Tenosynovial Giant Cell Tumor of the Hindfoot: Arthroscopic Treatment and Clinical Outcomes

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ABSTRACT

Introduction: Tenosynovial giant cell tumor is a benign synovial proliferation with locally aggressive behavior. Its occurrence in the hindfoot is uncommon and challenging. **Objective:** To evaluate the clinical outcomes and recurrence rate in patients with tenosynovial giant cell tumor of the ankle or subtalar joint treated with arthroscopic synovectomy without adjuvant radiotherapy. **Materials and Methods:** An observational study was conducted on seven patients treated exclusively by arthroscopy between 2014 and 2023, with a minimum follow-up of 24 months. The *American Orthopaedic Foot & Ankle Society* (AOFAS) score and the Visual Analog Scale (VAS) for pain were analyzed, and recurrence was monitored by magnetic resonance imaging. **Results:** Four diffuse and three localized forms were treated. Complete resection was achieved in all cases. The AOFAS score improved significantly from 63.43 to 94.57 ($p < 0.001$), and the VAS pain score decreased from 5.71 to 0.43 ($p < 0.001$). No complications or recurrences were observed after a mean follow-up of 57.4 months. **Conclusions:** In our series, arthroscopic synovectomy yielded satisfactory clinical outcomes, with no recurrences observed during follow-up. This technique may be considered an effective alternative in selected cases where complete resection of the pathological tissue is technically feasible, potentially avoiding the need for adjuvant radiotherapy.

Keywords: Tenosynovial giant cell tumor; pigmented villonodular synovitis; arthroscopy; ankle; subtalar joint; synovectomy.

Level of Evidence: IV

Tumor tenosinovial de células gigantes en el retropié. Tratamiento artroscópico y resultados clínicos

RESUMEN

Introducción: El tumor tenosinovial de células gigantes es una proliferación sinovial benigna, pero de comportamiento agresivo local, cuya presentación en el retropié es infrecuente y desafiante. **Objetivo:** Evaluar los resultados clínicos y la tasa de recidiva en pacientes con un tumor tenosinovial de células gigantes del tobillo o la articulación subastragalina tratados con una sinovectomía artroscópica, sin radioterapia adyuvante. **Materiales y Métodos:** Estudio observacional de 7 pacientes tratado exclusivamente mediante artroscopia, entre 2014 y 2023, con un seguimiento mínimo de 24 meses. Se analizaron los puntajes de la escalas de la AOFAS y la escala analógica visual, y se monitoreó la recidiva con resonancia magnética. **Resultados:** Se trataron 4 formas difusas y 3 localizadas. Se logró la resección completa en todos los casos. El puntaje de la escala de la AOFAS mejoró significativamente de 63,43 a 94,57 ($p <0,001$) y el dolor se redujo de 5,71 a 0,43 ($p <0,001$). No se registraron complicaciones ni recidivas tras un seguimiento promedio de 57.4 meses. **Conclusiones:** En nuestra serie, con la sinovectomía artroscópica, los resultados clínicos fueron satisfactorios y no hubo recidiva durante el seguimiento. La técnica podría considerarse una alternativa eficaz en casos seleccionados donde sea técnicamente factible lograr una resección completa del tejido patológico, evitando potencialmente la necesidad de radioterapia adyuvante.

Palabras clave: Tumor tenosinovial de células gigantes; sinovitis vellonodular pigmentada; artroscopia; tobillo; articulación subastragalina; sinovectomía.

Nivel de Evidencia: IV

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INTRODUCTION

Tenosynovial giant cell tumor (TGCT), formerly known as pigmented villonodular synovitis, is a benign proliferation of the synovial membrane with locally aggressive behavior. Clinically, it presents with persistent pain, joint swelling, progressive stiffness, and even joint effusion, making the differential diagnosis with common inflammatory or traumatic conditions, such as sprains or mechanical or inflammatory synovitis, particularly challenging.[1] Early diagnosis and timely treatment are essential to prevent progression to joint degeneration or structural deformity.[2]

