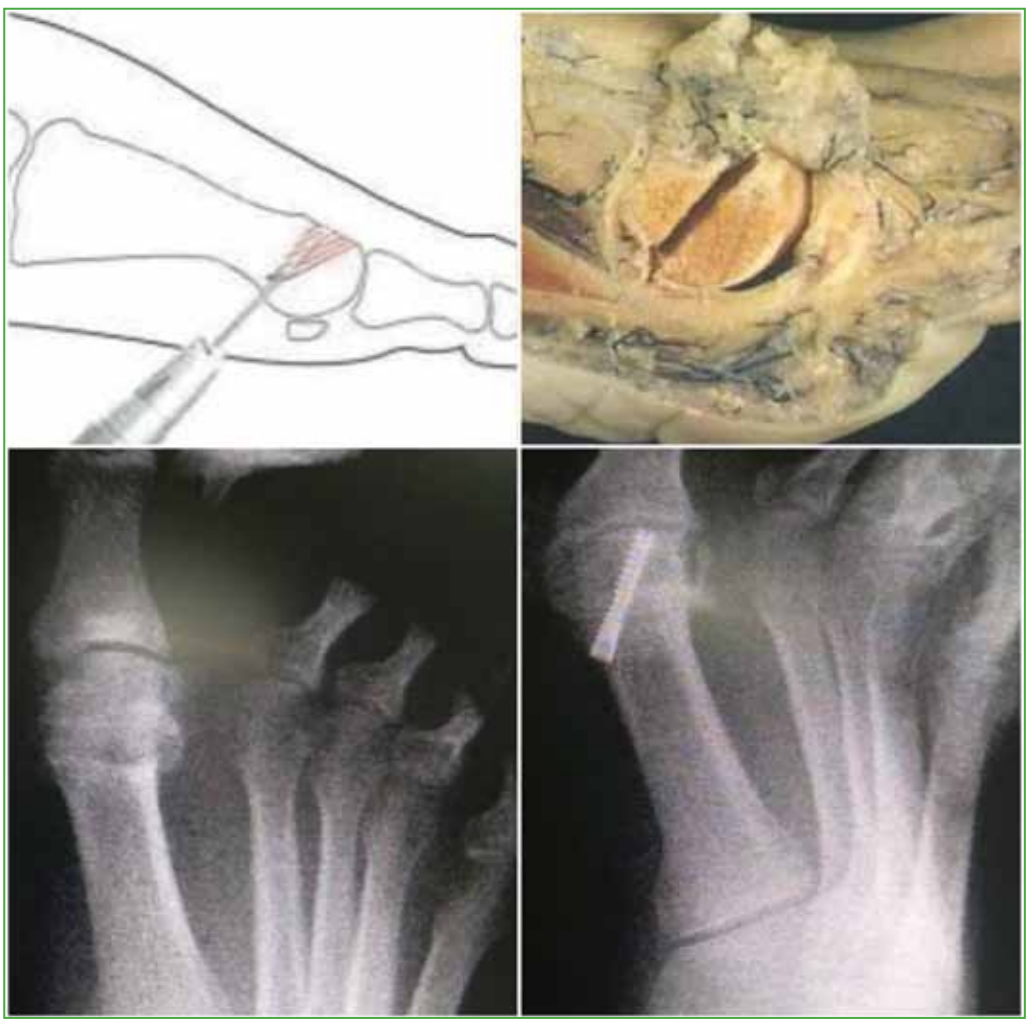

Figure 1. Metatarsal osteotomy.

Osteotomy of the proximal phalanx. A 4 mm medial percutaneous incision is made over the proximal phalanx, 1 cm distal to the first MTP joint. Desperiostization is performed, followed by dorsal wedge osteotomy using a long Shannon burr. Osteoclastic closure is then achieved, and fixation is performed with a compression screw, placed from proximal to distal and from medial to lateral, without compromising the articular surface of the phalanx (Figure 2).

Figure 2. Phalangeal osteotomy.

A bandage is applied with the hallux in slight hyperextension, and immediate weight-bearing with a postoperative sandal is indicated. Screw fixation allows early initiation of joint mobility and physical therapy exercises (Figure 3). Return to impact and sports activities is permitted three months postoperatively.

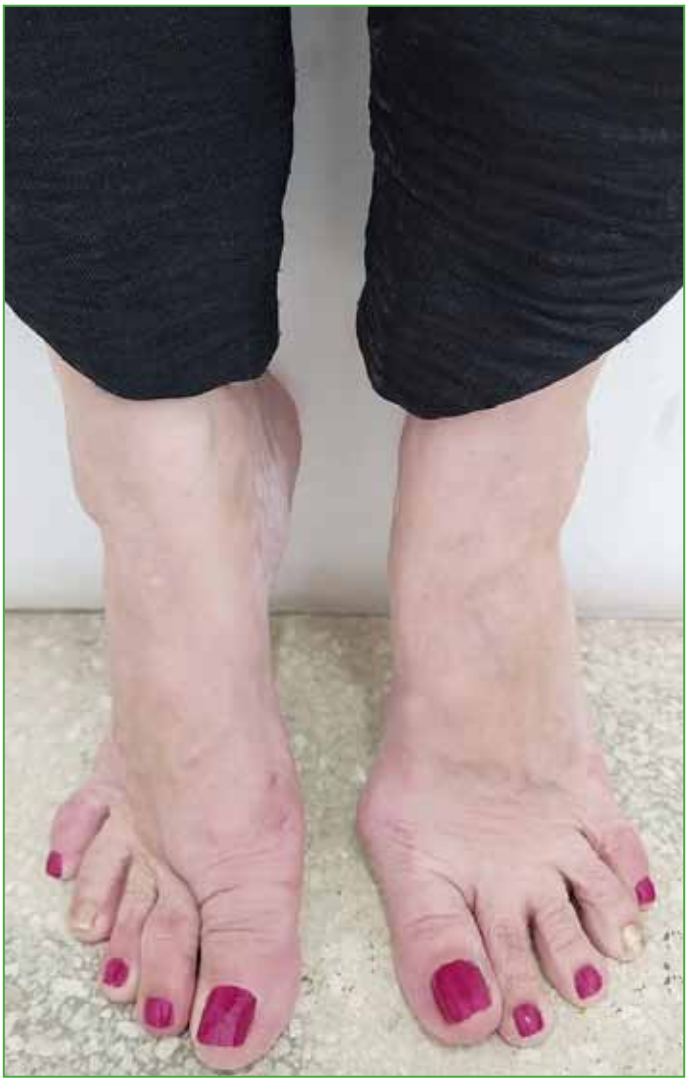

Figure 3. Early mobilization.

RESULTS

Prospectively collected data from a series of 15 patients (19 feet) treated between June 2019 and June 2022 were analyzed.

The outcome of the procedure was evaluated using the Coughlin and Shurnas[7] clinical classification for the MTP/interphalangeal joint of the hallux and the visual analog scale (VAS) for pain.[7-9]

Fifteen patients (19 feet), with a mean age of 54 years (range 38–71), were included. The mean preoperative VAS score was 7, which improved to 0.7 postoperatively ($p < 0.05$). Mean dorsiflexion increased from 30° to 49° ($p < 0.05$), and plantarflexion improved from 14° to 20° ($p < 0.05$).

The most common postoperative complications were edema and swelling, occurring in 42% of cases. No cases of nerve injury, extensor hallucis longus damage, or infection were observed.

The average time to return to regular footwear was three weeks, following the established protocol.

DISCUSSION

In this study, a percutaneous joint-preserving surgical technique performed in young patients was analyzed. Both the Visual Analog Scale (VAS) and American Orthopaedic Foot and Ankle Society (AOFAS) scores improved, and significant functional improvements in joint range of motion were observed.

Minimally invasive forefoot surgery has become a reality; over the past decades, it has been shown to offer several advantages over open techniques, with favorable outcomes for patients, such as fewer complications and shorter surgical times.[6,10-14]

Most studies highlight the benefits of minimally invasive cheilectomy compared to open surgery. Morgan et al.[13] conducted a prospective study comparing open and minimally invasive cheilectomy and found greater improvements in pain, function, and social interaction in the minimally invasive group. In the open surgery group, three failures were reported, all of which required conversion to arthrodesis.

Razik and Sott[14] evaluated 47 patients with a minimum follow-up of one year (22 underwent minimally invasive surgery and 25 open surgery). Pain scores improved in all patients according to the VAS; however, fewer infections and complications occurred in the minimally invasive group.

Despite these encouraging results, several issues related to the technique have been reported.

Complications associated with the minimally invasive approach include incomplete resection, need for revision surgery, and joint complications due to residual debris and loose bodies.

Stevens et al.[15] reported a similar reoperation rate (12.8%) in the minimally invasive group, due to issues directly related to the technique, such as injury to the dorsal medial cutaneous nerve and tear of the extensor hallucis longus tendon.

Teoh et al.[16] reported a 12% reoperation rate: seven patients required arthrodesis, four underwent revision cheilectomy for residual impingement, and one had a loose body removed via open surgery.

In our study, the mean VAS score improved from 7 preoperatively to 0.7 postoperatively ($p < 0.05$). All patients were satisfied with the outcome and would undergo the procedure again. Joint range of motion improved from a mean of 14° of plantar flexion and 30° of dorsiflexion preoperatively to 20° and 49°, respectively, postoperatively.

All patients began immediate weight-bearing with a postoperative sandal and transitioned to athletic shoes at three weeks postoperatively, following the established protocol. At an average final follow-up of 24 months, no wound infections, tendon injuries, or nerve damage were observed.

This study is not without limitations. One limitation is the relatively small sample size, including only 19 feet. Furthermore, cases where range of motion did not improve as significantly as others could be investigated in the future to determine the presence of bony or cartilaginous debris or synovitis via direct arthroscopic visualization.

CONCLUSIONS

The minimally invasive technique—dorsal cheilectomy combined with dorsiflexion osteotomy of the distal first metatarsal and proximal phalanx—may represent a reliable long-term treatment for grade I/II hallux rigidus. It appears to be a safe and effective option for young, active patients. Functional outcomes are optimal, pain levels are low, and mild complications are common.

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

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Treatment of Distal Tibia Fractures with a Retrograde Intramedullary Tibial Nail

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ABSTRACT

Background: This study aims to present our experience and outcomes in the treatment of distal tibia fractures using a retrograde intramedullary locking tibial nail. **Materials and Methods:** This implant was indicated for fractures of the distal tibia (within 10 cm of the tibiotalar joint), soft tissue injury on the medial aspect of the leg, injuries in the knee area, or ipsilateral knee arthroplasty. **Results:** A total of 15 patients (13 men, 2 women) with a mean age of 51.5 years were treated. Four cases involved open fractures—three classified as Gustilo IIIA and one as IIIB. Fracture healing was achieved within four months postoperatively in eight cases, while the remaining seven required five months (RUST score: 12). No angular deformities were observed in the distal tibia after bone union. According to the AOFAS score, 12 patients had excellent outcomes, while three had fair results. **Conclusions:** Retrograde intramedullary tibial nailing is a viable option for treating distal tibia fractures, providing rotational and axial stability comparable to conventional implants. While the initial results are promising, further studies with larger patient cohorts and longer follow-up periods are needed to confirm its long-term effectiveness.

Keywords: Distal tibia fracture; retrograde intramedullary nail.

Level of Evidence: IV

Tratamiento de fracturas de tibia distal con clavo endomedular retrógrado de tibia

RESUMEN

Introducción: El objetivo de este artículo es comunicar nuestra experiencia y los resultados del tratamiento de pacientes con fracturas de tibia distal utilizando un clavo endomedular retrógrado acerrojado de tibia. **Materiales y Métodos:** Se indicó este implante para fracturas de tibia distal (hasta 10 cm de la articulación tibio- astragalina), lesión de partes blandas en la cara medial de la pierna, en la zona de la rodilla o artroplastia de rodilla homolateral. **Resultados:** Se operaron 15 pacientes (13 hombres y 2 mujeres; edad promedio 51.5 años). Cuatro tenían fracturas expuestas, 3 Gustilo IIIA y una, IIIB. En 8 casos, la fractura consolidó a los 4 meses de la cirugía y demoró 5 meses, en los 7 restantes (puntaje RUST 12). No se observaron deformidades angulares en la tibia distal luego de la consolidación. Según el puntaje de la AOFAS, 12 resultados fueron excelentes y 3, regulares. **Conclusiones:** Este implante es una opción para tratar fracturas distales de tibia, genera estabilidad rotatoria y axial similar a la de los implantes clásicos. Aunque los resultados iniciales son satisfactorios, se necesitan más pacientes y un seguimiento más extenso para confirmar la real utilidad.

Palabras clave: Fractura de tibia distal; clavo endomedular retrógrado.

Nivel de Evidencia: IV

INTRODUCTION

Fractures of the distal third of the tibia can be treated with intramedullary nails or plates. The ideal implant is the one that provides greater stability at the fracture site with minimal aggression to the soft tissues in that anatomical region.[1] Intramedullary nails allow stable fixation with limited soft tissue disruption; however, in some very distal fracture patterns, stability may be insufficient due to the lack of contact between the implant and the cortices of the distal tibia, as well as the inability, in some nail designs, to place three locking screws in the distal fragment.[2] Locking plates have some biomechanical disadvantages compared to intramedullary implants, in addition to the potential soft tissue damage, which is often exacerbated by the energy of the initial trauma.[3]

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In 2014, a novel retrograde intramedullary nail was developed, offering a new option for the treatment of these fractures.[4]

The aim of this article is to present the treatment and outcomes in patients with distal tibial fractures managed with a retrograde steel intramedullary tibial nail.

MATERIALS AND METHODS

Between January and December 2022, a prospective study was conducted using a retrograde intramedullary nail in patients admitted to our department who met the following inclusion criteria (criteria 1 and 2 were mandatory, while any one of the remaining criteria was sufficient): 1) distal tibial fracture located within 10 cm of the tibiotalar joint, 2) age >18 years, 3) soft tissue injury on the anteromedial aspect of the leg, 4) soft tissue injury in the knee area (entry point of the intramedullary nail), and 5) ipsilateral knee arthroplasty.

Patients were excluded if they did not meet the above criteria or presented with any of the following: 1) bifocal fractures, 2) complex intra-articular fractures (extending to the tibial plafond), 3) previous ankle fracture, 4) angular deformities of the tibia, and 5) pathological fractures.

If the patient also had a fibular fracture compromising ankle stability, reduction and internal fixation with plate and screws was performed. When the fibular fracture was located beyond the distal 7 cm, an elastic intramedullary nail was placed.

Sutures were removed 15 days postoperatively. Radiographic follow-up was performed at 30, 60, 90, 120, and 180 days.

Partial weight-bearing with crutches was allowed after 30 days.

Open fractures were classified according to the Gustilo classification.[5] Fracture healing was assessed using the RUST (Radiographic Union Score for Tibia) scale,[6] and functional outcomes were evaluated with the AOFAS (American Orthopaedic Foot and Ankle Society) ankle-hindfoot score.[7]

Surgical Technique

With the patient in the supine position, a support is placed under the affected limb to allow proper visualization of the anteroposterior and lateral views of the tibia and ankle.

After aseptic preparation and placement of the surgical drapes—and prior to nail insertion—the fracture is reduced by longitudinal traction in comminuted patterns or percutaneously using a clamp in oblique fracture lines (Figure 1).

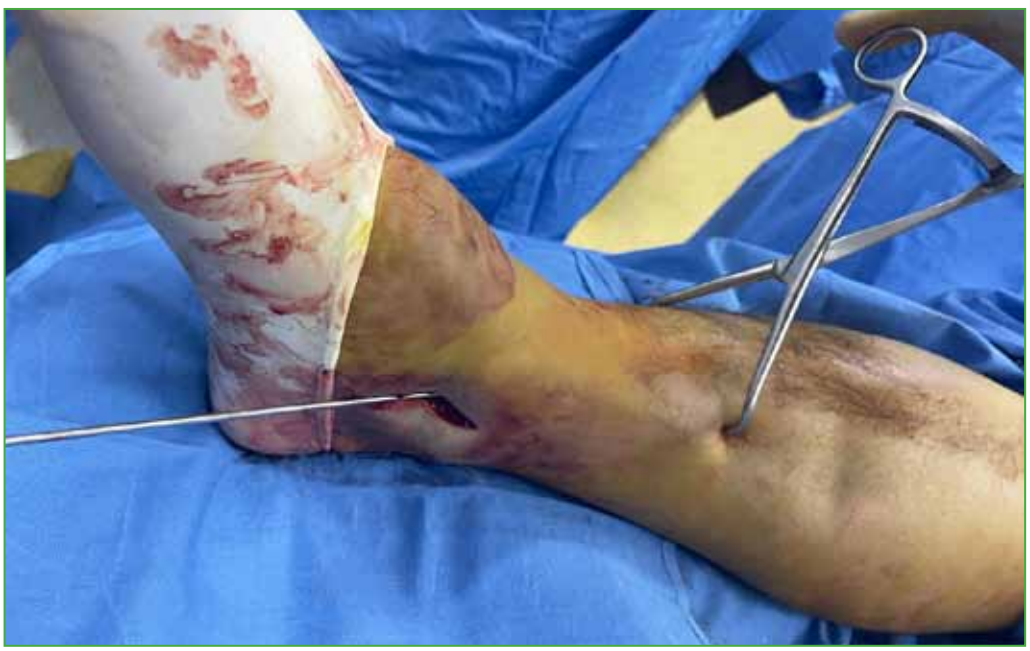

Figure 1. Percutaneous fracture reduction.

A 3 cm incision is then made distally from the tip of the tibial malleolus (Figure 2). Using a guidewire, the entry point is identified in the center of the tibial malleolus in both planes (Figures 3 and 4), and then enlarged with a cannulated reamer (Figure 5). An olive-tipped guidewire is inserted (Figure 6), and reaming of the medullary canal is performed through a soft tissue protector (Figure 7).

Figure 2. Approach for implant placement.

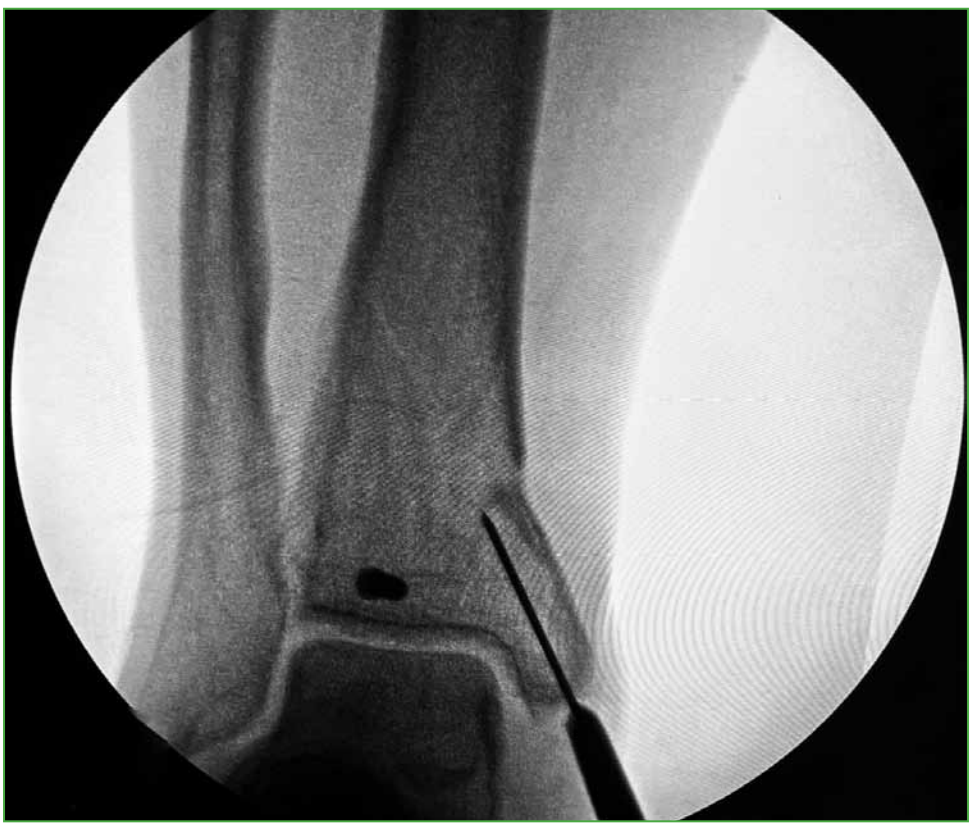

Figure 3. Guide pin for implant insertion, anteroposterior view.