TGCT occurs in two forms: localized (L-TGCT) and diffuse (D-TGCT). The localized form presents as well-defined nodules, is less aggressive, has a low recurrence rate, and is more common in the hands and feet. In contrast, the diffuse form extensively involves the synovial membrane, may extend to bursae and tendon sheaths, and is associated with greater joint damage and a higher recurrence rate when complete synovectomy is not achieved (Figures 1 and 2).[2,3]

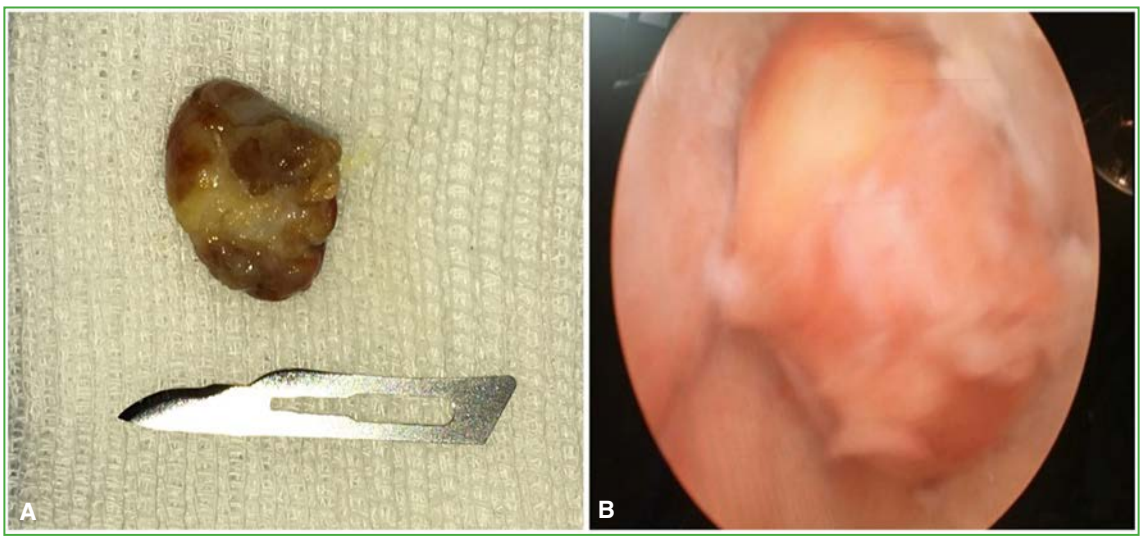

Figure 1. A. Macroscopic image of a resected localized tenosynovial giant cell tumor nodule. **B.** Arthroscopic image of an intra-articular localized tenosynovial giant cell tumor nodule.

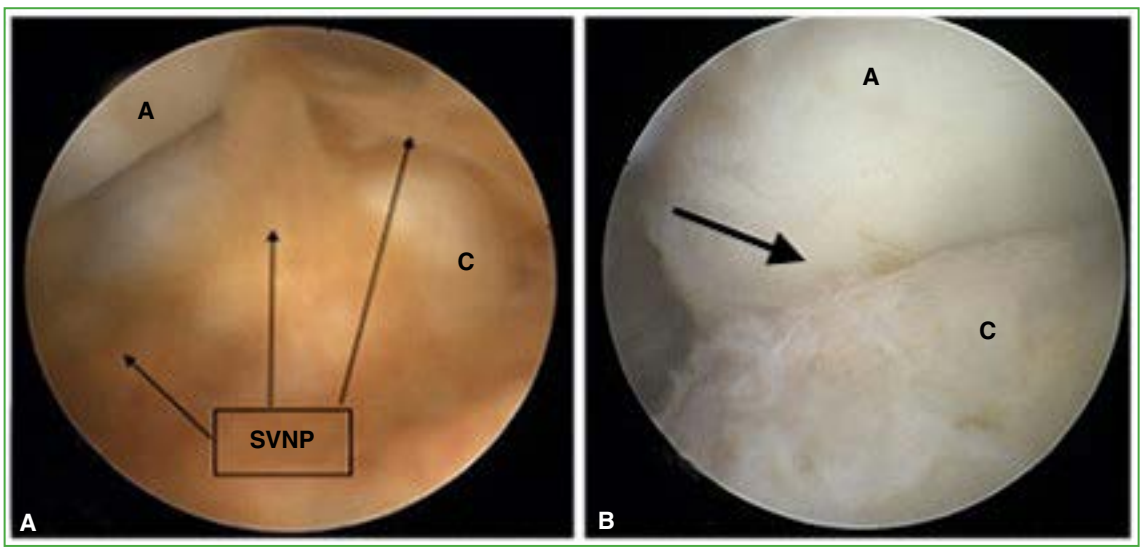

Figure 2. A. Intra-articular image of a diffuse tenosynovial giant cell tumor before synovectomy; black arrows indicate pathological synovial tissue. **B.** After synovectomy. The arrow points to the subtalar joint. C = calcaneus; T = talus.

The knee is the most commonly affected joint (70-80%), followed by the hip (10-20%). Ankle involvement accounts for only 2-4% of cases and is even less common in joints such as the subtalar, tarsometatarsal, or interphalangeal joints. The low prevalence of this condition in the ankle and foot poses a considerable diagnostic challenge. Its clinical presentation is often insidious and may be mistaken for other joint disorders.[1–3]

From an imaging standpoint, plain radiographs and computed tomography (CT) may initially reveal subchondral erosions with preservation of the joint space. Magnetic resonance imaging (MRI) is the imaging modality of choice, as it allows visualization of synovial proliferations and hemosiderin deposits, which are characteristic of this disease. In more advanced cases, multiple osseous erosions or extra-articular extension may be observed, further complicating therapeutic management (Figure 3).[3,4]