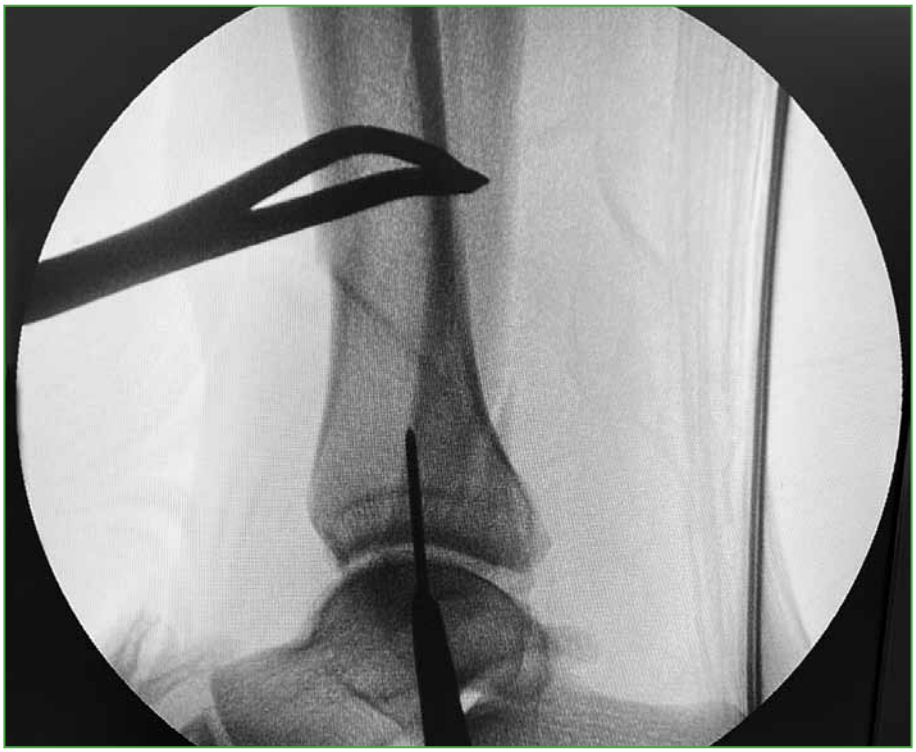

Figure 4. Guide pin for implant insertion, lateral view.

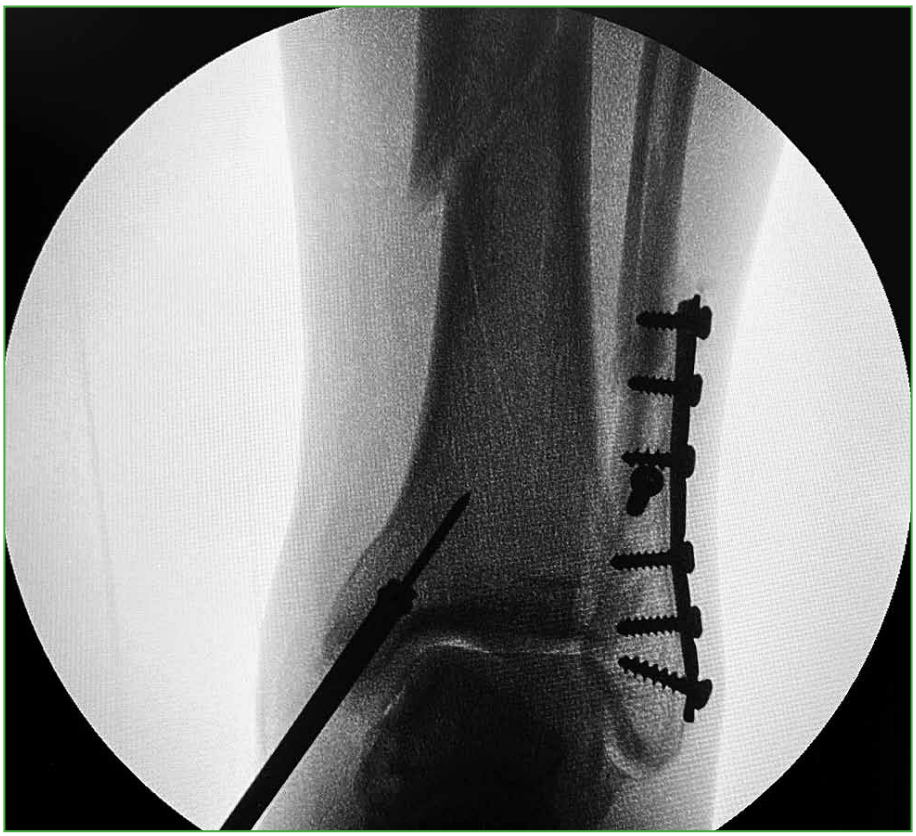

Figure 5. Initial cannulated reamer.

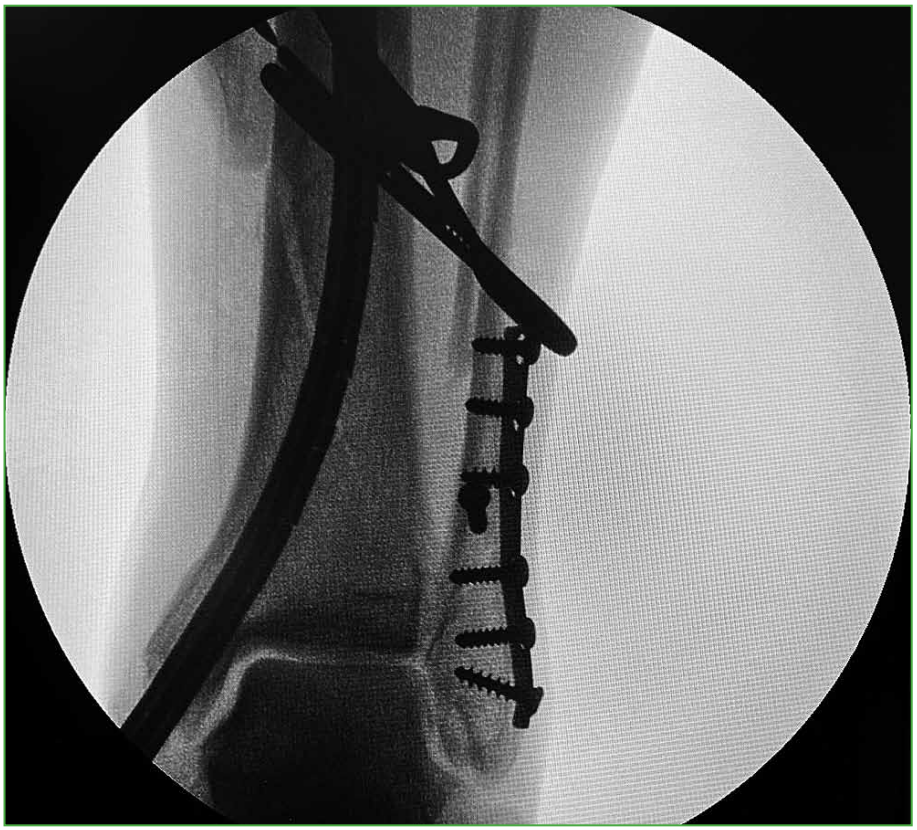

Figure 6. Reaming of the medullary canal.

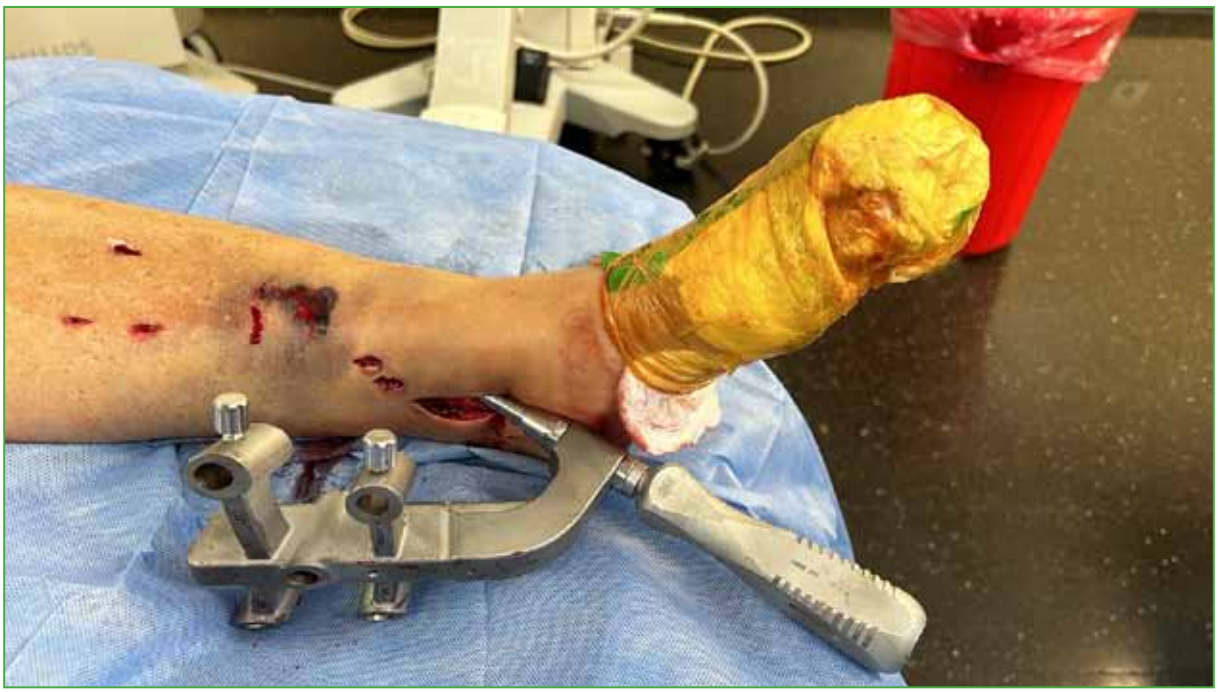

Figure 7. Approaches for nail placement and locking.

The nail of the preselected length is inserted under fluoroscopic guidance and anchored distally using the external targeting device, and proximally using a free-hand technique (Figures 8-10)

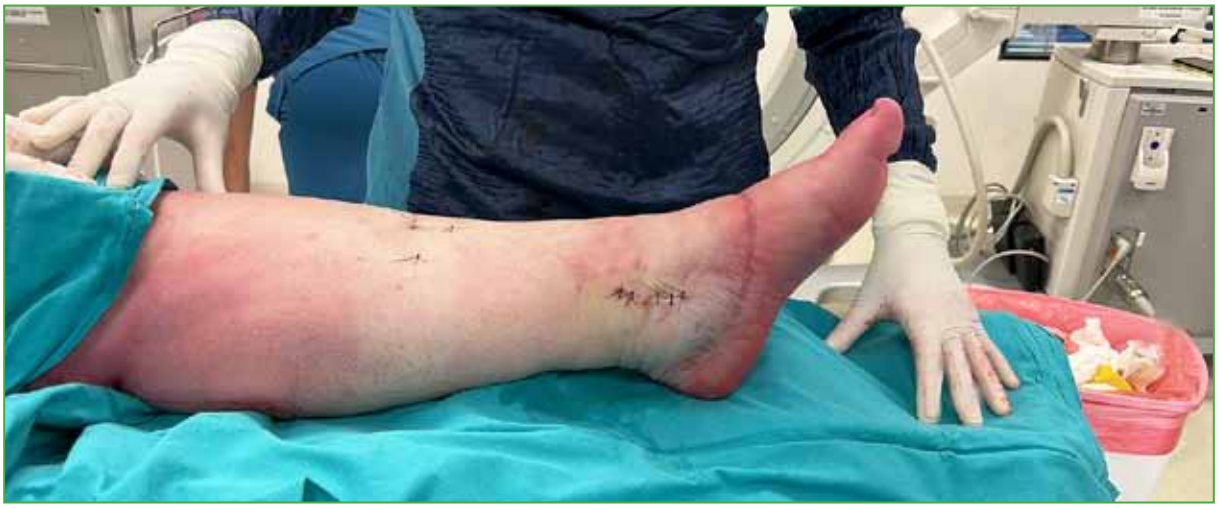

Figure 8. Wound appearance after nail placement.

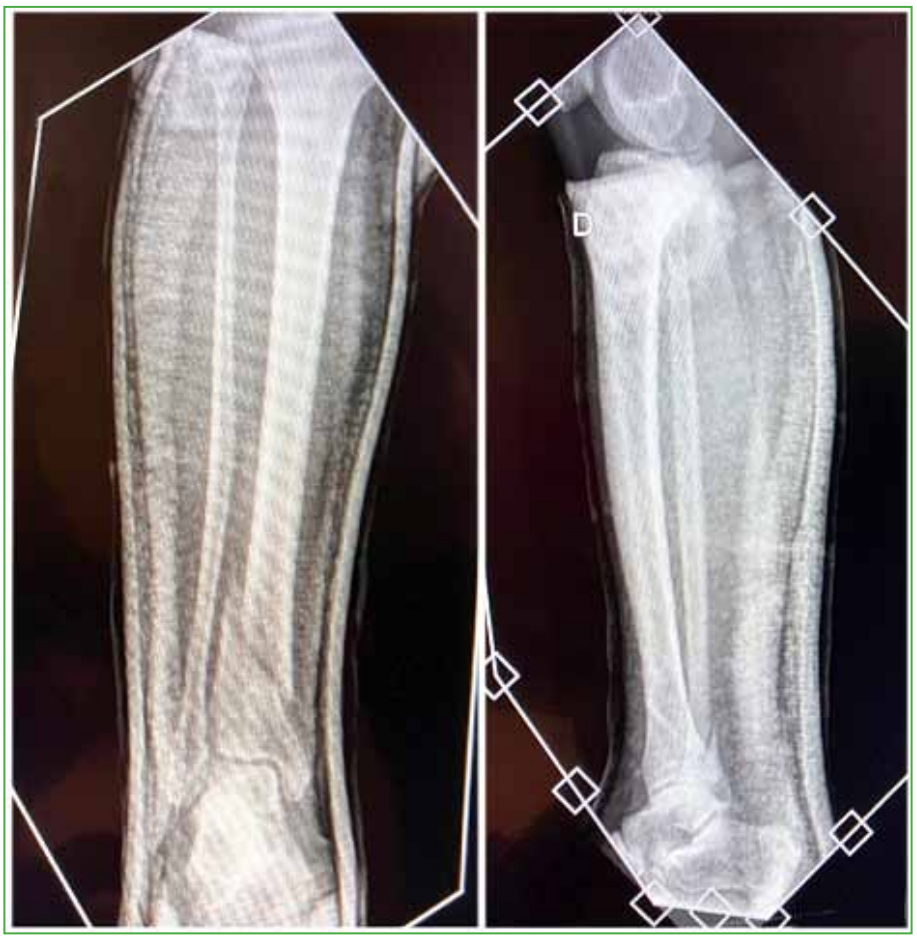

Figure 9. Anteroposterior and lateral radiographs of distal tibia. AO/OTA 43A1 fracture.

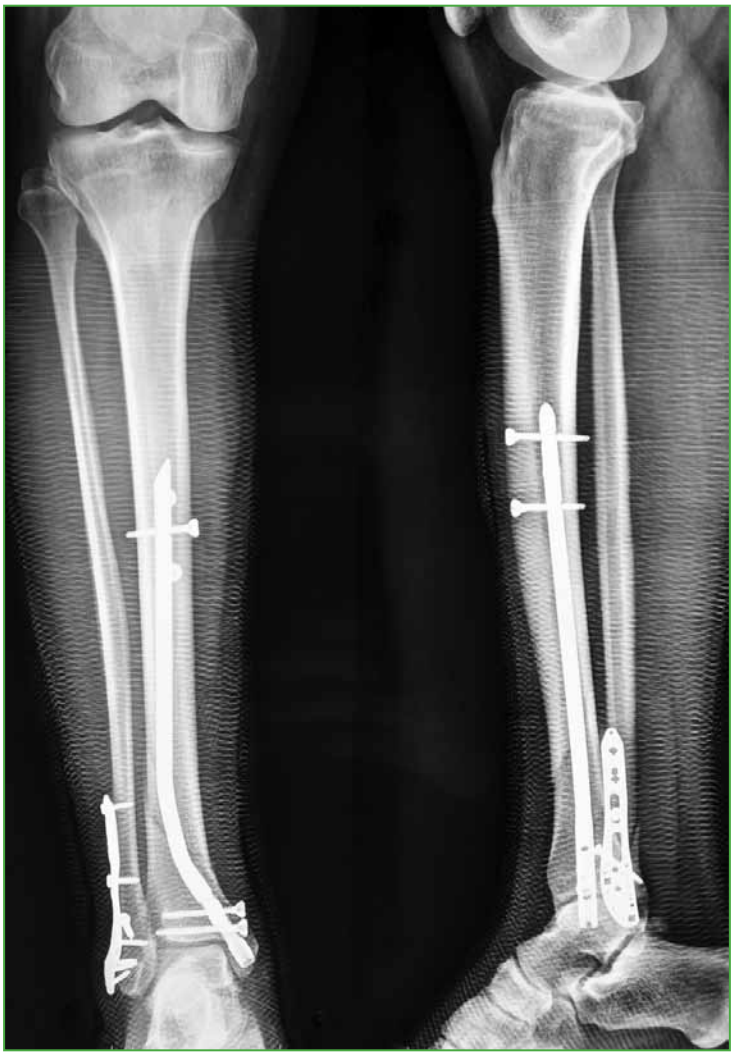

Figure 10. Anteroposterior and lateral radiographs of distal tibia. Fracture consolidation.

RESULTS

During 2022, this implant was used in 15 patients: 13 men and 2 women, aged 31 to 86 years (mean age 51.5 years). The mechanisms of injury included motorcycle accidents (6 cases), falls from height (8 cases), and a complication from a previous surgical procedure (1 case).

Fractures were classified according to the AO Foundation/Orthopaedic Trauma Association (AO/OTA) system: 11 were type 43A1, 2 were 43A2, 1 was 42A1, and 1 was 42A3. Four of these fractures were open: three Gustilo type IIIA and one type IIIB. These were initially managed with surgical debridement, negative pressure wound therapy, and external fixation. At 48 hours, they were converted to internal fixation with retrograde nailing, and in the IIIB case, a free lateral thigh flap was used for soft tissue coverage.

The fibula was stabilized in 10 patients—6 with plate and screws, and 4 with an elastic intramedullary nail.

In 8 cases, fracture healing occurred by 4 months postoperatively; in the remaining 7 cases, healing was achieved by 5 months (RUST score 12).

No angular deformities were observed in the distal tibia after consolidation. According to the AOFAS scale, outcomes were excellent in 12 cases and fair in 3, one of which involved the patient with the type IIIB open fracture requiring soft tissue reconstruction (Table).

Table. Description of patients.

Patient	Sex	Age	Side	AO/OTA Classification	Gustilo	Other injuries	Consolidation (months)	AOFAS	RUST
1	M	62	L	42A3	-	-	5	90	12
2	M	31	L	43B1	IIIB	-	5	65	12
3	M	33	R	43A1	IIIA	Fracture of clavicle, forearm, femur	5	90	12
4	M	37	R	43A2	-	-	4	100	12
5	M	41	L	43A2	-	-	4	90	12
6	M	60	R	43A3	-	-	4	89	12
7	M	42	L	43A1	-	-	4	95	12
8	M	72	R	43A1	-	-	5	90	12
9	F	86	R	43A1	IIIA	-	5	90	12
10	M	46	R	43A2	-	-	4	90	12
11	M	53	R	43A2	-	-	4	100	12
12	M	66	L	43B1	-	-	5	100	12
13	M	52	L	43B1	IIIA	-	4	90	12
14	M	39	L	42A1	-	-	4	100	12
15	F	69	L	43A2	-	-	5	90	12

M = male; F = female; L = left; R = right; AO/OTA = *AO Foundation/Orthopaedic Trauma Association*; AOFAS = *American Orthopaedic Foot and Ankle Society*; RUST = *Radiographic Union Score for Tibia*.

DISCUSSION

Fractures of the distal third of the tibia are common.[1] There is ongoing controversy regarding the ideal fixation method for extra-articular fractures, particularly between intramedullary nails and locking plates.[2]

The selected implant should provide sufficient stability with minimal soft tissue disruption in this anatomical region. Plate osteosynthesis, using a minimally invasive technique, is a reasonable option. However, in patients with medial soft tissue injury, chronic vascular disease, or diabetes, the risk of complications increases.[3]

Osteosynthesis with an antegrade intramedullary nail preserves the soft tissues of the leg. Nevertheless, it requires the ability to place three distal locking screws to achieve adequate stability, as the nail does not engage the cortices in the distal tibia.

The use of a retrograde tibial nail was first described by Kuhn et al. in 2014,[4] who, after conducting biomechanical studies, reported that the rotational and axial stability provided by this implant is comparable to that of the antegrade tibial nail.

In 2022, Bin et al.[8] treated nine patients with this implant and reported bone healing at an average of 3.3 months. Functional outcomes, assessed with the AOFAS score, included six excellent and three good results—similar to those obtained in our study.

In our series, we attributed the two fair outcomes in the functional assessment to the severity of soft tissue injury (a Gustilo IIIB fracture requiring a fasciocutaneous flap and a Gustilo IIIA fracture requiring medial ligament reconstruction), rather than to the bone injury or the implant used.

The design of this nail allows the distal locking screws to reach close to the articular surface of the tibia, offering a clear advantage in the treatment of distal fractures. Furthermore, the stability provided by the three fixed-angle

distal locking screws—secured both to the nail and the medial cortex—minimizes potential discomfort caused by the prominence of conventional locking screw heads.

The insertion technique must be performed with care, due to the risk of tibial malleolus fracture. The fracture must be reduced prior to nail insertion, as the implant cannot serve as a tool for indirect reduction.

At the proximal level, we recommend placing all locking screws to optimize construct stability.

The retrograde tibial nail is not intended to replace standard implants commonly used for distal tibial fractures, but rather to complement antegrade nails and locking plates—particularly in specific clinical situations, as outlined in the inclusion criteria.

This study has some limitations: it does not include a comparison with patients treated using other osteosynthesis methods for similar fractures; the number of patients is small; and the assessment was conducted by the authors themselves. Nevertheless, we consider the initial results to be encouraging, although further evaluation in a larger patient cohort is needed to determine the true utility of this implant.

CONCLUSIONS

This is the first report in our setting on the use of the retrograde tibial nail for the treatment of distal tibial fractures. We believe that this implant offers certain advantages over traditional implants, especially in specific scenarios such as when the proximal tibia is occupied by a knee arthroplasty.

Conflict of interest: Dr. Río and Dr. Gotter were involved in the development of the implant. The rest of the authors declare no conflicts of interest.

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Sinus Tarsi Approach and Osteosynthesis with Cannulated Screws in Calcaneal Fractures with Articular Depression

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ABSTRACT

Introduction: Open reduction and internal fixation via an extended lateral approach is the most commonly accepted surgical strategy for managing intra-articular calcaneal fractures with articular depression. However, the high rate of soft tissue complications associated with this technique has led to the development of less invasive alternatives that aim to reduce complications and improve functional outcomes. **Objective:** To evaluate the complications and functional outcomes of calcaneal fracture fixation using the sinus tarsi approach and cannulated screws. **Materials and Methods:** Between June 2016 and June 2022, 14 intra-articular calcaneal fractures with articular depression were treated using the sinus tarsi approach and cannulated screw fixation. Postoperative complications, radiographic outcomes (Gissane angle, Böhler angle, calcaneal length and width), and CT findings (Sanders classification) were assessed, along with functional outcomes using the American Orthopaedic Foot & Ankle Society (AOFAS) score and a self-administered satisfaction questionnaire. **Results:** With a mean follow-up of 19.28 months, the average AOFAS score was 84.14. One superficial infection was reported and successfully treated with oral antibiotics. In two patients, hardware removal was required. Immediate and late postoperative imaging showed no significant differences compared to the contralateral healthy calcaneus. No postoperative articular step-offs greater than 2 mm were observed on CT scans. Eight patients reported being satisfied with the outcome, and six were very satisfied. **Conclusion:** The sinus tarsi approach combined with cannulated screw fixation provides functional and radiographic outcomes comparable to or better than those achieved with the extended lateral approach and lateral plating, with fewer soft tissue complications.

Keywords: Calcaneus; minimally invasive approach; sinus tarsi.
Level of Evidence: IV

Abordaje del seno del tarso y osteosíntesis con tornillos canulados en fracturas de calcáneo con depresión articular

RESUMEN

Introducción: La reducción abierta y fijación interna mediante un abordaje lateral amplio representa la estrategia quirúrgica más aceptada para el manejo de las fracturas de calcáneo con depresión articular. Sin embargo, las altas tasas de complicaciones de partes blandas llevaron a desarrollar técnicas menos invasivas que causaron menos complicaciones y lograron mejores resultados funcionales. **Objetivo:** Evaluar las complicaciones y los resultados funcionales de la reducción y osteosíntesis de calcáneo mediante el abordaje del seno del tarso y tornillos canulados. **Materiales y Métodos:** Entre junio de 2016 y junio de 2022, se trataron 14 fracturas de calcáneo con depresión articular por un abordaje del seno del tarso y tornillos canulados. Se evaluaron las complicaciones posoperatorias, los resultados en las radiografías y las tomografías, los resultados funcionales con la escala de la AOFAS y un cuestionario autoadministrado sobre la conformidad. **Resultados:** Con un seguimiento medio de 19.28 meses, el puntaje promedio de la AOFAS fue de 84,14. Hubo una infección superficial tratada con antibiótico por vía oral. En 2 pacientes, fue necesario retirar el material de osteosíntesis. Las imágenes del posoperatorio inmediato y alejado no mostraron diferencias significativas con el calcáneo contralateral sano. No hubo escalones articulares >2 mm en los controles tomográficos posoperatorios. Ocho estaban conformes con el resultado y 6, muy conformes. **Conclusión:** El abordaje del seno del tarso asociado a tornillos canulados asegura iguales o mejores resultados funcionales y en los estudios por imágenes, con menos complicaciones, que el abordaje lateral amplio con una placa lateral.

Palabras clave: Calcáneo; abordaje mínimamente invasivo; seno del tarso.
Nivel de Evidencia: IV

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INTRODUCTION

Calcaneal fractures represent 2% of all fractures and 60% of all tarsal fractures. In 75% of cases, there is involvement of the posterolateral articular facet, which is a cause of future morbidity.[1,2]

For decades, their surgical management was considered controversial. A better understanding of the mechanism of injury and fracture morphology has made it possible to classify these injuries, plan treatments, and even predict outcomes.[3-6] This led to the current conception: with surgery, the best functional outcomes can be expected. To achieve this, it is imperative to meet two objectives: restore the body shape (height, width, and length) and the congruence of the posterolateral articular facet of the calcaneus (PLAF).

Open reduction and internal fixation using an extended lateral approach (ELA) has been the most widely accepted surgical strategy in recent decades. This approach provides adequate visualization of the PLAF, facilitates manipulation of the fracture fragments, and allows for the placement of a plate on the lateral aspect of the calcaneus. However, it has high rates of soft tissue complications (11–25%), infections, and sural nerve injuries, which have discouraged its use.[7-9]

A study evaluating 838 patients treated with an ELA and 810 patients treated with a sinus tarsi approach (STA) concluded that complication rates are significantly lower with less invasive techniques.[10]

Minimally invasive techniques aim to reduce and fix the fracture entirely percutaneously or through small approaches, such as the STA.[11] In these techniques, K-wires, specific plates, screws, or a combination of these implants are used as definitive internal fixation.[12] The advantage of reduced trauma to the skin and soft tissues results in lower complication rates. Regardless of the fixation method, minimally invasive techniques have achieved better functional outcomes and fewer complications than those using an ELA.[13]

The objective of our research was to evaluate the complications, as well as the functional and imaging outcomes, of minimally invasive surgery using the STA and cannulated screw osteosynthesis in calcaneal fractures with articular depression (CFAD) (Sanders types II and III).

MATERIALS AND METHODS

The sample consisted of 17 patients with calcaneal fractures, selected through critical, non-probabilistic sampling. The sex distribution was 12 men and 5 women. The average age was 54 years (range 28–76). Patients who underwent open reduction of the PLAF using an STA and internal fixation with cannulated screws between June 2016 and June 2022 were included. The mechanism of injury, comorbidities, associated injuries, average time from injury to surgery, and average hospital stay were assessed.

Inclusion criteria were: Sanders type II and III calcaneal fractures, closed, treated with open reduction (STA) and fixation with cannulated screws, and a follow-up period of more than 12 months.

Exclusion criteria were: open fractures, age under 18 years, previous calcaneal fracture, bilateral calcaneal fracture, previous or acute tarsal fractures, and inability to establish contact for the final remote follow-up.

Imaging evaluations were performed before surgery, in the immediate postoperative period, and in the long-term postoperative period, along with analysis of the healthy contralateral side. For this purpose, radiographs and computed tomography (CT) scans were used.

The radiological evaluation included analysis of lateral foot radiographs, measuring the calcaneal length, Böhler's angle, and Gissane's angle. On axial radiographs of the calcaneus, width was evaluated. Prior to surgery, CT scans were used to classify fractures according to Sanders.[5] Additionally, calcaneocuboid joint involvement was assessed based on Gallino's criteria.[14] Type I is defined as a fracture line extending to the articular surface with minimal displacement; type II is characterized by comminution of the articular cartilage involving less than 50% of the joint; and in type III, the comminution affects more than 50% of the joint and is associated with lateral subluxation.[6]

In the immediate postoperative period, the same radiographic projections and measurements were used as in the preoperative evaluation. A good radiographic reduction was defined as an angular difference of no more than 5° compared to the healthy contralateral side. All reductions were also evaluated by CT in the postoperative period, analyzing the quality of PLAF reduction according to Sanders' criteria: anatomic reduction: off-step in PLAF ≤1

mm, near-anatomic reduction: off-step between 1 and 3 mm, approximate reduction: off-step between 3 and 5 mm, reduction failure: off-step >5 mm.[6]

The evaluation in the long-term postoperative period was performed using the same radiographic projections as in the immediate postoperative period. Secondary displacement was considered present when there was a change of more than 5° compared to measurements taken immediately postoperatively.

Functional evaluation was conducted using the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot scale and a questionnaire assessing functional outcomes, based on a 4-item Likert-type scale: very satisfied, satisfied, not satisfied, or dissatisfied.

Postoperative complications were evaluated. Secondary displacements (i.e., >5° difference in radiographic measurements between the immediate and long-term postoperative periods) were also analyzed. The need for removal of osteosynthesis material was evaluated as an additional complication.

Surgical Technique

After regional block and anesthetic sedation, the patient is placed in lateral decubitus, with the leg of the limb to be operated on in a leg brace. A hemostatic cuff is placed on the thigh. The leg remains parallel to the floor, as does the longitudinal axis of the foot. The image intensifier is positioned to obtain calcaneal, Broden, and axial profile projections by simply moving the C-arm.

A transfixing Schanz nail is placed in the greater calcaneal tuberosity from lateral to medial, marking the entry point on the profile view, proximal to the plantar cortex. The Schanz nail is oriented perpendicular to the greater tuberosity, and its parallelism to the plantar cortex is assessed in the axial projection (Figure 1A).

The first assistant proceeds to perform traction using the transfixing Schanz nail to correct the deformity. Axial and varus/valgus traction is applied to restore calcaneal anatomy by ligamentotaxis. A first guide pin (for a 6.5/7 mm positioning screw) is then placed parallel to the medial cortex to attach the greater tuberosity to the sustentacular fragment—an anatomical component that is generally stable and undisplaced (Figure 1B).

STA is then performed, and the PLAF is reduced under direct visualization (Figure 2).

The PLAF is fixed with one or two pins, placed from lateral and posterior to anterior and medial, directed toward the sustentaculum tali. These are subsequently replaced with 3.5/4 mm cannulated compression screws (Figure 1C). Finally, the second guide pin (line C) is placed and replaced by a 6.5/7 mm full-thread cannulated screw. This screw runs parallel to the lateral cortex and supports the greater tuberosity with the lesser tuberosity (Figures 1D and 3).

The number and orientation of the 6.5/7 mm screws will depend on the fracture lines. The objective of these screws is to support the greater tuberosity with the calcaneal body and the lesser tuberosity, also creating a "scaffolding" that provides stability to the posterolateral articular facet (Figures 4-6).

Statistical Analysis

Quantitative variables are described as means, standard deviations, medians, ranges, and percentile ranges, according to their distribution, while qualitative variables are expressed as percentages. Continuous data were compared using Student's t-test for independent samples. A p-value <0.05 was considered statistically significant. The study of linear relationships for categorical variables was performed using Spearman's correlation test; a p-value <0.01 was considered statistically significant. All data were entered into an MS Excel spreadsheet, and statistical calculations were performed using IBM SPSS 23.0.

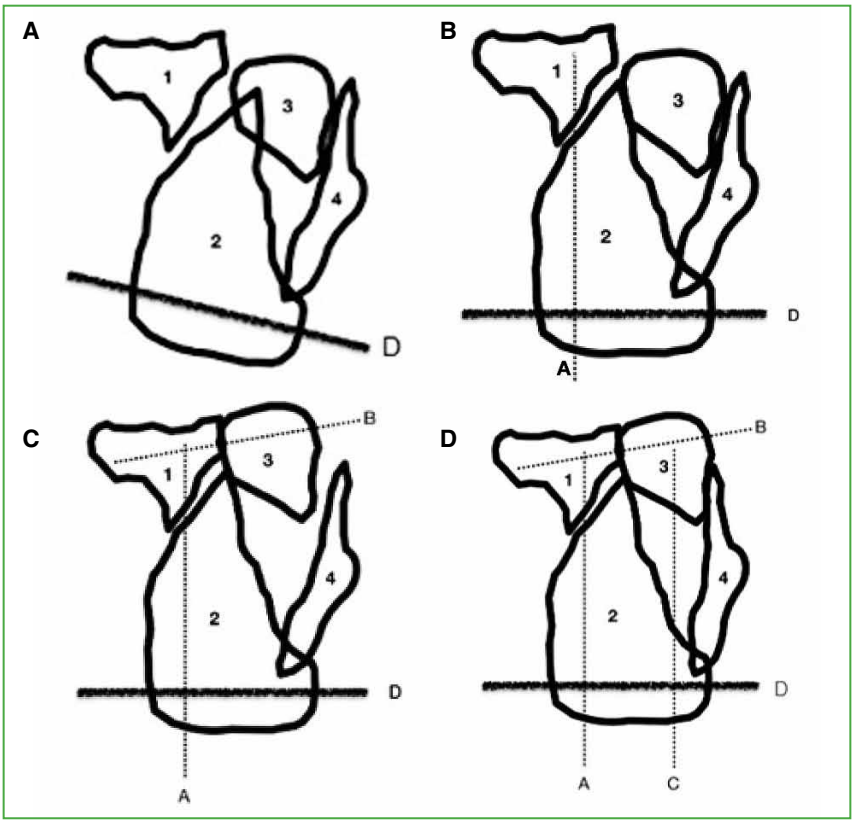

Figure 1. **A.** Sustentacular fragment (1); greater tuberosity (2) with transfixing Schanz nail (D), positioned parallel to the plantar cortex; depressed posterolateral facet (3); lateral wall of the calcaneus (4). **B.** The dotted line (A) represents the guide pin that will anchor the sustentacular fragment (1) to the greater tuberosity (2). **C.** The depressed posterolateral facet (3) is elevated and temporarily fixed to the sustentacular fragment (1). Line B represents the guide pin for the 3.5 or 4 mm cannulated compression screw. **D.** Line C represents the guide pin for the second 6.5/7 mm positioning screw that will fix the greater tuberosity to the lesser tuberosity.

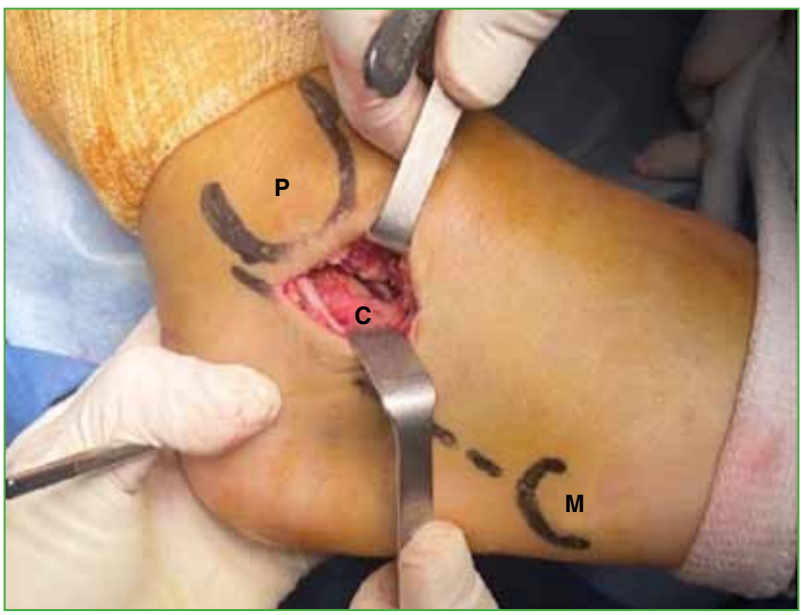

Figure 2. Sinus tarsi approach. P = fibula; 3 = posterolateral facet of the depressed calcaneus; M = fifth metatarsal.

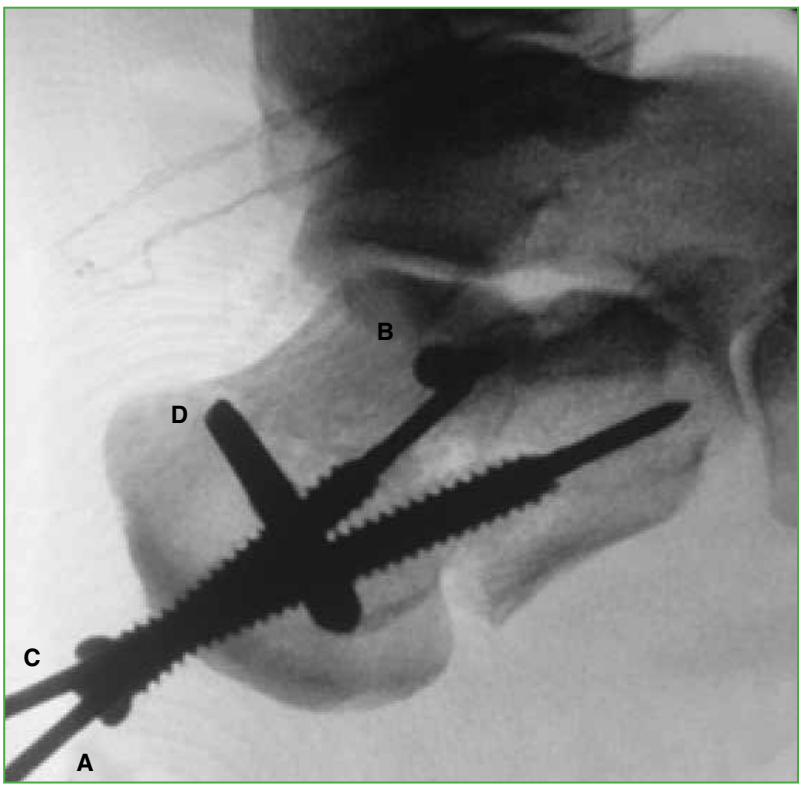

Figure 3. Intraoperative lateral radiographic view of the calcaneus. **A.** Guide pin parallel to the medial cortex, directed toward the sustentaculum tali, with its corresponding 6.5/7 mm cannulated screw. **B.** 3.5/4 mm cannulated screw used for osteosynthesis of the posterolateral articular facet of the calcaneus. **C.** Guide pin and corresponding 6.5/7 mm cannulated screw from the greater tuberosity to the lesser tuberosity. **D.** Transfixing Schanz nail placed parallel to the plantar cortex.