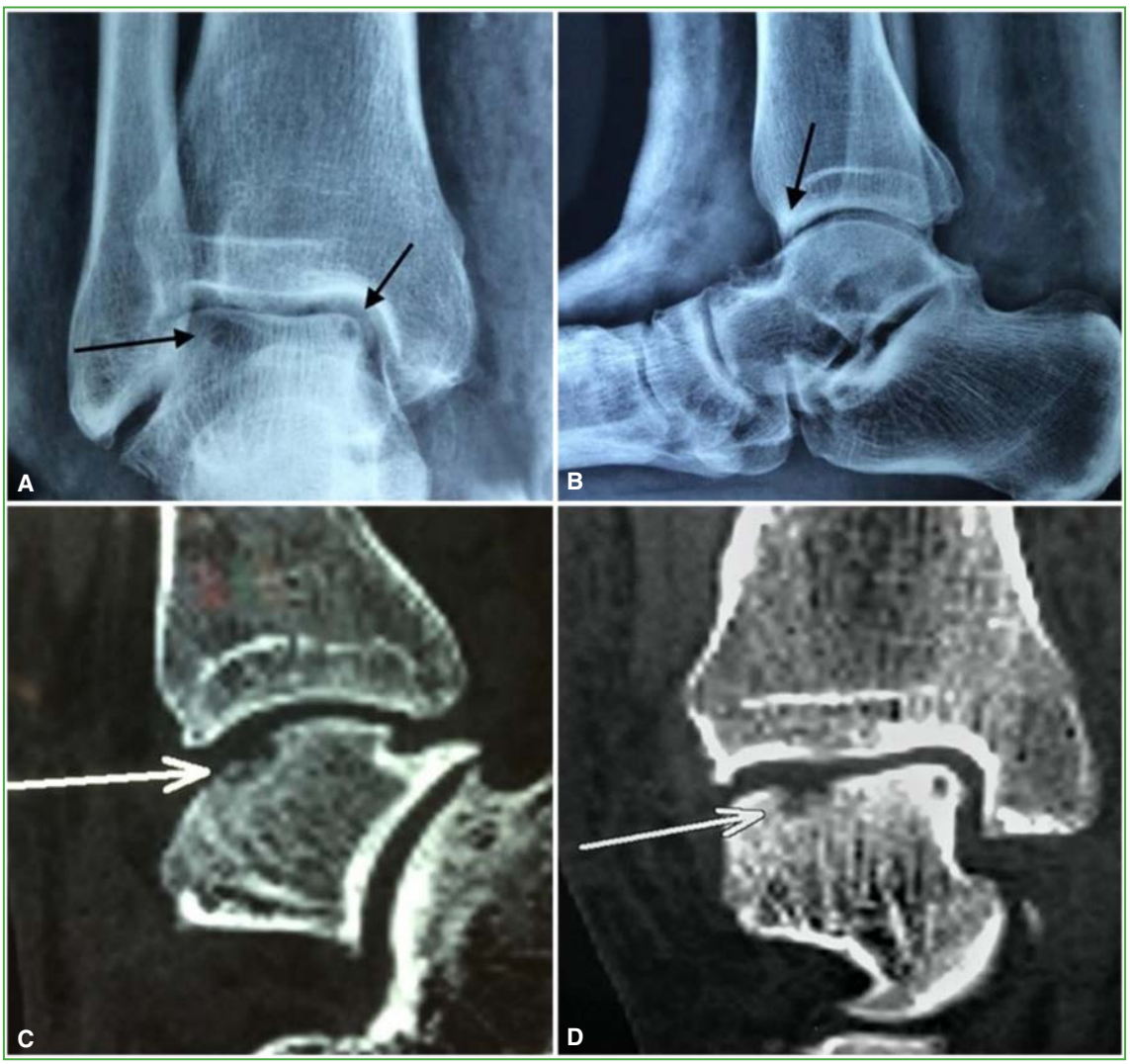

Figure 3. A. Anteroposterior ankle radiograph. The arrows indicate osteochondral lesions of the talar dome. **B.** Lateral ankle radiograph. The arrow indicates anterior bony impingement. **C and D.** Sagittal and coronal computed tomography (CT) images of the ankle. The arrows indicate osteochondral lesions.

Surgery is the mainstay of treatment, and arthroscopic or open synovectomy is the treatment of choice for resection of the affected synovial tissue. D-TGCT has a recurrence rate ranging from 10% to 50%, particularly when extra-articular involvement precludes complete resection. In a series of 76 patients with ankle TGCT, the recurrence rate was 11%, occurring exclusively in the diffuse variant.[1,4]

In cases of more aggressive disease or postoperative recurrence, some authors advocate adjuvant radiotherapy as a complementary treatment. However, its use remains controversial because of potential adverse effects and the lack of consensus regarding its long-term efficacy.

Although TGCT has been recognized for decades, its low prevalence in the ankle and foot may explain the limited published literature specifically addressing these locations. This highlights the importance of reporting clinical experience to improve our understanding of the diagnostic and therapeutic management of these lesions.

The objective of this study was to evaluate the clinical outcomes and recurrence rate in a series of patients with TGCT who underwent arthroscopic synovectomy of the ankle or subtalar joint without adjuvant radiotherapy.

MATERIALS AND METHODS

An observational, descriptive, longitudinal study was conducted to analyze a series of patients diagnosed with tenosynovial giant cell tumor (TGCT) of the ankle or subtalar joint. All patients had been treated exclusively by arthroscopic surgery between July 2014 and June 2023 and had a minimum follow-up of 24 months.

The inclusion criteria were: histopathological confirmation of TGCT (Figure 4), involvement of the ankle or subtalar joint, treatment exclusively by arthroscopic synovectomy without adjuvant radiotherapy, and a minimum of 24 months of clinical and imaging follow-up. The diagnosis was based on clinical findings and, primarily, magnetic resonance imaging (MRI), which guided the indication for arthroscopic synovectomy and tissue sampling for histopathological examination.

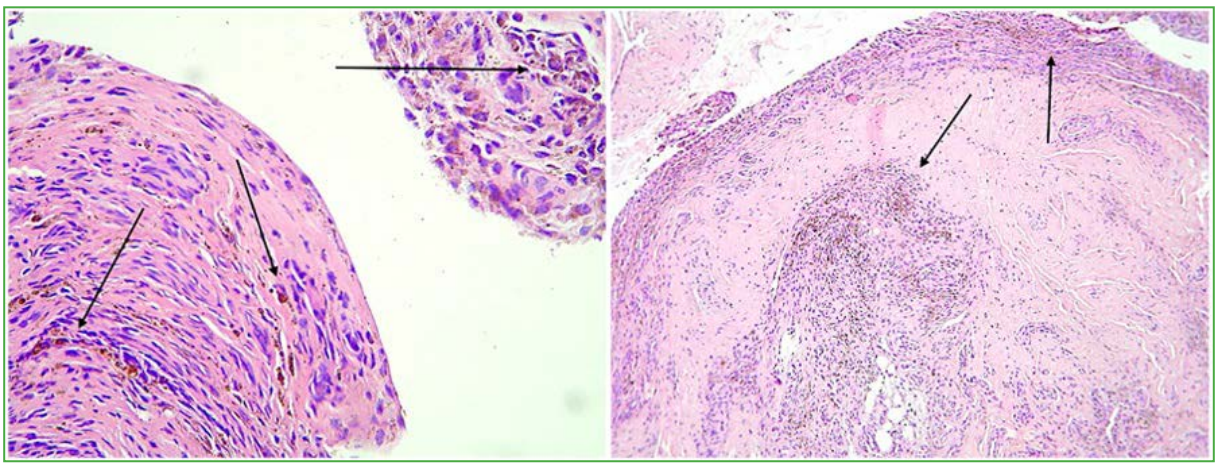

Figure 4. Histological findings from an arthroscopically obtained specimen. The arrows indicate hemosiderin deposits. Hematoxylin and eosin stain.

All patients underwent MRI during follow-up and at the final evaluation to assess for signs of recurrence.

The following variables were recorded: sex, age, affected side, involved joint (ankle, subtalar, or both), type of TGCT (localized or diffuse), presenting symptoms, and postoperative follow-up duration (months). The completeness of arthroscopic resection of the affected synovium (complete or incomplete) was also assessed. Preoperative imaging studies included anteroposterior, lateral, and oblique radiographs of the ankle and foot, as well as computed tomography (CT) and MRI of the ankle and foot. At the final follow-up visit, radiographs and MRI were repeated to rule out recurrence (Figures 5 and 6).

Preoperative and postoperative clinical outcomes were evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) score to assess pain, function, and foot and ankle alignment, as well as the visual analog scale (VAS) for pain. Patients were also asked whether they would choose to undergo the procedure again. Immediate and late postoperative complications (recorded at the final follow-up visit) were documented.