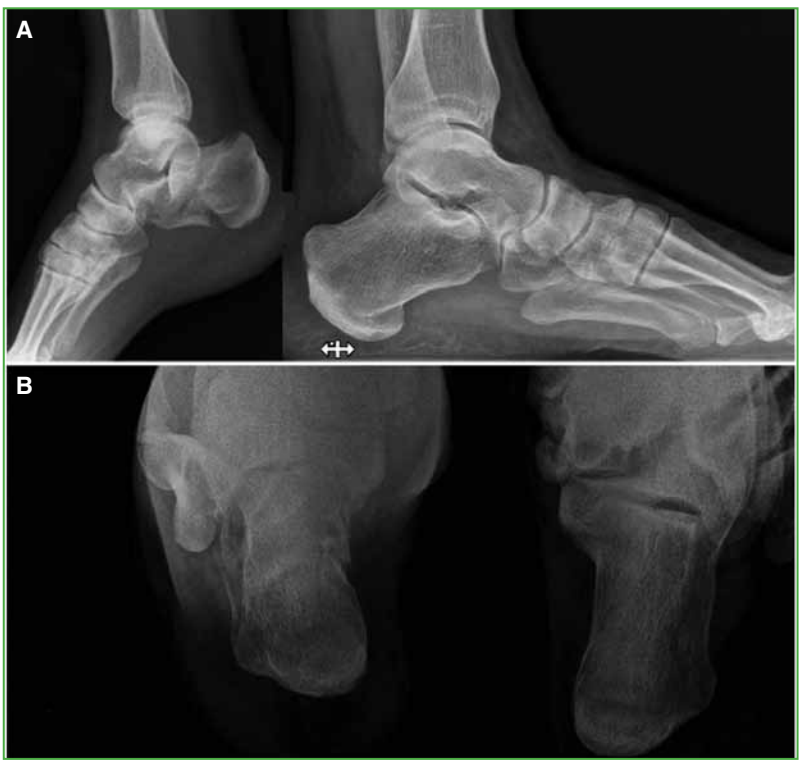

Figure 4. Lateral (**A**) and axial (**B**) ankle radiographs, showing preoperative views of the fractured side and the contralateral healthy side.

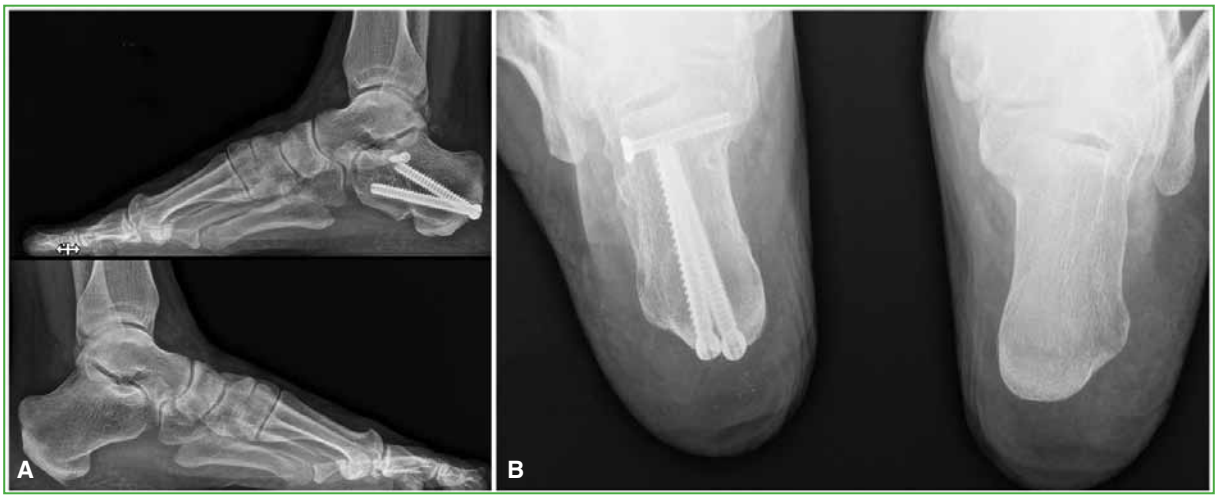

Figure 5. Lateral (**A**) and axial (**B**) ankle radiographs in the late postoperative period, comparing the fractured side with the contralateral healthy side.

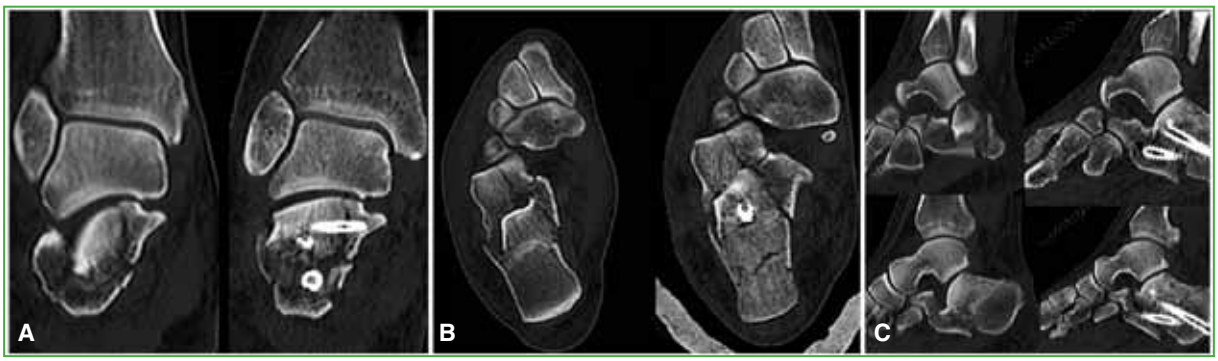

Figure 6. Preoperative and immediate postoperative computed tomography scans of the ankle and hindfoot: coronal (**A**), axial (**B**), and sagittal (**C**) views. Anatomical reduction is observed.

RESULTS

Fourteen patients (14 fractures) met the inclusion criteria. According to the Sanders classification, 10 (71.43%) were type II and 4 (28.57%) were type III. The calcaneocuboid joint was affected in 8 patients (57.14%). According to Gallino's criteria, 4 were type I (28.57%), 3 were type II (21.43%), and one (7.14%) was type III. The fracture was caused by a fall from height in 13 cases (92.86%) and by a motorcycle accident in one case (7.14%). Regarding comorbidities, two patients were diabetic. As for associated injuries, one patient (7.14%) had a fracture of the first lumbar vertebra.

The mean time from injury to surgery was 7 ± 3.16 days. The mean hospital stay was 1.21 ± 0.43 days, and the mean follow-up was 19.28 months (range, 14–26).

Regarding complications, we documented a superficial infection in a diabetic patient, which resolved with oral antibiotic treatment. Removal of osteosynthesis material was necessary in two patients. One had shoe intolerance related to a 7 mm screw. Another had tenosynovitis due to friction between the short peroneal tendon and a 4 mm screw, located near the PLAF. Five patients experienced occasional discomfort from the implants, which did not justify their removal.

The mean Böhler angle showed significant differences between the contralateral healthy calcaneus (30.76° ± 5.71°) and the preoperative measurement (14.05° ± 6.60°). However, the differences between the healthy side

(30.76° ± 5.71°) and the postoperative values, both immediate (29.50° ± 5.96°) and remote (29.86° ± 6.51°), were minimal. The 25th, 50th, and 75th percentiles were also considered. Student's t-tests for independent samples confirmed that there was no statistically significant difference between measurements on the healthy contralateral calcaneus and the immediate postoperative values (95% confidence interval [CI], p = 0.571, d = 0.216) or the remote values (95% CI, p = 0.700, d = 0.147), whereas there were significant differences compared to the preoperative values (95% CI, p < 0.001, d = 2.708).

The mean Gissane angle showed differences between the contralateral healthy calcaneus (119.03° ± 6.99°) and the preoperative value (110.31° ± 10.01°). However, the differences between the healthy side (119.03° ± 6.99°) and the immediate (118.85° ± 7.54°) and remote (119.00° ± 7.43°) postoperative values were not statistically significant. Student's t-tests for independent samples confirmed that there was no statistically significant difference between the healthy contralateral calcaneus and the immediate (95% CI, p = 0.948, d = 0.0248) or remote (95% CI, p = 0.992, d = 0.004) postoperative values, while there was a significant difference compared to the preoperative values (95% CI, p = 0.013, d = 1.010).

The mean calcaneal length showed minimal differences between the contralateral healthy calcaneus (77.61 ± 8.25), the preoperative value (76.01 ± 8.47), and the immediate (78.26 ± 8.01) and remote (76.99 ± 7.56) postoperative values. Student's t-tests for independent samples confirmed that there were no statistically significant differences between the healthy contralateral calcaneus and the preoperative value (95% CI, p = 0.617, d = 0.191), the immediate (95% CI, p = 0.835, d = –0.080), or the remote (95% CI, p = 0.836, d = 0.078) postoperative values.

The mean calcaneal width showed differences between the contralateral healthy calcaneus (36.94 ± 4.09) and the preoperative value (44.13 ± 9.36). However, the differences between the healthy side (36.94 ± 4.09°) and the immediate (39.17 ± 4.77) and remote (38.99 ± 5.16) postoperative values were minimal.

Postoperative CT scans revealed 9 anatomic reductions and 5 near-anatomic reductions.

The mean AOFAS score was 84.14 ± 11, and the median was 86.00 (Table).

Regarding the self-administered survey on functional satisfaction perceived by the patients, the results were: very satisfied (42.90%) and satisfied (57.10%).

Table. Functional outcomes according to the AOFAS score.

AOFAS score		
n	Valid	14
	Lost	0
Mean		84.14
Median		86.00
Mode		82*
Standard deviation		11.00
Range		32.00
Minimum		68.00
Maximum		100.00
Percentiles	25	71.75
	50	86.00
	75	92.00

*There are multiple modes. The smallest value is shown.

DISCUSSION

The surgical management of displaced intra-articular calcaneal fractures (DIACF) involves achieving two main objectives: restoring the shape of the calcaneus (height, length, and width) and reestablishing the congruence of the posterior facet of the subtalar joint (PLAF). Restoring normal anatomy is associated with better functional outcomes and reduces the need for reinterventions.[15] In this context, open reduction and internal fixation (ORIF) with plates and screws via an extensile lateral approach (ELA) has been the standard treatment for these fractures over the past decades.[16] However, the high rate of complications—including skin dehiscence and necrosis, superficial and deep infections, hematoma formation, and injury to the sural or superficial peroneal nerves—has prompted a reassessment of the safety of this technique and led to the development of less invasive approaches with fewer complications.[17]

The ELA provides excellent visualization of the fracture and allows the surgeon to comfortably reduce and fix the fragments.[1] Atraumatic soft tissue handling and the creation of a full-thickness flap are imperative to minimize complications. Folk et al.[8] reported wound complications in 48 (25%) of 190 patients treated via ELA, with 40 (21%) requiring reoperation. Diabetes and smoking were identified as independent risk factors. In a review of 218 fractures treated using the ELA, Harvey et al.[9] reported an overall wound complication rate of 11%, with 6 patients (2.8%) experiencing sural nerve involvement.

The sinus tarsi approach (STA), which extends 3–5 cm from the lateral malleolus toward the base of the fourth metatarsal, allows wide exposure of the PLAF with minimal dissection. It avoids dislocation of the peroneal tendons and can be extended distally to expose the calcaneocuboid joint. Although the STA significantly reduces complication rates, superficial infections have been reported in up to 14% of cases in some studies, and thus should be considered. Weber et al.[18] compared 24 DIACFs treated with STA and cannulated screws to 26 cases treated via ELA and lateral plating. In the ELA group, complications included delayed wound healing (1 case, 3.85%), hematoma (1 case, 3.85%), sural nerve injury (2 cases, 7.69%), and complex regional pain syndrome (4 cases, 15.4%). The STA group reported no complications. Similarly, Kline et al.[19] observed a significant reduction in wound complications and reoperations in patients treated via STA and recommended its use in cases with high risk of wound problems. Nosewicz et al.[17] conducted a systematic review and meta-analysis of nine studies, comprising 331 fractures treated with STA and 390 with ELA. Minor wound healing complications occurred in 11 cases (4.9%) with STA and in 82 cases (24.9%) with ELA; 71% of these were classified as minor and 29% as major. In our series, only one patient (7.14%) developed a superficial wound infection, which resolved with oral antibiotic therapy. This patient had diabetes. No deep infections, necrosis, wound dehiscence, or sural nerve involvement were recorded.

The fixation capability of cannulated screws may be questioned; however, few studies have clearly established the ideal implant for DIACF. In a cadaveric study, Nelson et al.[20] compared an anatomic lateral plate to cannulated screws in 20 specimens with simulated Sanders IIB fractures and concluded that both methods provided adequate fixation. Similarly, Ni et al.[12] found no clear advantage of plates over cannulated screws. Wang et al.,[21] in a systematic review and meta-analysis of randomized clinical trials, compared both fixation methods regarding function, reduction quality, and complications. Radiological outcomes favored cannulated screws; functional outcomes were comparable, but cannulated screws were associated with fewer soft tissue complications. Guo et al.[22] also compared cannulated screws and anatomic plates via STA and found no significant differences in reduction quality or function, but noted significantly lower costs with screw fixation.[7] If cannulated screws are chosen, the literature does not clearly define the optimal construct. Our aim was to simplify the body fracture by joining the greater tuberosity to the anterior tuberosity with 6.5 or 7 mm cannulated screws, and to provide a supporting scaffold to the posterolateral facet, previously fixed to the sustentaculum tali with one or two 4.5 mm cannulated compression screws. No secondary displacements were observed in our series, which supports the safety of this technique. Furthermore, we consider cannulated screws easier to insert and less aggressive to soft tissues, potentially reducing complications.

Although the ELA offers better fracture exposure and should theoretically yield superior reductions, STA with cannulated screws has been shown to be more reliable in restoring Gissane and Böhler angles. Pitts et al.[23] compared 51 DIACFs treated with STA and cannulated screws to 23 treated with ELA and found no significant differences. Wang et al.[21] argue that cannulated screws ensure better reductions In our series, postoperative Gissane and Böhler angles were not significantly different from the contralateral healthy calcaneus, suggesting that limited exposure does not compromise reduction quality. Sanders et al. recommend CT imaging to evaluate postoperative PLAF reduction and classify outcomes based on the residual step height: reductions are considered anatomic when the step is ≤1 mm and near-anatomic when it measures between 1 and 3 mm.[6] In our series, STA enabled us to achieve 9 anatomic and 5 near-anatomic reductions; no steps >2 mm were recorded. We believe that the visualization of the PLAF provided by the STA is sufficient for adequate reduction.

Regarding functional outcomes, STA combined with cannulated screws has not demonstrated superiority over other techniques. Weber et al.[18] compared 24 STA and cannulated screws with 26 ELA and lateral plate. The AOFAS score was 82.6 for ELA and 87.2 for STA ($p = 0.17$). Peng et al.[10] retrospectively analyzed 45 DIACFs (21 cannulated screws vs. 24 plates). The AOFAS score was 80.3 for cannulated screws and 83.6 for plates ($p = 0.09$). In another retrospective study, Weng et al.[24] compared 78 cannulated screws and 72 plates, with a follow-up of 8.7 years, and found no statistically significant differences between the methods In our series, the mean AOFAS score was 84.14 (range, 67–94). These favorable results are comparable to those reported by most authors. Eight patients in our study were satisfied with the outcome, and six were very satisfied.

Intolerance to osteosynthesis material is a common late complication in operated calcaneal fractures. According to the literature, between 10% and 88% of plates placed via an extended lateral approach (ELA) require removal.[6] However, cannulated screws can also cause symptoms, warranting their removal. Driessen et al.[25] reported removal of 60% of cannulated screws implanted in the greater tuberosity due to local skin irritation. In our series, hardware removal was the most frequent secondary procedure. In one patient, 7.5 mm screws had to be removed due to heel skin irritation. Another patient developed peroneal tendon tenosynovitis caused by friction against the prominent flat head of a 4.5 mm PLAF screw. In both cases, symptoms resolved immediately after implant removal.

We believe cannulated flat-head screws are the best option, as they typically do not require removal if implanted correctly. However, if the screws are excessively long and cause friction, they may be less well tolerated than round-head screws. If removal is necessary, it can usually be performed using a minimally invasive and outpatient approach, avoiding the wide exposures required for plate removal and thus reducing the risk of complications.

Rodemund et al.[26] combined a sinus tarsi approach (STA) with cannulated screws and recommended performing surgery within the first 3 days post-injury, even in the presence of soft tissue edema, without increasing the risk of wound-healing complications. Shams et al.[27] published a prospective case series of fracture reduction and fixation using an STA and cannulated screws. According to these authors, a 91% satisfaction rate and a Maryland score of 85 may be attributable to early surgery (mean, 3.2 days).

Our therapeutic approach favors early surgery; the shorter the interval between injury and surgery, the easier the mobilization and reduction of fracture fragments. In our series, the mean time from injury to surgery was 7.64 days (range, 1–10). We concur on the importance of early surgical intervention, although we acknowledge that such short intervals may be difficult to achieve in our setting.

The limitations of our study include the small sample size and a mean follow-up of 19.28 months, which prevents the evaluation of medium- and long-term complications. As strengths, we highlight the detailed description of the surgical technique, appropriate imaging assessment (radiographs and CT), and statistical analysis of the outcomes.

CONCLUSIONS

The STA provides adequate exposure of the posterior lateral articular facet (PLAF) with minimal dissection and soft tissue trauma. Internal fixation with cannulated screws is safe, and secondary displacements are rare. With an STA and cannulated screws, imaging and functional outcomes comparable or superior to those achieved with an ELA and lateral plate can be expected, with fewer associated complications.

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

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Progressive Collapsing Foot Deformity

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ABSTRACT
Adult-acquired flatfoot deformity is a complex orthopedic condition that was redefined with a new nomenclature and classification system published in 2020. In this article, we critically examine the newly introduced concepts, including the use of weightbearing computed tomography, detailing the changes in terminology and classification of the deformity and their clinical relevance. Additionally, we review current studies that support and refine this classification and identify areas for future research.
Keywords: Flatfoot; posterior tibial tendon; classification; collapsing deformity.
Level of Evidence: V

Deformidad colapsante progresiva del pie

RESUMEN
El pie plano del adulto es una entidad ortopédica compleja que ha sido objeto de una nomenclatura y clasificación nuevas publicadas en 2020. En este artículo, examinamos críticamente los nuevos conceptos introducidos, como la utilización de la tomografía computarizada con carga, analizando, en detalle, los cambios en la terminología y la categorización de la deformidad, así como su relevancia en la práctica clínica. Además, se revisan los estudios actuales que respaldan y refinan esta clasificación, y se identifican áreas para investigaciones futuras.
Palabras clave: Pie plano; tendón tibial posterior; clasificación; deformidad colapsante.
Nivel de Evidencia: V

INTRODUCTION

Adult flatfoot is a debilitating clinical condition characterized by a gradual loss of the medial longitudinal arch and foot function. It represents one of the most controversial and discussed disorders in the field of Orthopedics and Traumatology. The difficulty in understanding the disease may stem from its complex etiology, natural progression, varied clinical presentations, and diverse treatment approaches. Another obstacle to understanding this condition is the variety of names it has been given throughout history, such as adult-acquired flatfoot, posterior tibial tendon dysfunction (PTTD), tibialis posterior tendinopathy, lateral peritalar subluxation, or simply adult flatfoot. However, with the emergence of new anatomical concepts, imaging technologies, and surgical techniques, understanding the details of this complex disease has grown exponentially.[1,2]

In 2019, a group of expert surgeons with a significant number of publications on this condition met to reach a new consensus and redefine concepts regarding the terminology, classification, and treatment of the disease.[3]

The aim of this article is to provide a review of the current nomenclature and classification of this condition.