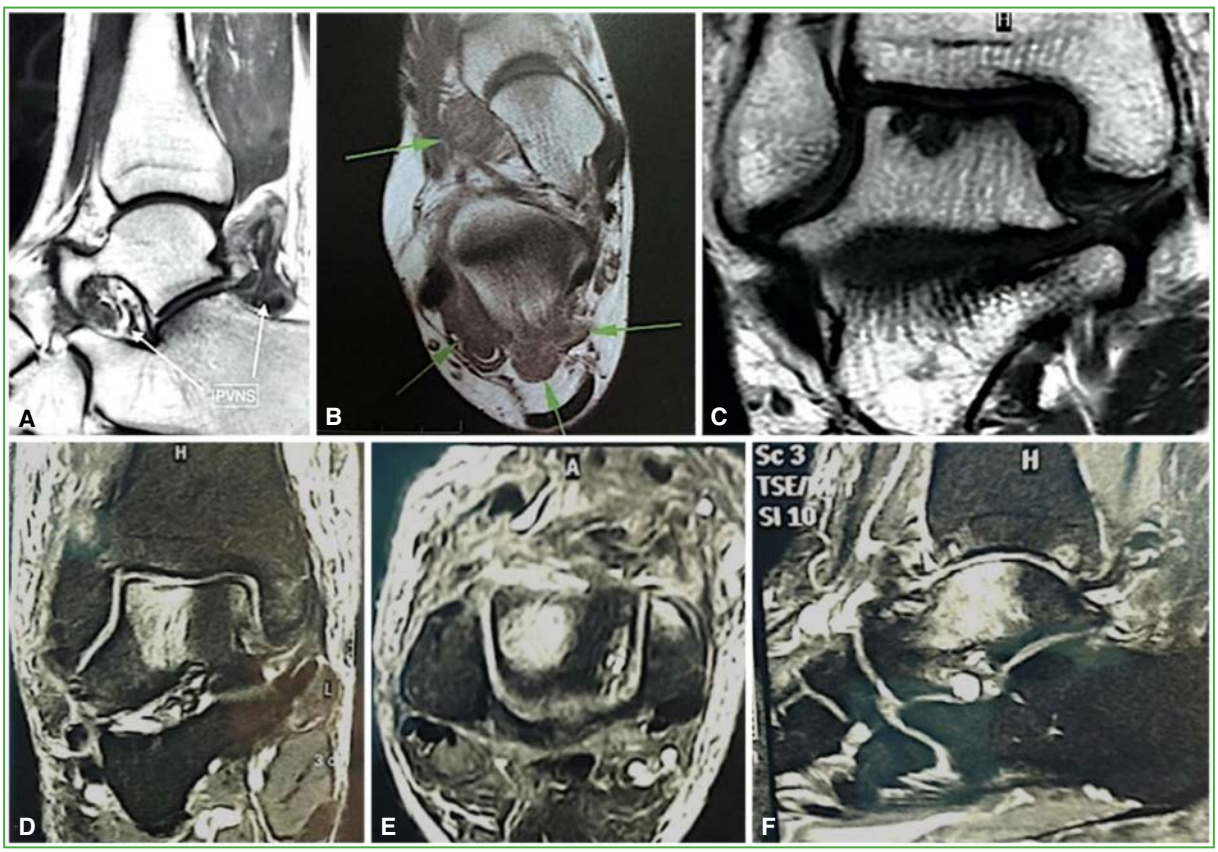

Figure 5. Magnetic resonance imaging of the ankle and hindfoot. The lesions are typically hypointense on both T1- and T2-weighted sequences because of the paramagnetic properties of hemosiderin. **A.** Sagittal T1-weighted image of the subtalar joint. Note the hypointense appearance of a tenosynovial giant cell tumor in the sinus tarsi and the posterior facet (white arrows). **B.** Axial image. Green arrows indicate the hypointense lesions of a tenosynovial giant cell tumor. **C.** Coronal image. Articular involvement of the talar cartilage and bone marrow. **D.** Coronal T2-weighted image of a tenosynovial giant cell tumor. **E.** Axial image. Extensive bone marrow edema involving the articular cartilage of the talar dome. **F.** Sagittal image. Kissing lesions involving the talar dome and the tibial plafond.