Selection of Experts

The original idea for the new consensus was developed by surgeons Cesar de Cesar Netto and Scott Ellis. They selected nine expert surgeons based on a minimum of 10 publications indexed in PubMed in high-impact journals covering various aspects of the diagnosis and treatment of adult flatfoot. The expert panel included Cesar de Cesar

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Netto (USA), Scott Ellis (USA), Lew Schon (USA), Mark Myerson (USA), Beat Hintermann (Switzerland), David Thordarson (USA), Jeffrey Johnson (USA), Jonathan Deland (USA), and Bruce Sangeorzan (USA). Each expert was asked to give a 10-minute presentation on a specific aspect of the diagnosis or treatment of adult flatfoot. From these presentations and subsequent discussions, additional aspect-specific consensus statements were formulated and voted on. Voting on each consensus statement consisted of agreement or disagreement. The strength of each statement was determined by the percentage of approval: unanimous (100%), strong (over 75%), or weak (between 50% and 75%). Following the final statements, each member was asked to write a manuscript summarizing the rationale for supporting the statements related to their talk, based on previous group discussions, clinical experience, and literature evidence.[3]

Consensus topics included: (a) new nomenclature and classification, (b) goals of surgical treatment, (c) evaluation of the amount of bony correction in surgical treatment, (d) use of weightbearing computed tomography (WBCT), (e) indication for medializing calcaneal osteotomy, (f) indication for lateral column lengthening, (g) indication for dorsal-opening wedge osteotomy of the medial cuneiform (Cotton osteotomy), (h) indication for isolated arthrodesis of the subtalar and cuneonavicular joints, and (i) indication for reconstruction of the deltoid and spring (plantar calcaneonavicular) ligaments.[4-12]

New Nomenclature

The consensus group recommended changing the term "adult-acquired flatfoot deformity" to Progressive Collapsing Foot Deformity (PCFD).

The term deformity is used because this is a complex, three-dimensional condition involving varying degrees of hindfoot valgus, forefoot abduction, midfoot varus, and medial ankle instability. The term collapsing emphasizes that the foot becomes globally dysmorphic, not just marked by isolated flattening of the medial arch. In addition, the term collapse is more objective and easier to describe and quantify than the more subjective term flat.

The word progressive reflects the natural history of the condition, indicating that it tends to worsen over time. It also clarifies that many patients may have painless flat feet initially, and it is only when progression toward collapse occurs that symptoms and dysfunction emerge.[4]

New Classification

The first classification for adult flatfoot was published by Johnson and Strom in 1989 (Table 1).[13.]

Table 1. Johnson and Strom classification.

Variable	Stage 1 Mild, medial pain	Stadium 2 Moderate, medial pain	Stage 3 Severe, medial and lateral pain
Physical examination	Mild swelling and tenderness along the PTT	Moderate swelling and tenderness along the PTT.	No swelling, but marked tenderness along the PTT
Single-leg heel raise	Mild weakness	Marked weakness	Marked weakness
Too many toes sign	Absent	Present	Present
Deformity	Absent	Present (flexible)	Present (fixed)
PTT	Normal tendon length, paratendinitis	Elongated with longitudinal tears	Disrupted
Images	No changes	Gross deformity	Deformity with osteoarthritis
Treatment	Nonoperative, tenosynovectomy	FDL Transfer	Triple arthrodesis

PTT = posterior tibial tendon; FDL = flexor digitorum longus.

The authors classified it into three stages, associated with dysfunction and eventual tear of the posterior tibial tendon (PTT), and referred to it as PTT dysfunction. Myerson, in 1997, added stage IV, referring to valgus ankle joint involvement: IV-A (flexible) and IV-B (rigid).[14] Recognizing instability of the medial column, forefoot abduction, and midfoot varus, Bluman et al., in 2007, modified all stages by subdividing them into different categories, with the most notable expansion in stage II (Table 2).[15]

Table 2. Bluman's classification.

Stage	Substage	Clinical findings	Radiographic findings	Treatment
I	A	Normal anatomy Tenderness along PTT	Normal	Immobilization, NSAIDs, Orthoses, Tenosynovectomy
	B	Normal anatomy Tenderness along PTT	Normal	Immobilization, NSAIDs, Orthoses, Tenosynovectomy
	C	Slight HF valgus Tenderness along PTT	Slight HF valgus	Immobilization, NSAIDs, Orthoses, Tenosynovectomy
II	A1	Supple HF valgus Flexible forefoot varus Possible pain along PTT	HF valgus Meary's line disruption Loss of calcaneal pitch	Orthoses Med. displ. calc. osteot. Achilles tendon lengthening or Strayer and FDL transf. if deformity corrects only with ankle plantarflexion
	A2	Supple HF valgus Fixed forefoot varus Possible pain along PTT	HF valgus Meary's line disruption Loss of calcaneal pitch	Orthoses Med. displ. calc. osteot. and FDL transf. Cotton osteotomy
	B	Supple HF valgus Forefoot abduction	HF valgus Talonavicular uncovering Forefoot abduction	Orthoses Med. displ. calc. osteot. and FDL transf. Lateral column lengthening
	C	Supple HF valgus Fixed forefoot varus Medial column instability Sinus tarsi pain	HF valgus First TMT plantar gapping	Med. displ. calc. osteot. and FDL transf. Cotton's osteotomy or medial column fusion
III	A	Rigid HF valgus Sinus tarsi pain	Subtalar joint space loss HF valgus Gissane's angle sclerosis	Custom bracing if not surgical candidate Triple arthrodesis
	B	Rigid HF valgus Sinus tarsi pain Forefoot abduction	Subtalar joint space loss HF valgus Gissane's angle sclerosis Forefoot abduction	Custom bracing if not surgical candidate Triple arthrodesis + lateral column lengthening
IV	A	Supple tibiotalar valgus	Tibiotalar valgus HF valgus	Surgery for HF valgus and associated deformity Deltoid reconstruction
	B	Rigid tibiotalar valgus	Tibiotalar valgus HF valgus	Tibiotalocalcaneal fusion or or pantalar fusion

NSAIDs = nonsteroidal anti-inflammatory drugs; FDL = flexor digitorum longus; Med. displ. calc. osteot.= medial displacement calcaneal osteotomy; HF = hindfoot ; TMT = tarsometatarsal joint; PTT = posterior tibial tendon.

This classification was widely used due to its added value as a guide for surgical indication and the type of procedure to be performed. However, it is recognized that this modification was also limited and did not sufficiently include the anatomical and radiographic details of the deformity. In 2012, Raikin et al. introduced a new classification more focused on the midfoot, called RAM, which divides the deformity into the individual components involved in the disease process (Table 3).[16] It retains the original classification of three stages, as well as the subclassifications introduced by Bluman et al., but applies them separately to the rearfoot (R), ankle (A), and midfoot (M).[16] In 2013, Richter and Zech published another clinical classification. They divided adult flatfoot disease into four stages according to PTT function, independent of joint flexibility. The authors' original intent was to differentiate PTT insufficiency and stiffness from deformity, suggesting that some patients with collapsed feet are not stiff, and others have stiff feet without any PTT lesion.[17]

Table 3. RAM classification.

	Rearfoot	Ankle	Midfoot
Ia	PTT tenosynovitis	Neutral alignment	Neutral alignment
Ib	PTT tendonitis without deformity	Mild valgus (<5º)	Mild flexible supination
IIa	Flexible planovalgus (<40% talar uncoverage, <30º of Meary angle, incongruency angle 20º-45º).	Valgus with deltoid ligament insufficiency (no osteoarthritis)	Supination without radiographic signs of instability
IIb	Flexible planovalgus (>40% talar uncoverage, >30º Meary angle, incongruency angle >45º)	Valgus with deltoid ligament insufficiency with tibiotalar osteoarthritis	Supination with instability without osteoarthritis
IIIa	Fixed/arthritic planovalgus (<40% talar uncoverage, <30º Meary angle, incongruency angle 20º-45º).	Valgus associated with lateral collapse of the tibial plafond (normal deltoid ligament).	Isolated osteoarthritis of the medial column (cuneonavicular joint or first tarsometatarsal joint).
IIIb	Fixed/arthritic planovalgus (>40% talar uncoverage, >30º Meary angle, incongruency angle >45º) - not correctable through triple arthrodesis	Valgus associated with lateral collapse of the tibial plafond with deltoid ligament insufficiency.	Medial and middle column with osteoarthritis (in general, with supination or abduction of the midfoot).

PTT = posterior tibial tendon.

While these classifications are still in use, the expert group had three main goals for incorporating a new classification: 1) to explicitly remove PTT as the primary cause of the disease; 2) to emphasize the fact that multiple deformities can occur simultaneously, in different anatomical sectors (multifocal) of the foot and ankle; and 3) to abandon the concept of sequential development of deformity by anatomical sectors (i.e., first PTT injury, and eventually ankle involvement), asserting instead that there is temporal progression—first the deformities are flexible and then they become rigid.

The new classification proposed by the expert group covers both anatomical and functional aspects. It is based solely on the flexibility or stiffness of the affected anatomical segment, and on the type and location of the deformity as determined by physical examination. The classification includes five classes of deformities that may occur in isolation or simultaneously (combined). Each class can be subdivided into stage I (flexible) or stage II (rigid). The five types of deformity (classes) are: (A) rearfoot valgus, (B) midfoot/forefoot abduction, (C) forefoot varus

or medial column instability, (D) peritalar subluxation, and (E) ankle instability.[4] Experts proposed using different letters for the classes to highlight that the patient may present with one or more elements of the deformity simultaneously. For example, if a patient has PTT dysfunction with stage and class 1AB, this refers to flexible deformities with marked hindfoot valgus and increased midfoot abduction. Another example could be a patient classified as stage 1ABE 2D, indicating a clinical case with hindfoot valgus, midfoot abduction, ankle valgus deformity (all flexible deformities), plus a rigid forefoot in supination or medial instability of the medial column.

Lee et al. studied the intra- and interobserver reliability of the new PCFD classification. They evaluated 94 feet with three independent observers. The findings demonstrated high intraobserver and moderate interobserver agreement. Only 5.8% of patients had isolated deformities, and the most frequent combinations were 1ABC, 1AC, and 1ABCD.[18] Li et al. evaluated the diagnostic accuracy of the classification. They prospectively studied 20 patients with 13 observers. The results yielded overall, class-specific, and stage-specific diagnostic accuracies of 71%, 78.3%, and 81.7%, respectively.[19]

Computed Tomography (Weight-bearing)

Many of the classes can be easily diagnosed clinically and through radiographs, such as class A (hindfoot valgus) and class E (ankle instability). However, class D (peritalar subluxation), which presents with external rotation, valgus, and lateral translation of the calcaneus in relation to the talus, is best diagnosed with cone-beam computed tomography (CBCT). Although experts highlight the broad benefits of CBCT, its inclusion in the new classification system received a weak recommendation.[7] One of the reasons is its limited availability. In South America, there are only two of these devices. Experts suggest that, when available, CBCT should be used for preoperative planning. They unanimously agreed that the signs to be evaluated on imaging include: sinus tarsi impingement, increased valgus tilt of the posterolateral facet of the subtalar joint, subluxation of the posterolateral or medial facet of the subtalar joint, and subfibular impingement.[7] CBCT not only allows confirmation of the diagnosis but also helps predict prognosis and disease progression. de Cesar Netto et al. retrospectively studied CBCT (coronal slices) in patients with PCFD and a control group. They reported that patients with PCFD had higher values of joint uncoverage and incongruity of the medial facet of the subtalar joint ($p < 0.0001$), which served as an isolated marker of peritalar subluxation. In addition, they found that joint uncoverage and incongruity in that facet had high diagnostic accuracy (>17.9%, with 100% specificity and 96.7% sensitivity; >8.4° with 100% specificity and 100% sensitivity, respectively) and represented an early marker of peritalar subluxation (medial facet vs. posterior facet: 17.7%) in PCFD.[20,21] Despite the advancements in CBCT, conventional anteroposterior and lateral weight-bearing radiographs of the foot, as well as forefoot or ankle mortise views, remain essential.

Stage I

A key aspect of this new consensus is the abandonment of Stage I (patients with pain but no deformity) from older classifications. The consensus states that there is no valid description for this stage, and only 5 of the 9 experts (56%) believe that surgery may be indicated. Experts suggest that at this stage, the condition reflects tendinitis or tendinosis of the posterior tibial tendon (PTT), but without deformity, describing it as a stable process. They argue that PTT failure occurs secondary to ligamentous attenuation in patients with underlying bony deformities.[4] Despite this, some authors argue that Stage I should continue to be used for patients with a subtle hindfoot valgus deformity (not visible on weight-bearing radiographs but detectable on CBCT), with medial soft tissue pain and inflammation (involving the PTT, calcaneonavicular, or deltoid ligament), and the presence of risk factors for disease progression (such as obesity, ligamentous laxity, chronic inflammatory disease, or gastrocnemius contracture).[22]

During the consensus discussions and voting, the most important finding in former Stage I was reported to be PTT pain (5/9, 56%), followed by gastrocnemius contracture and moderate hindfoot valgus (2/9, 22%). The surgeries considered potentially beneficial in this stage were gastrocnemius recession, PTT tenolysis and debridement, and medializing calcaneal osteotomy (5/9, 56%), followed by Cotton osteotomy, PTT tenolysis and debridement, and arthroeresis (1/9, 11%).[4]

Over the past 30 years, numerous classifications have been published, mainly based on flexibility and the site of deformity, emphasizing PTT injury as the primary cause. Perhaps due to this reasoning, progress in understand-

ing the disease's causes was limited. However, new studies in anatomy, biomechanics, and imaging have led to better insights into underlying deformities—such as joint positioning, angulation, and bone morphology—which may explain disease onset and even predict which patients may develop PCFD. Perhaps the key to resolving the controversy surrounding adult flatfoot lies in moving away from the idea of PTT failure as the cause of the condition.

Strengths

The change in terminology from adult acquired flatfoot to PCFD reflects a more comprehensive understanding of the condition as a progressive entity. This is significant, as the term "flatfoot" is often associated with a static and benign clinical picture, whereas "collapsing deformity" implies a dynamic and progressive process that can result in pain and functional impairment. The new terminology incorporates the use of CBCT, which enables assessment of foot alignment under partial weight-bearing conditions, providing a more realistic and accurate visualization of bony and articular architecture. It also offers a more detailed description of the stages and categories, which facilitates treatment planning and improves communication among surgeons.

Weaknesses

As with previous classifications, the current system includes several classes that may be difficult to memorize and apply in clinical settings. The subdivision into multiple classes may seem excessive and overly complex for quick application in everyday practice. The inclusion of only 2 stages and 5 classes results in up to 242 possible combinations. Classifications should be simple and easy to use.

As suggested by Boakye et al., to enhance usability, the classification should follow a more intuitive structure. Although the expert group based the classification on anatomical organization, it does not follow a linear pattern: it begins with hindfoot valgus deformity as Class A and moves distally to Class C (forefoot varus), then retrogresses to peritalar subluxation as Class D, and finally to ankle instability as Class E. A linear progression from ankle to forefoot would be easier to remember.

Another limitation is the lack of specification on whether flexible deformities are stable or unstable, and some joints may exhibit flexibility alongside arthritic changes.[23] PCFD is not a rare condition; therefore, the new classification may not align with the terminology and criteria used in prior studies and clinical registries on adult flatfoot, potentially hindering longitudinal comparisons and evaluations of treatment efficacy over time.

As with any shift in medical terminology, there may be resistance from clinicians accustomed to previous terms and classifications. This reluctance can delay adoption and limit implementation. In many cases, the most enduring classifications are those that withstand the test of time, even amid the development of new treatments.

CBCT represents a major advance in the assessment of PCFD. However, its limited availability in some countries may restrict its utility. It is essential for new classifications based on this imaging to remain adaptable and usable alongside traditional diagnostic methods in areas where CBCT is not accessible.

These criticisms highlight common concerns when transitioning to new medical terminologies, where the challenge lies in balancing accuracy and relevance with clinical practicality. While the intent behind updating nomenclature and classification is to improve clinical and surgical management of patients with PCFD, there are notable challenges in implementation, comprehension, and consistency.

CONCLUSIONS

Advances in the understanding of foot deformities and associated findings arising from new research eventually lead to revisions or updates in classification systems.

Staging systems are often developed to classify the severity of a condition according to various criteria, such as clinical features, imaging findings, and functional impairment. The proposed new staging for PCFD could provide surgeons with a more standardized approach to assessing and managing the condition, which may lead to improved patient outcomes. It would be valuable to further evaluate this new staging system in terms of its validation, reliability, and clinical utility to determine its effectiveness in guiding treatment decisions and predicting prognosis.

The new nomenclature aims to improve the clarity, accuracy, and consistency of terminology applied to PCFD. If this new nomenclature is to be adopted, it would be beneficial to assess its acceptance and implementation within the trauma and orthopedic medical community to understand its potential impact on clinical practice and future research.

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

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Chronic Swivel Dislocation of the Talonavicular Joint Due to Low-Energy Trauma: A Case Report

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ABSTRACT
Midfoot dislocations are rare injuries, and talonavicular joint dislocations often go unnoticed. In the literature, reports of swivel dislocations are limited to case studies, most of which are associated with high-energy trauma and acute kinematics. We present a case of a swivel dislocation with a six-week evolution following low-energy trauma. This report discusses the management of this unusual condition and how an earlier diagnosis could have been suspected and achieved.
Keywords: Talus; dislocation; swivel; chronic; arthrodesis; low energy.
Level of Evidence: IV

Luxación inveterada de la articulación astrágalo-escafoidea, de tipo giratoria, por traumatismo de baja energía. Reporte de un caso

RESUMEN
Las luxaciones del mediopié son lesiones raras, y las de la articulación astrágalo-escafoidea, con frecuencia, se pasan por alto. En la bibliografía, solo hay informes de casos sobre luxaciones de tipo giratorio (*swivel*), la mayoría de ellas, secundarias a traumatismos de alta energía y cinemática aguda. Se presenta un caso de una luxación de este tipo provocada por un traumatismo de baja energía, con 6 semanas de evolución. Se comenta el manejo de este cuadro inusual y cómo se podría haber sospechado y diagnosticado antes.
Palabras clave: Astrágalo; luxación giratoria; inveterado; artrodesis; baja energía.
Nivel de Evidencia: IV

INTRODUCTION

Midfoot dislocations are rare injuries, accounting for 2% of all traumatic foot injuries, according to Elmaghrby et al. Fewer than 12% of midfoot dislocations correspond to a talonavicular swivel dislocation, making it a unique injury.[1]

In 1975, Main and Jowett published the first descriptions of the classification and presentation of this type of injury. They defined dislocation of the talonavicular joint with preservation of the calcaneocuboid and talocalcaneal joints as "rotating" or rotational injuries, depending on the direction of the deforming force: medial compression, lateral, plantar, longitudinal, and crushing. In these cases, the talus rotates over the calcaneus, with the sustentaculum tali and interosseous ligament acting as a fulcrum, leading to talonavicular dislocation (Figure 1).[2,3]

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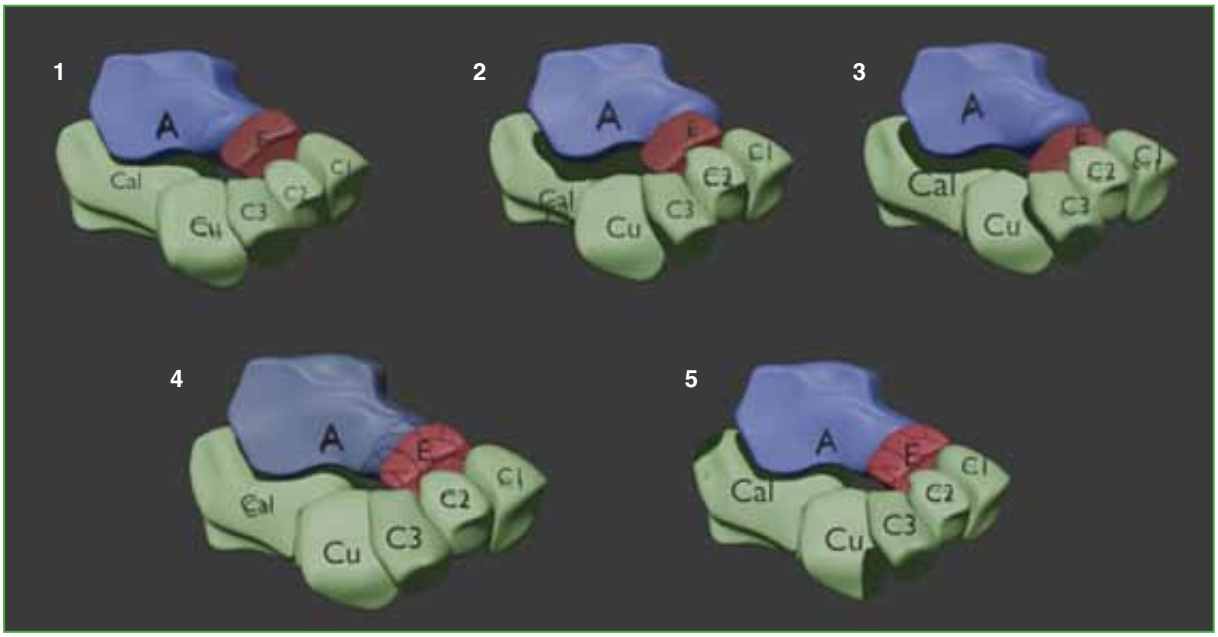

Figure 1. Main and Jowett's 1975 classification of talonavicular injuries according to direction. **1.** Medial dislocation. **2.** Lateral dislocation. **3.** Plantar dislocation. **4.** Crush injury. **5.** Longitudinal compression injury (3D model of the foot courtesy of Juan Fernando Romero Rosero).

In this article, we describe the clinical history, treatment, and follow-up of a patient with a chronic medial swivel dislocation caused by low-energy trauma. The literature on this condition is limited to a few case reports.[3-8.]

CLINICAL CASE

A 60-year-old male, employed in a factory, with a history of uncontrolled hypertension and a body mass index of 24.2, reported having sustained trauma to his right foot six weeks earlier. The incident occurred while stepping off a stationary bus while carrying a 10 kg bag in his right hand. After placing full weight on his right foot, he experienced intense pain, perceived a deformity, and had significant functional limitation.

He was initially evaluated by a general practitioner, who referred him to Orthopedics for outpatient consultation rather than emergency care. He presented late to our Department, with lameness, residual edema, pain, and medial deformity in the midfoot, as well as a tendency toward supinatus and cavus. He had limited inversion, eversion, and plantar flexion movements.

Initial radiographs showed a medially rotated talonavicular dislocation with impaction of the navicular on the anterior articular surface of the talus and a fracture of the cuboid. A CT scan was performed to identify associated injuries and assist in surgical planning (Figure 2). Given the chronic nature of the case and the presence of an osteochondral injury, we opted for open reduction of the dislocation, followed by stabilization with arthrodesis and bone graft. The patient signed an informed consent form authorizing the use of his images.

Surgical Technique

A dorsal approach was performed in the midfoot over the area of deformity. Using blunt dissection, the extensor hallucis longus tendon and the dorsalis pedis artery were retracted laterally, and the anterior tibial tendon medially. The joint capsule was incised, and the fibrous tissue interposed in the talonavicular space was removed. The remaining cartilage from both bones was debrided using a blade, distractor, and a reaming drill. Headless compression screws were placed, and a bone substitute was applied to the arthrodesis site as well as to the articular defect of the talus. In this case, no procedures were performed for the cuboid fracture, which was chronic, with a sagittal fracture line and minimal displacement.

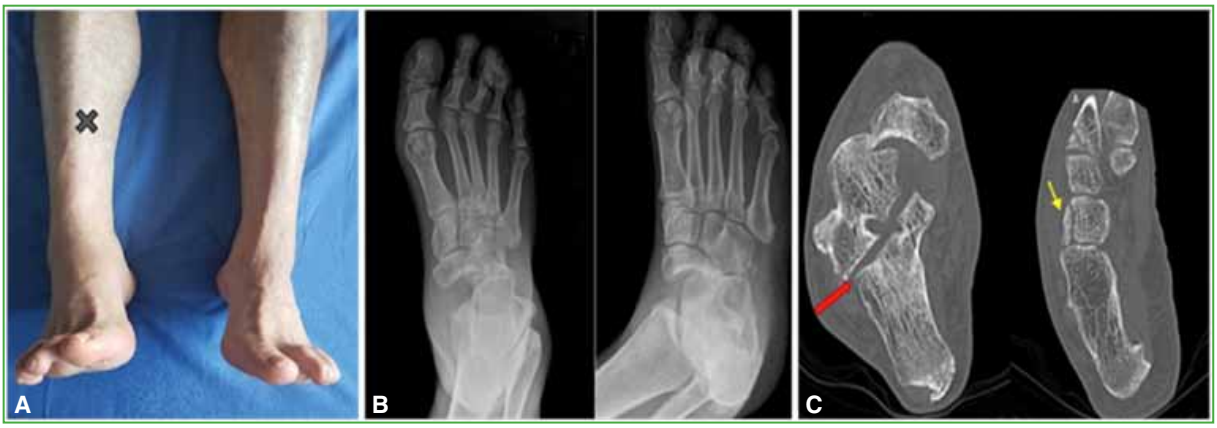

Figure 2. **A.** Clinical image of the right foot (x) showing medial arch deformity with a tendency toward cavus. **B.** Anteroposterior and oblique radiographs of the right foot demonstrating dislocation of the talus, with the talar head impacted on the tarsal scaphoid. **C.** Axial computed tomography of the right foot showing an intact subtalar joint (red arrow) and a cuboid fracture (yellow arrow) with a congruent calcaneocuboid joint.

Postoperatively, control radiographs were obtained, analgesia was administered, and intravenous antibiotic prophylaxis was given for 24 hours. Early rehabilitation was indicated by the physiatry team.

The patient was discharged. At the 3-week follow-up visit, sutures were removed. Weight-bearing was restricted for 8 weeks, after which progressive loading was allowed.

At the conclusion of follow-up, 18 months postoperatively, the patient had a stable, plantigrade, pain-free foot. The American Orthopaedic Foot and Ankle Society (AOFAS) score was 87.

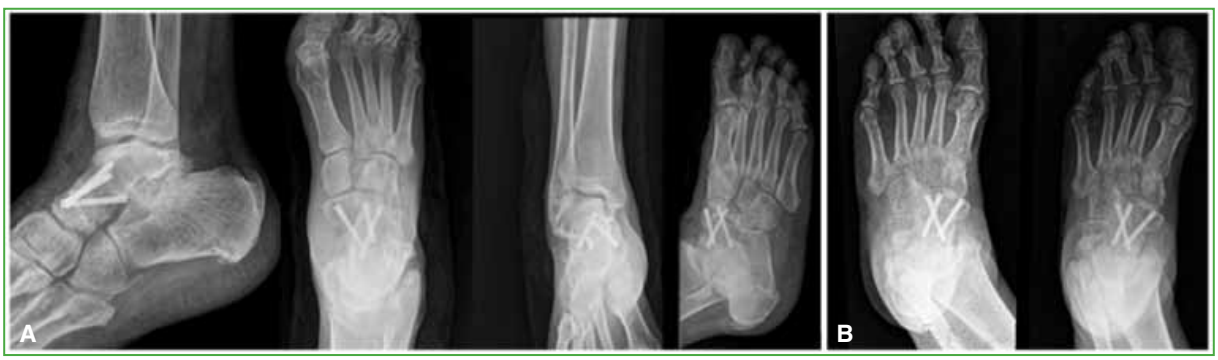

Figure 3. Anteroposterior and oblique radiographs of the right foot. **A.** Initial postoperative control. **B.** Complete consolidation of the arthrodesis at 6 months.

DISCUSSION

Dislocations of the talonavicular joint are infrequent injuries; only isolated case series have been published. When reviewing the literature since 1977, we found cases of this type associated with high-energy trauma mechanisms, such as falls from heights and traffic accidents,[4,5] as well as low-energy mechanisms such as ankle inversion, twisting of the foot, or even walking—[1,6,8] all managed acutely within the first 21 days.

Regarding treatment, closed reduction is the first step in managing this condition.[1,6] When this is not possible, a direct surgical approach to the talonavicular joint is used to achieve a congruent reduction. In such cases, the joint has been stabilized with Kirschner wires (K-wires).[4,5,8]

Cases of late-treated injuries have also been reported.[7,9] Only three involved high-energy trauma and were managed after more than 6 weeks. In two of these cases, open reduction and stabilization with K-wires were performed (in patients aged 20 and 35 years). In the third case, Kumar et al.[7] performed arthrodesis due to the time elapsed and the joint damage to the talar surface, in a 48-year-old patient.

Our case is unique in the literature of the last 45 years, as it involves a chronic medial swivel talonavicular dislocation caused by a low-energy mechanism, in an active working patient without risk factors such as overweight, steroid use, or known collagen disorders. A cuboid fracture was also documented, likely due to tension in the lateral column—contrary to Main and Jowett's 1975 hypothesis,[2] which associated cuboid fractures exclusively with lateral rotational injuries involving compression of the lateral column. This raises the possibility that the pathophysiological mechanisms underlying this type of injury are not yet fully understood.

CONCLUSIONS

Injuries of this nature are relatively easy to diagnose in the acute setting when associated with high-energy trauma, such as motorcycle accidents or falls from heights. They present with pain, edema, ecchymosis, deformity, loss of the medial arch contour, and inability to bear weight. A radiographic foot series including anteroposterior, oblique, and lateral views enables visualization of the disrupted talonavicular relationship. Closed reduction can then be attempted under sedation or general anesthesia to achieve maximum muscle relaxation.

However, in cases of low-energy trauma (e.g., twisting injuries or monopodal support), the findings may be subtle and fail to raise clinical suspicion, leading to delayed consultation and functional sequelae in the medium and long term.

When injuries are more than 3 weeks old (chronic), clinical findings such as gait limitation, residual edema, midfoot deformity, and radiographic evidence of disrupted talonavicular joint alignment, associated fractures, osteochondral lesions, joint impaction, or exposure of the talar head, suggest a delayed presentation. In these cases, closed reduction is no longer feasible, and open reduction is required. Joint stabilization may involve K-wire fixation or, depending on the condition of the articular cartilage, debridement and arthrodesis with rigid internal fixation.

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

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Volkmann and Tillaux Fracture in Adults. Unusual Bimalleolar Equivalent. A Case Report

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ABSTRACT
Fractures of the distal anterolateral malleolus of the tibia, or Tillaux-Chaput fractures, are frequently seen in skeletally immature patients and rarely in adults. The posterior distal ridge of the tibia or Volkmann's fragment may be presented as an isolated fracture, but most often forming part of ankle fracture-dislocation trimalleolar, quadrimalleolar, as well as in Maisonneuve-type injuries. However, the synchronous presence of Volkmann-Tillaux fractures is very unusual and rarely reported in the literature. We present a case of bimalleolar equivalent fracture in an adult, along with its diagnosis, classification, management and clinical-radiological evolution.
Keywords: Tillaux; Chaput; malleolar equivalent; Volkmann; bimaleolar; case report.
Level of Evidence: IV

Fractura de Volkmann y Tillaux en adultos. Equivalente bimaleolar inusual. Reporte de un caso

RESUMEN
Las fracturas del maléolo anterolateral distal de la tibia o de Tillaux-Chaput son frecuentes en los pacientes esqueléticamente inmaduros y son raras en los adultos. El reborde distal posterior de la tibia o fragmento de Volkmann puede presentarse como una fractura aislada, pero, con más frecuencia, como parte de una luxofractura trimaleolar, cuadrimaleolar, así como en lesiones de tipo Maisonneuve. Sin embargo, la presencia sincrónica de fracturas de Volkmann-Tillaux es muy inusual y pocas veces publicada. Presentamos un caso de fractura equivalente bimaleolar en un adulto, su diagnóstico, la clasificación, el manejo y la evolución clínico-radiológica.
Palabras clave: Tillaux; Chaput; equivalente maleolar; Volkmann; bimaleolar; reporte de caso.
Nivel de Evidencia: IV

INTRODUCTION

The distal tibiofibular joint is a syndesmosis, or fibrous joint, composed of two bones and four ligaments. The bony components are the distal tibia and fibula, while the ligamentous structures include the anteroinferior tibiofibular ligament, interosseous ligament, posteroinferior tibiofibular ligament, and transverse ligament.[1] At the apex of this syndesmosis, the tibial crest divides into an anterior margin that ends at the distal anterolateral portion of the tibial plafond, known as Tillaux-Chaput's tubercle, while the posterior ridge ends at the distal posterolateral tibial margin, called Volkmann's tubercle. Together, these structures form the triangular bony bed of the talocrural joint, which houses the distal 6 cm of the fibula.[2]

The distal posterior tibial margin was first described by Destot in 1911 and has been referred to as the third malleolus, although this may not be the most anatomically accurate term, as it does not resemble a small hammer (the original meaning of the Latin term malleolus). The distal anterolateral tubercle is known as Tillaux-Chaput's tubercle, named after the two French surgeons who studied this area in 1872 and 1907, respectively. Since 1996, thanks to the work of van Laarhoven,[3] it has also been referred to as the fourth malleolus.

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The anteroinferior tibiofibular ligament is the smallest of the syndesmotic ligaments, with a fibular insertion of 8.5 mm.[2] It originates from Tillaux-Chaput's tubercle and inserts into the distal anterior portion of the fibula, known as Wagstaffe-Le Fort's tubercle. This ligament provides 35% of syndesmotic stability. The posteroinferior tibiofibular ligament runs between Volkmann's tubercle and the posterior margin of the distal fibula, contributing 33% of syndesmotic stability. Its deep portion, known as the transverse inferior tibiofibular ligament, is a strong fibrocartilaginous structure just distal to the posteroinferior tibiofibular ligament. Lastly, the interosseous ligament, which is the distal extension of the interosseous membrane, is located 9.3 mm from the tibial plafond and contributes 22% of syndesmotic stability.[4]

Tillaux-Chaput fractures account for 2.9% of physeal injuries in skeletally immature patients. This injury results from trauma in adolescents aged 14 to 16 years, who present with asymmetric closure of the distal tibial physis. It is classified as a Salter-Harris type III fracture.[5] In contrast, this injury is rare in adults. As of 2019, only small series of cases had been published, with no more than 32 cases reported. The mechanisms of trauma in adults include ankle sprains (50%), traffic accidents (24%), and falls from heights (24%).[6]

Posterior malleolar fractures are often associated with lateral malleolar injuries, medial malleolar fractures, or Maisonneuve fractures. However, when isolated, they account for only 0.5–1% of all ankle fractures. As of 2016, the number of reported isolated cases did not exceed 75 patients. In these cases, the pathophysiological mechanism primarily involved axial loading with a fixed ankle in plantarflexion, although rotational forces were also thought to contribute.[7]

Ankle radiography is the first-line imaging modality in trauma patients. However, its sensitivity for detecting isolated posterior malleolar fractures is only 63%, and for Tillaux-Chaput fractures, it is as low as 50%. Given these limitations, the use of complementary imaging techniques, such as computed tomography (CT), has become standard practice in foot and ankle trauma. CT offers minimal motion artifacts, high image resolution, and the possibility of three-dimensional reconstruction. Although the radiation dose is approximately 1 mSv (compared to 0.01 mSv for conventional radiography), it remains within the low-dose range when compared to tomographic studies of other body regions.[8]

The classification systems proposed by Rammelt (2015) and Bartoníček (2021) provide a framework for categorizing these fractures. Tillaux-Chaput fractures are classified into three types based on size, involvement of the fibular incisura, and articular depression. For posterior malleolar fractures, there are five types, categorized by fragment morphology, the presence of an intercalary segment, medial extension, and involvement of the tibial incisura. These classifications help guide surgical approach and management.[9,10]

Here, we present the diagnosis and management of a rare injury in an adult patient with ankle trauma. The patient sustained a simultaneous anterior and posterior malleolar fracture, with no other associated injuries, representing a bimalleolar equivalent fracture. To date, only a few cases of this specific injury pattern have been published.

CLINICAL CASE

A 62-year-old housewife, previously independent in her self-care and household activities, with non-insulin-dependent type 2 diabetes mellitus, controlled arterial hypertension, and asymptomatic bilateral hallux valgus, presented to the Emergency Department of our institution after suffering an inversion trauma while descending a step. She reported pain, edema, and an inability to stand or walk. On examination, she had pain on palpation of the dorsum of the foot, spontaneous toe movement, and a symmetrical palpable foot pulse. No deformities or open injuries were observed. She underwent anteroposterior and lateral radiographs of the right ankle, which revealed asymmetry at the tibiofibular junction and loss of tibial joint congruity (Figures 1 and 2).

Based on these findings, a CT scan was requested, revealing a displaced anterolateral Tillaux-Chaput tubercle fracture, rotated in a shear pattern, and a simultaneous displaced Volkmann's posterior malleolus fracture. These fractures were classified as Rammelt type III and Bartoníček type II, respectively (Figure 3).

This injury pattern resulted in a bimalleolar equivalent fracture with syndesmotic instability due to an extension of the joint notch. It was decided to proceed with open reduction and internal fixation.

The patient provided written informed consent for surgery. Intravenous antibiotic prophylaxis and spinal anesthesia were administered. After asepsis and antisepsis, the patient was positioned in a lateral decubitus position. A posterolateral approach to the distal tibia was performed, with dissection by planes, opening of the crural fascia, identification and protection of the sural nerve, and dissection between the flexor hallucis longus medially and the peroneal tendons laterally. The Volkmann's malleolus fracture was reduced and fixed with two cannulated screws and a washer, achieving stabilization. The patient was then repositioned to a supine position for an anterolateral

approach to the distal tibia. Dissection by planes was carried out, identifying and protecting the sensory branch of the superficial fibular nerve. The Tillaux-Chaput fracture was then exposed, the articular surface was reduced, and fixation was performed using a 2.7 mm L-plate with 2.4 mm screws, achieving reduction and stabilization of the fragment.

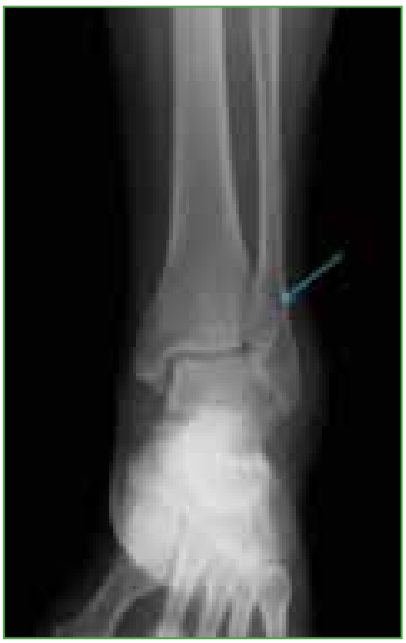

Figure 1. Anteroposterior radiograph of the left ankle. Asymmetry of the anterolateral malleolus contour (blue arrow).

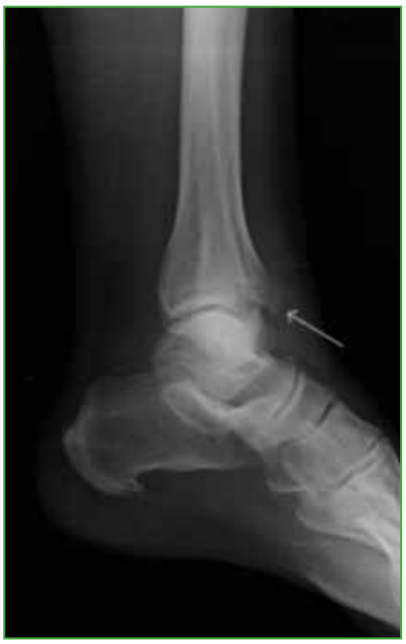

Figure 2. Lateral radiograph of the left ankle. Displaced anterior tibial bone fragment (blue arrow).

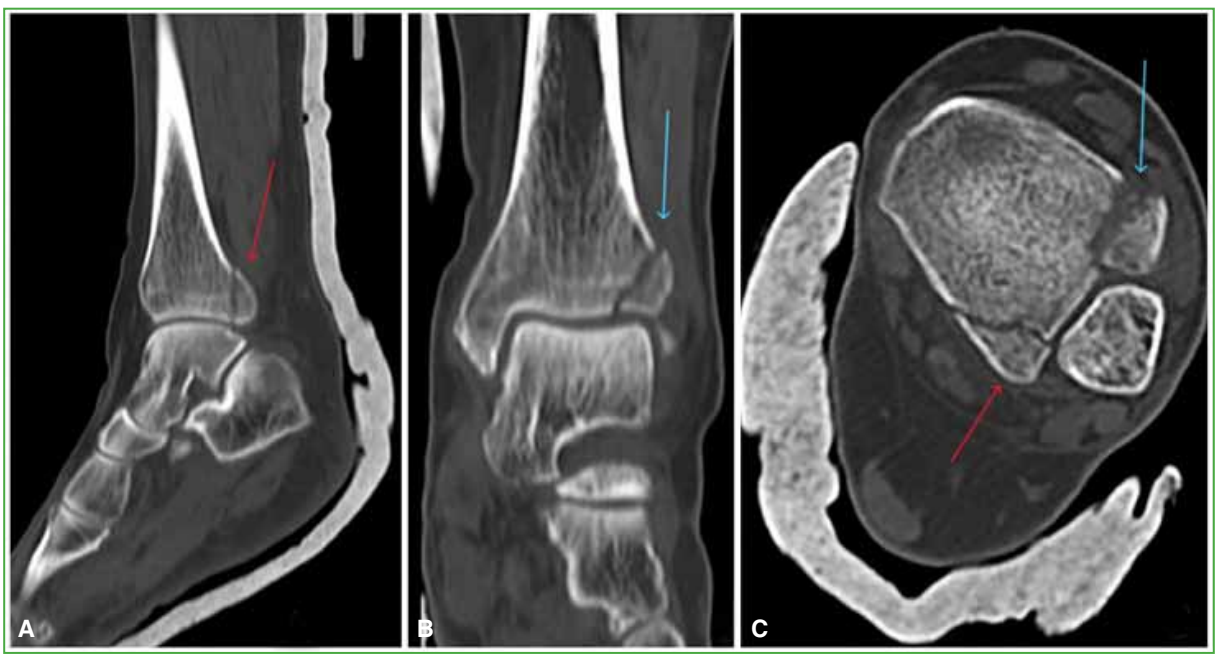

Figure 3. Computed tomography of the left ankle. **A.** Sagittal section showing a posterior malleolus fracture (red arrow). **B.** Coronal section showing an anterolateral malleolus fracture (blue arrow). **C.** Axial view showing simultaneous fractures of the Volkmann fragment (red arrow) and the Tillaux-Chaput fragment (blue arrow), with involvement of the fibular notch.

The patient was discharged with a Robert Jones bandage. Active mobility exercises, analgesic management, and thromboprophylaxis were prescribed for 15 days, with no weight bearing allowed. In the second week, the surgical wounds were examined, and she began a physical therapy program with progressive weight-bearing using crutches. Full weight-bearing was authorized at six weeks.

After 12 months, fracture healing was confirmed (Figures 4 and 5), and the patient resumed her usual activities. Her American Orthopedic Foot and Ankle Society (AOFAS) score was 91, and her Olerud-Molander functional scale score was 95 (Figure 6).

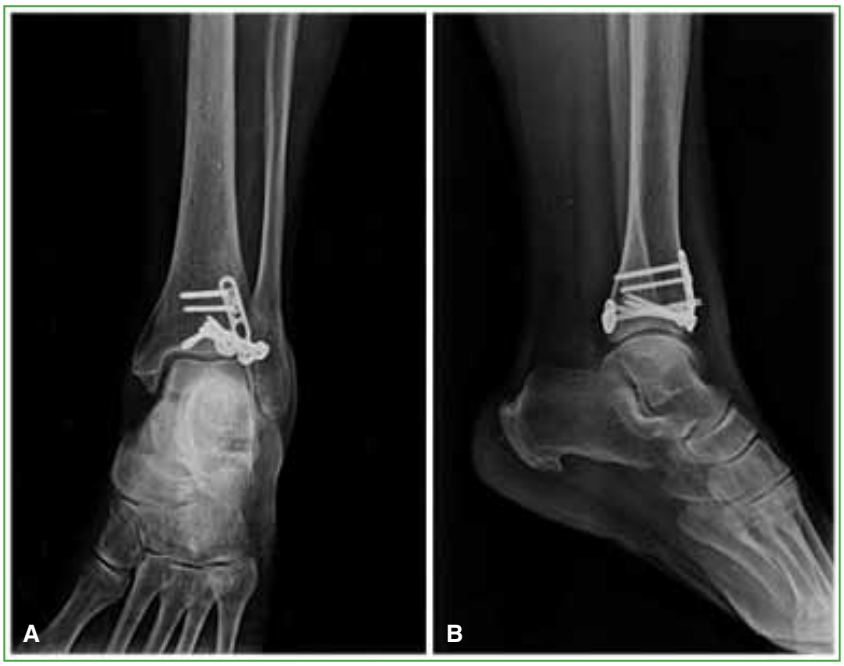

Figure 4. Left ankle radiographs at 12-month follow-up. **A.** Anteroposterior view, showing no intra-articular material. **B.** Lateral view, demonstrating complete healing of both Volkmann and Tillaux fractures, with congruent tibiotalar reduction.

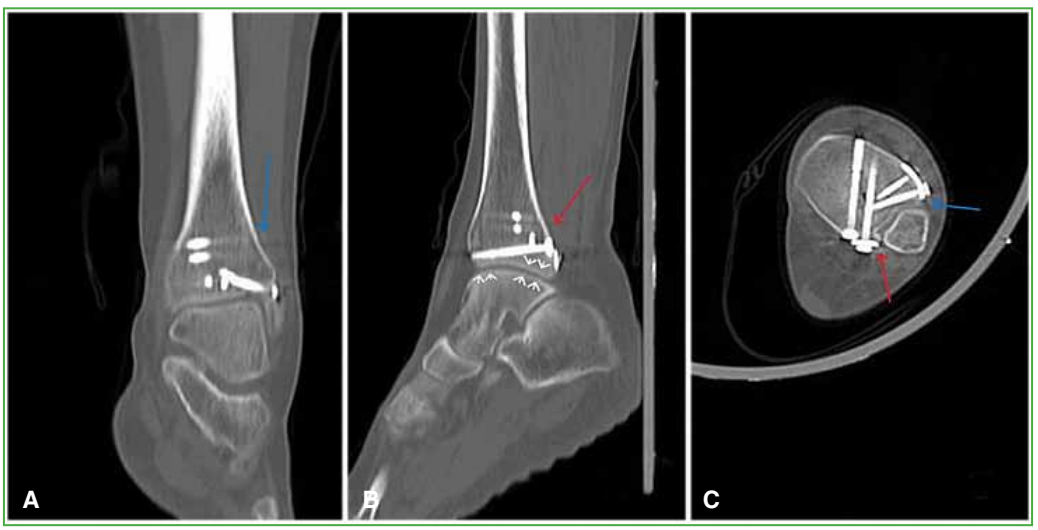

Figure 5. Computed tomography of the ankle at 12 months. **A.** Complete union of the Tillaux-Chaput fracture (blue arrow). **B.** Adequate healing of the Volkmann fracture (red arrow), with slight narrowing of the tibiotalar joint space (white arrowheads). **C.** Concentric reduction of the fibula within the fibular notch. Stable internal fixation of the Tillaux-Chaput (blue arrow) and Volkmann (red arrow) fractures.

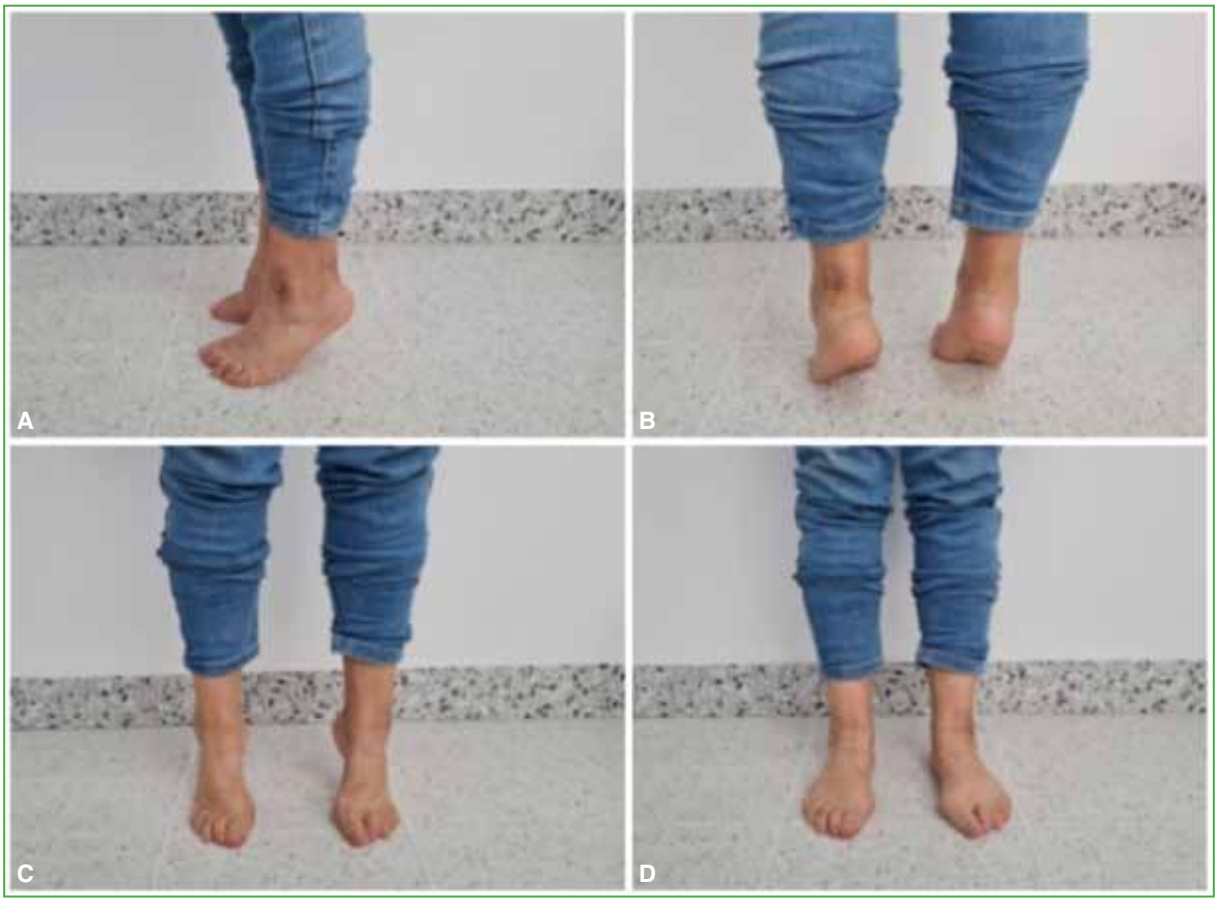

Figure 6. Clinical and functional assessment at the end of follow-up. **A-C.** Lateral, posterior, and anterior views showing adequate plantar flexion. **D.** Anterior view demonstrating the absence of malalignment.

Approval was obtained from the Ethics Committee of Clínica Antioquía for the publication of clinical data and images.

DISCUSSION

The concept of ring injuries in ankle trauma suggests that injuries occur sequentially, akin to a clock, without "skipping" anatomical structures. If a discordance is found, it is likely that an occult injury has been overlooked or that the injury mechanism has been misinterpreted. The predictive concordance of this model is 96%.[11] Consequently, bone and ligament stabilization of unstable ankle injuries reduces the need for trans-syndesmotic fixation in up to 83% of cases.[12]

However, ankle trauma can also present with injury patterns that do not follow the rule, manifesting in unusual ways—such as the combination of anterolateral Tillaux-Chaput fractures with posterior Volkmann's malleolus fractures. There are very few publications on these injuries. We conducted a literature search in databases such as PubMed, Embase, Cochrane, Google Scholar, and LILACS, covering the period from 1964 to 2024, in both Spanish and English. Over these 60 years, only a few case reports have been published (Table).[13-16]

Thus, we present our case as a rare bimalleolar equivalent fracture: Volkmann and Tillaux in an adult, with no other associated injuries. This represents the eighth reported case in the literature over the past six decades. Reduction and fixation of both bony components were performed, successfully restoring the stability of the distal tibiofibular ring. The patient demonstrated favorable clinical and radiological evolution, achieving functional recovery and complete fracture healing.

Table. Literature review with case reports.

Study	Number of patients	Diagnosis	Treatment	Follow-up/Evolution
Kose et al.[13] (2016)	2	Displaced Tillaux fracture >2 mm and non-displaced Volkman fracture	Tillaux fracture fixation with a compression screw and a washer. Without fixation of the posterior malleolus.	6-14 months/complete consolidation AOFAS: 100 in both cases
Mansur et al.[14] (2019)	1	Tillaux and Volkmann lesion in a patient with Maisonneuve lesion.	Fixation of each of the components: one-third tubular plate, one full threaded screw, two anterolateral cannulated screws	12 months/pain-free AOFAS: 100
Pérez et al.[15] (2021)	1	Displaced Tillaux fracture >2 mm and non-displaced Volkmann's fracture	Tillaux fracture fixation with cannulated screws. Without fixation of the posterior malleolus.	6 months/adequate radiographic evolution AOFAS: not reported
Rammelt et al.[16] (2022)	4	Displaced Tillaux's fracture and Volkmann's fracture	The type of fixation is not reported	Follow-up/AOFAS: not reported

AOFAS = *American Orthopedic Foot and Ankle Society Score*.

The main limitation of our study is that it consists of a single case with only 12 months of follow-up. There are no large case series or published guidelines to establish standardized management protocols. However, based on our experience, we can infer that anatomic reconstruction improves clinical and radiological outcomes in patients with similar injuries in the future.

CONCLUSIONS

The continuous expansion of the literature suggests that anatomical reconstruction of ankle injuries—through reduction and fixation of each bony component, particularly around the syndesmosis—achieves better functional and radiological outcomes than simply restoring syndesmotic stability using rigid or flexible syndesmotic trans-fixation methods.

In cases of ankle trauma, it is essential to remember that the ankle is a dynamic and functional structure. The presence of a malleolar fracture, and indirectly a ligamentous injury (such as syndesmotic widening), is not merely an isolated event but is often part of a broader spectrum of injuries. These must be thoroughly evaluated using radiographs and CT scans to assess fragment size, involvement of the incisura, gaps, step-offs, or occult fractures.

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

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Case Resolution

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Case Presentation on page 112.

Pain in the Hindfoot

ABSTRACT
We present the case of a 20-year-old male football player who consulted for medial hindfoot pain in his left foot, lasting for a few months, with no identifiable history of trauma and unresponsive to analgesics. On physical examination, pes planovalgus was observed, more pronounced on the affected side. Radiographs and magnetic resonance imaging (MRI) revealed an expansile, eccentric, well-defined, multilobulated lesion with internal fluid-fluid levels. Differential diagnoses are discussed: aneurysmal bone cyst, ganglion cyst, and intraosseous lipoma. The possible treatment is described.
Keywords: Bone cysts; calcaneus
Level of Evidence: IV

Dolor en el retropié

RESUMEN
Se presenta a un varón de 20 años, que practica fútbol habitualmente, y consulta por dolor interno del retropié izquierdo, de un par de meses de evolución, sin poder determinar un antecedente traumático y que no calma con analgésicos. En el examen físico, se constata pie plano valgo, más acentuado del lado del dolor. Se solicitan radiografías y una resonancia magnética que muestran una lesión expansiva, excéntrica, de contornos bien definidos, polilobulada, con niveles líquido-líquido en su interior. Se discuten los diagnósticos diferenciales: quiste óseo aneurismático, quiste óseo sinovial y lipoma intraóseo. Se describe el tratamiento posible.
Palabras clave: Quistes óseos; calcáneo.
Nivel de Evidencia: IV

DIAGNOSIS: Aneurysmal bone cyst (ABC).

DISCUSSION

The differential diagnoses of a benign polylobulated calcaneal tumor included a simple bone cyst (Figure 4), an ABC (Figure 5), or an intraosseous lipoma (Figure 6).

A needle biopsy was performed under image intensifier guidance in the operating room, based on the assumption that the appearance of the extracted fluid would confirm the diagnosis. If the fluid was yellow, it would indicate a synovial cyst, requiring a specific type of treatment. If the fluid was hematic, it would confirm the diagnosis of an ABC.

Received on February 20th, 2025. Accepted after evaluation on February 24th, 2025 • Prof. Dr. JUAN MANUEL TREBINO MOLTENI • mtrebino@gmail.com https://orcid.org/0009-0001-0643-8391
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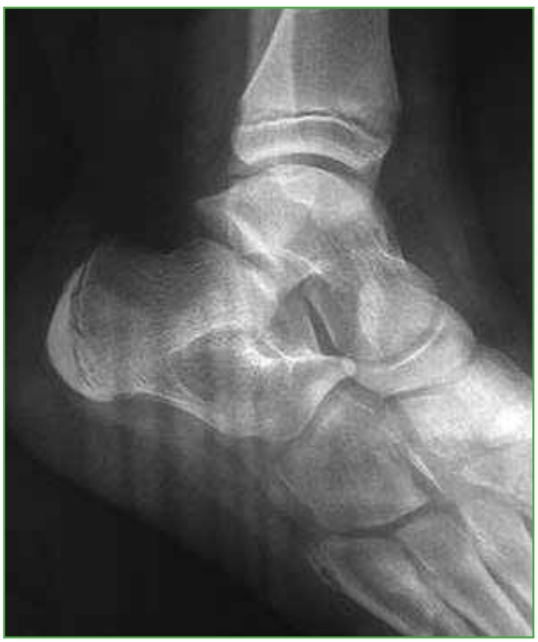
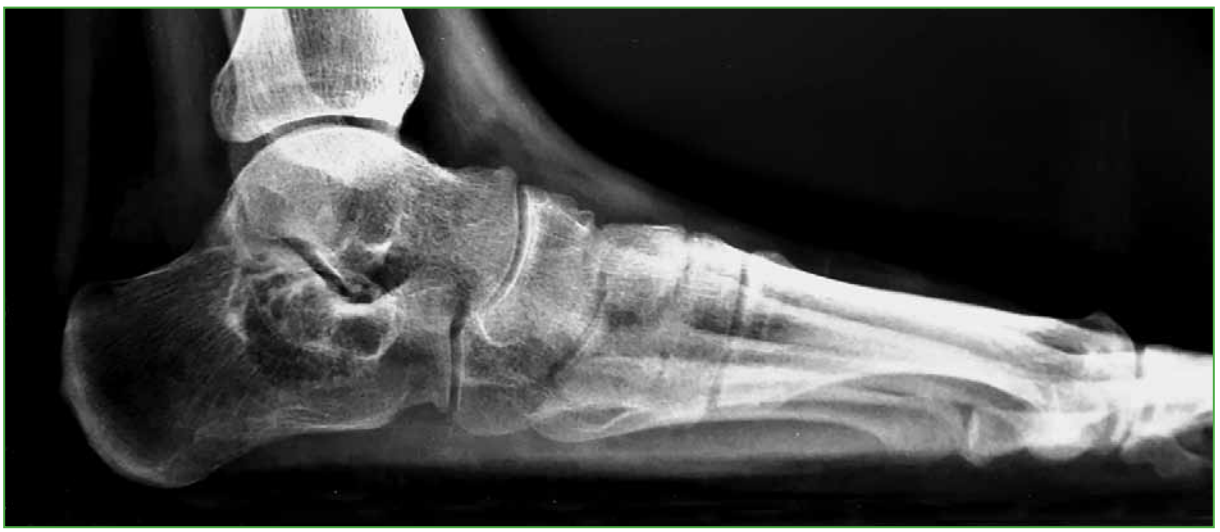


Figure 4. Lateral radiograph of the foot. Simple bone cyst.

Figure 5. Lateral radiograph of the foot. Aneurysmal bone cyst.



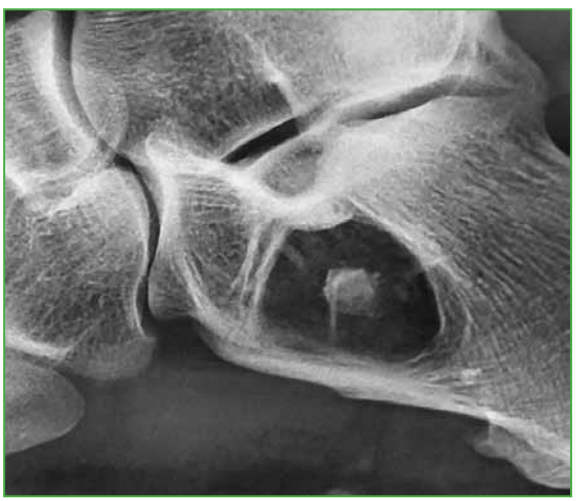


Figure 6. Lateral radiograph of the foot, focusing on the calcaneus. Intraosseous lipoma.

Figure 7. Diagnostic needle biopsy and drainage of hematic fluid, confirming the diagnosis of aneurysmal bone cyst.

Figure 8. Needle used for the procedure.

Figure 9. Polidocanol ampoules.

Figure 10. Administered dose of sclerosant ampoules.

After aspirating as much blood as possible, an ampoule of 3% polidocanol (a venous sclerosant) was injected (Figures 7-10).

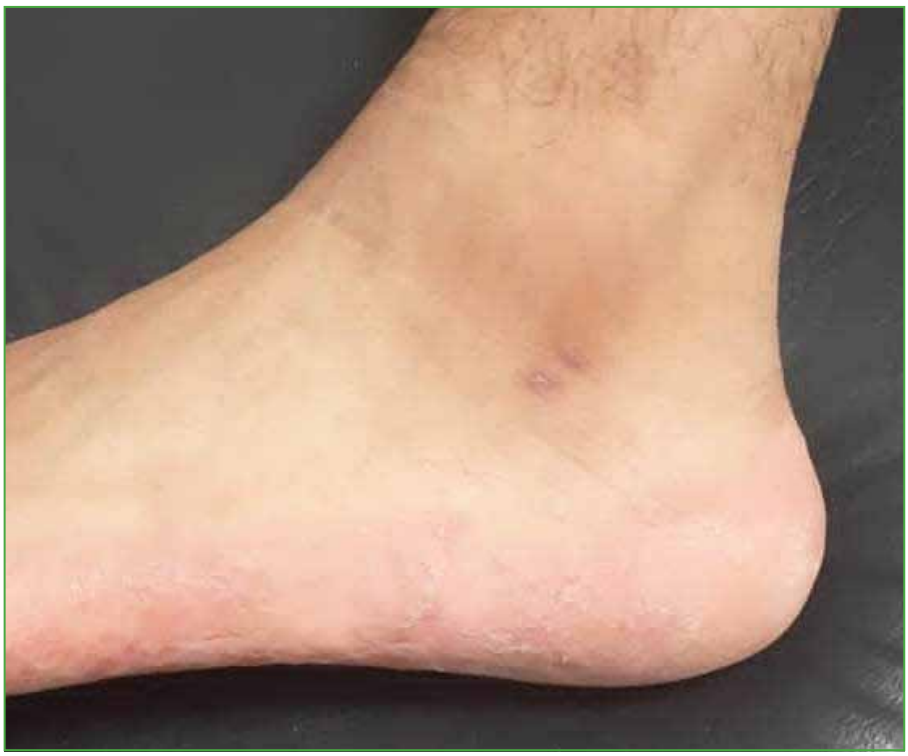


Figure 11. Lateral clinical appearance of the foot two months after surgery.

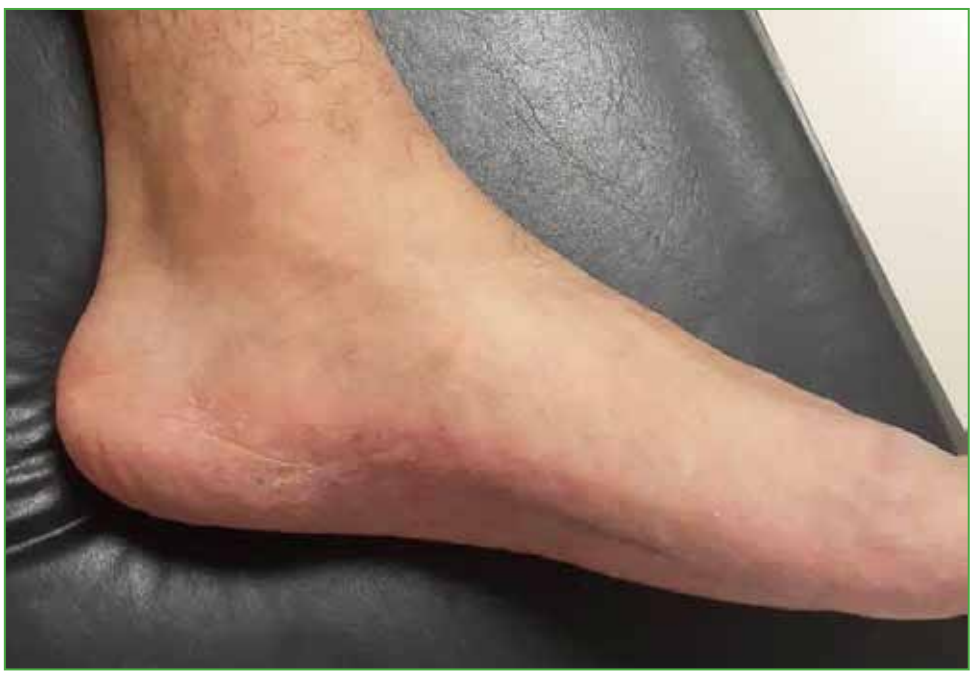


Figure 12. Postoperative medial clinical appearance of the foot.

Figures 11 and 12 show the clinical appearance of the patient two months after surgery, with no pain, minimal morbidity, and no complications.

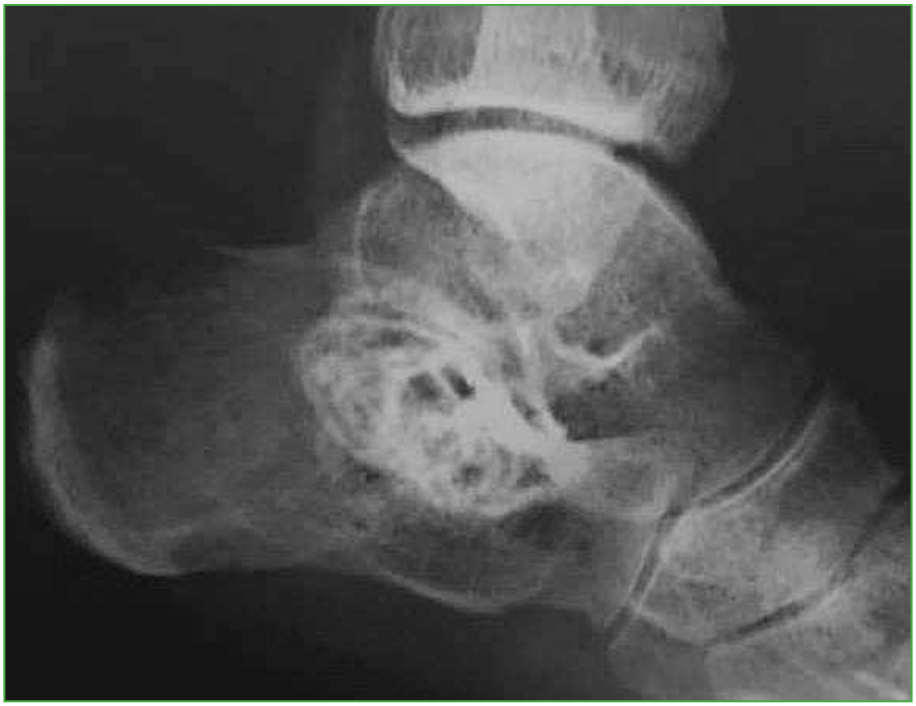


Figure 13. Lateral radiograph of the internal side of the foot, four months after the procedure.

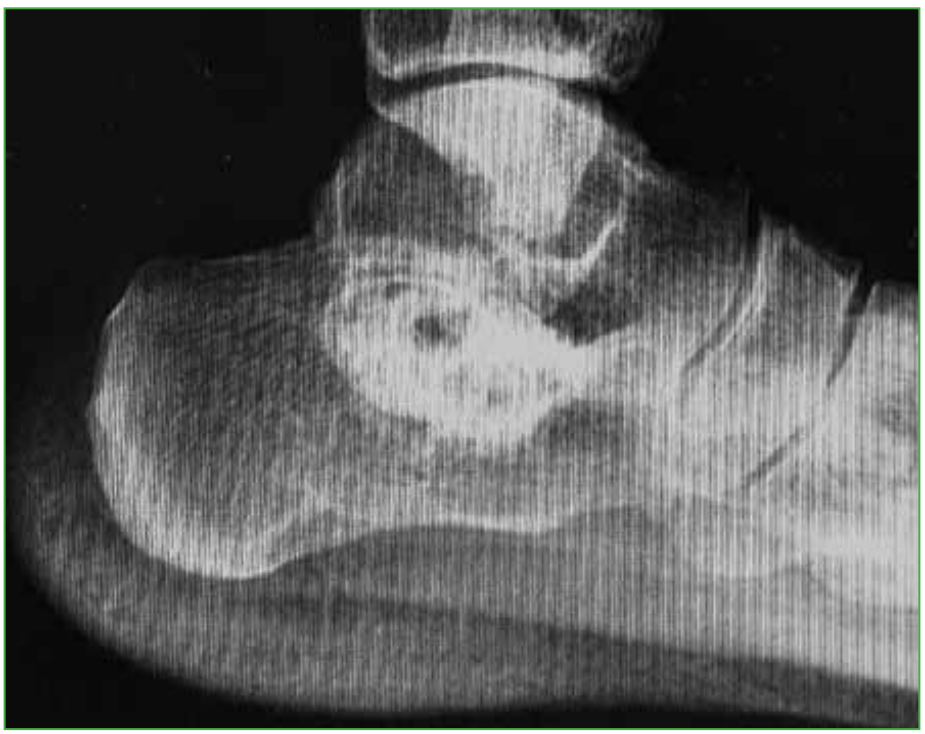


Figure 14. Lateral radiograph of the foot, seven months after the procedure. Calcified cyst.

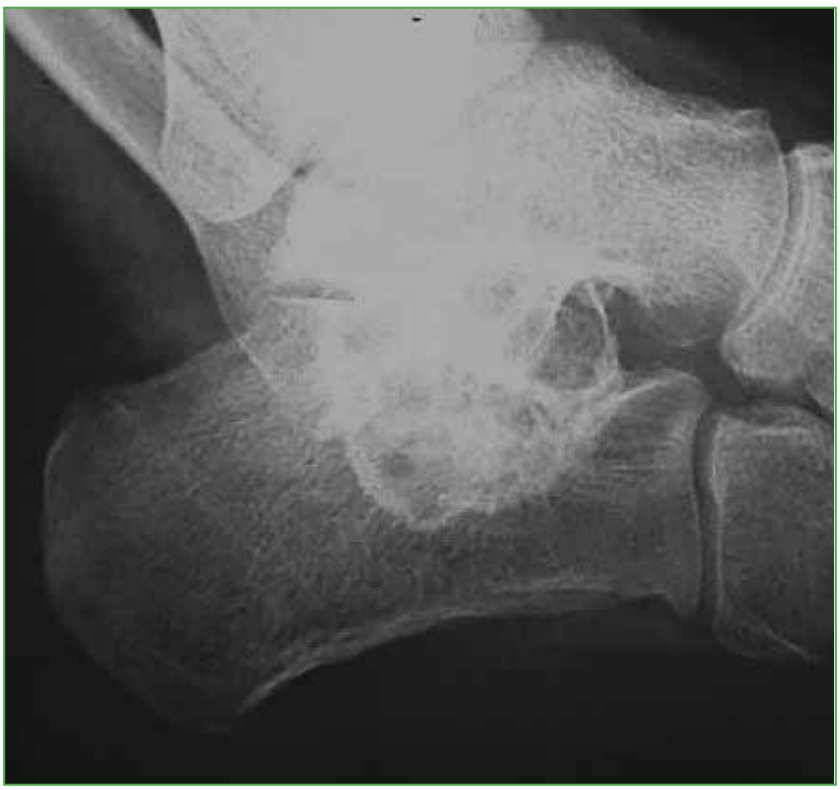


Figure 15. Oblique radiograph of the foot 7 months postoperatively, showing calcification from another view.

In successive clinical and radiological follow-ups, cyst ossification and pain resolution were confirmed (Figures 13-15). After more than two years of follow-up, the patient has not sought further medical consultation. Since ABC is known to have a recurrence risk, long-term monitoring should be maintained.

ABC is a benign, expansile, locally aggressive bone pseudotumor. It is defined as a blood-filled cavity separated by connective tissue septa containing spindle cells, multinucleated giant cells, areas of hemosiderin staining, and a trabecular pattern. It has a high propensity for recurrence. ABC is a rare condition, with an incidence of approximately 0.14 per 100,000 population, representing between 1% and 1.4% of primary bone tumors. It can appear at any age, predominantly in children and young people under 20 years of age.[1,2]

In a study of 1,200 bone tumors, only 25 were multifocal ABCs (2.1% of the total).[3]

The optimal treatment for ABC remains a matter of debate and includes aggressive curettage with adjuvants such as cryotherapy, methacrylate or phenol cement, sclerotherapy, selective arterial embolization, and denosumab, with or without these procedures. Occasionally, ABCs heal spontaneously or after a pathological fracture.[1,2,4,5]

Varshney et al. compared 94 patients divided into two groups: Group 1 underwent repeated percutaneous sclerotherapy with polidocanol, while Group 2 underwent extended curettage and bone grafting to treat ABC, with a minimum follow-up of 3.2 years. Cure rates were similar in both groups, but complication rates, functional outcomes, and hospital burden were worse in Group 2. Recurrence rates were comparable between the two treatment methods. The authors concluded that repeated sclerotherapy is a minimally invasive and safer approach.[4]

Rastogi et al. evaluated the efficacy of percutaneous intralesional administration of 3% polidocanol (hydroxypolyethoxydodecane) as sclerotherapy in 72 patients (46 men, 26 women) with histologically diagnosed ABCs at various skeletal sites. They reported that it is a safe alternative to conventional surgery, can be used in surgically inaccessible locations, and is an outpatient procedure.[5]

Mohaidat et al. studied 25 patients (17 male, 8 female), most of whom were either under 10 years old or over 20 years old. Unusual tumor locations included the scapula, olecranon, hamate bone, calcaneus, and first metatarsal.

They found that radiological imaging suggested other primary diagnoses in eight patients, and the diagnosis was confirmed via core needle biopsy in only two of seven cases. The authors emphasize the diagnostic challenges of ABC.[6]

Reddy et al. introduced a novel biopsy technique called "curopsy," which consists of limited percutaneous curettage at the time of biopsy. This method involves obtaining the lining membrane from multiple quadrants of the cyst, leading to consolidation ("curopsy" = biopsy with curative intent), as some patients experienced spontaneous healing following biopsy alone.[2]

Van Geloven et al. state that curettage remains a valid therapeutic option, particularly when combined with adjuvant reaming, autologous bone grafting, and phenolization. However, percutaneous sclerotherapy with polidocanol is a viable alternative, achieving similar results in larger studies. Systemic therapy with denosumab has shown promising outcomes but should be reserved for unresectable lesions, as it can induce severe hypercalcemia in children. These authors recommend considering localization, stability, and safety when selecting a treatment approach.[7]

In a systematic review, Cottalorda et al. found that less invasive treatments—such as selective arterial embolization, alcohol or polidocanol sclerotherapy, and demineralized bone matrix injection—produce outcomes comparable to surgery, often with fewer complications. Therefore, these treatments can be recommended as first-line therapy.[8]

CONCLUSIONS

Diagnostic imaging and blood-fluid aspiration are sufficient for diagnosis and allow simultaneous injection of the sclerosing agent. In our case, this procedure was effective and did not cause complications. Given the rarity of this lesion, consultation with specialists in bone tumors is recommended.

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Dr. Daniel Repetto (1954-2024)

Dr. Daniel Repetto was born on December 20, 1954, in Lanús, Province of Buenos Aires, and passed away far too soon at the age of 69 on March 13, 2024. He studied medicine at the University of Buenos Aires and trained as a specialist in Orthopedics and Traumatology at the Hospital Naval de Buenos Aires.

In 1982, during the Malvinas War, he served as part of the medical corps aboard the icebreaker Almirante Irízar in the South Atlantic.

His passion for medicine—particularly spinal surgery—took root at Hospital Naval, where he was among the first group of residents under the instruction of Prof. Dallago.

A distinguished member of the AAOT and full member of the SAPCV, Dr. Repetto was the driving force behind the creation of the Spine Unit at Hospital Naval in the 1990s, with the support of Dr. Horacio Sarramea as a consultant.

Under his leadership, the unit expanded, welcoming new staff physicians and training numerous resident physicians over the years.

For those of us who had the privilege of working with him, Daniel was an unwavering example of dedication—both as a physician and as a person.

In the office, the operating room, or academic discussions, he conveyed his knowledge with clarity and conviction, always emphasizing what he believed truly mattered. Yet, he remained open to new approaches, provided they were grounded in sound reasoning. One of his favorite maxims was: "*Let your decision be guided by the strengths of its arguments*."

He had a deep love for traveling, learning, and reading. He was an avid golfer, a loyal friend, and a devoted family man.

Dear Daniel, thank you for all that you gave to your colleagues in the Orthopedics and Traumatology Service and, above all, to the Spine Team at the Naval.

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Ricardo Tito Amor (1934-2025)

"THE AIR FILE"

I loved him very much. This simple phrase sums up my relationship with Tito throughout my professional life.

As a Student

When I was a medical student, I took my final exam in Orthopedics and Traumatology with him.

The setting was the Hospital de Clínicas. The case, a patient with an ischial tumor—undoubtedly a challenging scenario for a student.

During that exam, I not only demonstrated what I had learned but also learned how to take an exam. Tito had a way of instilling calm, guiding the analysis of the case from the simple to the complex, and fostering reasoning.

As a Young Professional

After completing my medical degree and finishing my residency, I earned a position at the prestigious Policlínico Bancario. There, I shared outpatient consultations and surgical procedures with Tito.

It was nearly impossible not to learn at his side—his approach reminded me of my father, Carmelo, whom I remember dearly: systematic study, a refined surgical technique, and absolute sincerity with his patients.

I collaborated with Tito in organizing an international conference and editing a journal (*Cirugía de la Pierna, del Tobillo y del Pie*). Through this, I came to admire his strengths as a leader—his meticulous planning and unwavering commitment to the established agenda.

As Chief of Service

I did not hesitate to propose Tito as Consultant of the Orthopedics and Traumatology Service at Hospital Universitario Austral. By then, years had passed for both of us—Tito, the seasoned teacher, and I, now leading a service. A lifetime shared.

When I decided to present my work for full membership in the *Asociación Argentina de Ortopedia y Traumatología*, he guided me with wisdom and insight:

"I know you have well-documented cases of reconstructive knee surgery, but they were treated at another institution. Now, as a young Chief at Austral, you've managed to treat a series of patients requiring ankle reconstruction using a procedure rarely performed in our field. I recommend that you focus on that topic."

Dr. CARLOS MARÍA AUTORINO • carlos.autorino@gmail.com https://orcid.org/0000-0001-6410-3816

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I followed his advice. The result was: *Symptomatic Osteoarthritic Ankle with Severe Joint Involvement: Arthroplasty by Modeling Resection and Joint Distraction.*

A trusted mentor—once again, thank you, Tito!

"The Air File"

My father was wise: "*You will know your colleagues not by their résumés, but by their character and their daily virtues.*"

More meaningful than a Curriculum Vitae—a mere tally of degrees and certifications—is what I call the "Air File": the sum of attitudes, gestures, and behaviors that make a person loved by all and envied by a few.

Tito and I shared a deep love for music, in all its forms.

Tango, in its lunfardo slang, offers a word that transcends "professor" and "master" when describing Tito: He will always be remembered as *troesma*.