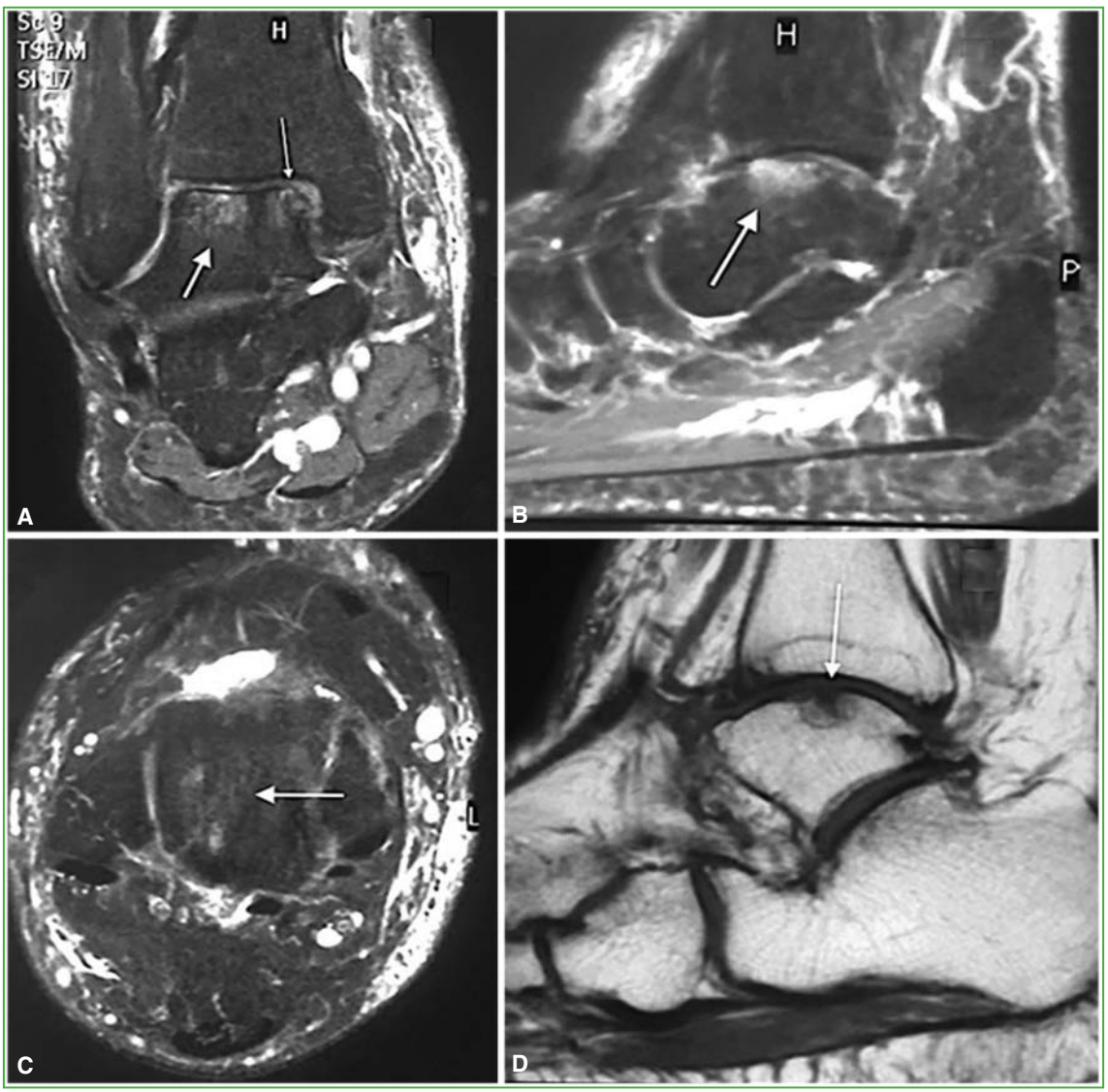

Figure 6. T2-weighted magnetic resonance images of the ankle and hindfoot obtained at the 36-month follow-up. **A.** Coronal image. **B.** Sagittal image. **C.** Axial image. The arrows indicate improvement of the bone marrow edema and osteochondral lesion. **D.** Sagittal T1-weighted image. Improvement of the articular surface of the talar dome is observed.

Surgical Technique and Postoperative Management

The procedure was performed under popliteal nerve block and sedation. A thigh tourniquet was inflated to 250 mmHg after limb exsanguination.

Arthroscopy was performed using normal saline irrigation. In all cases, the objectives were complete resection of the affected synovium to prevent recurrence and procurement of tissue samples for histopathological examination.

The arthroscopic portals were planned according to the specific location of the lesion in each case. Anterior ankle arthroscopy was performed through the standard anteromedial and anterolateral portals, with the patient in the supine position, using a 4-mm arthroscope. For subtalar arthroscopy, 2.7-mm or 4.0-mm arthroscopes were used according to surgeon preference. Lateral, posterior, or combined lateral and posterior portals were used, with the patient positioned in the lateral decubitus or prone position, depending on the case. In one patient, lateral portals were used with a 2.7-mm, 30° arthroscope. In another patient with involvement of both the sinus tarsi

and the posterior aspect of the subtalar joint, both lateral and posterior portals were required to achieve complete access to the subtalar joint. In this particular case, 2.7-mm and 4.0-mm arthroscopes were used, and the patient was placed in the prone position to allow knee flexion and external rotation of the leg, thereby facilitating access to the lateral aspect of the foot. In another patient, posterior arthroscopic portals were used with the patient in the prone position and a 4.0-mm arthroscope, applying gentle traction with a sling to reach the anterior portion of the posterolateral facet of the subtalar joint (Figure 7).

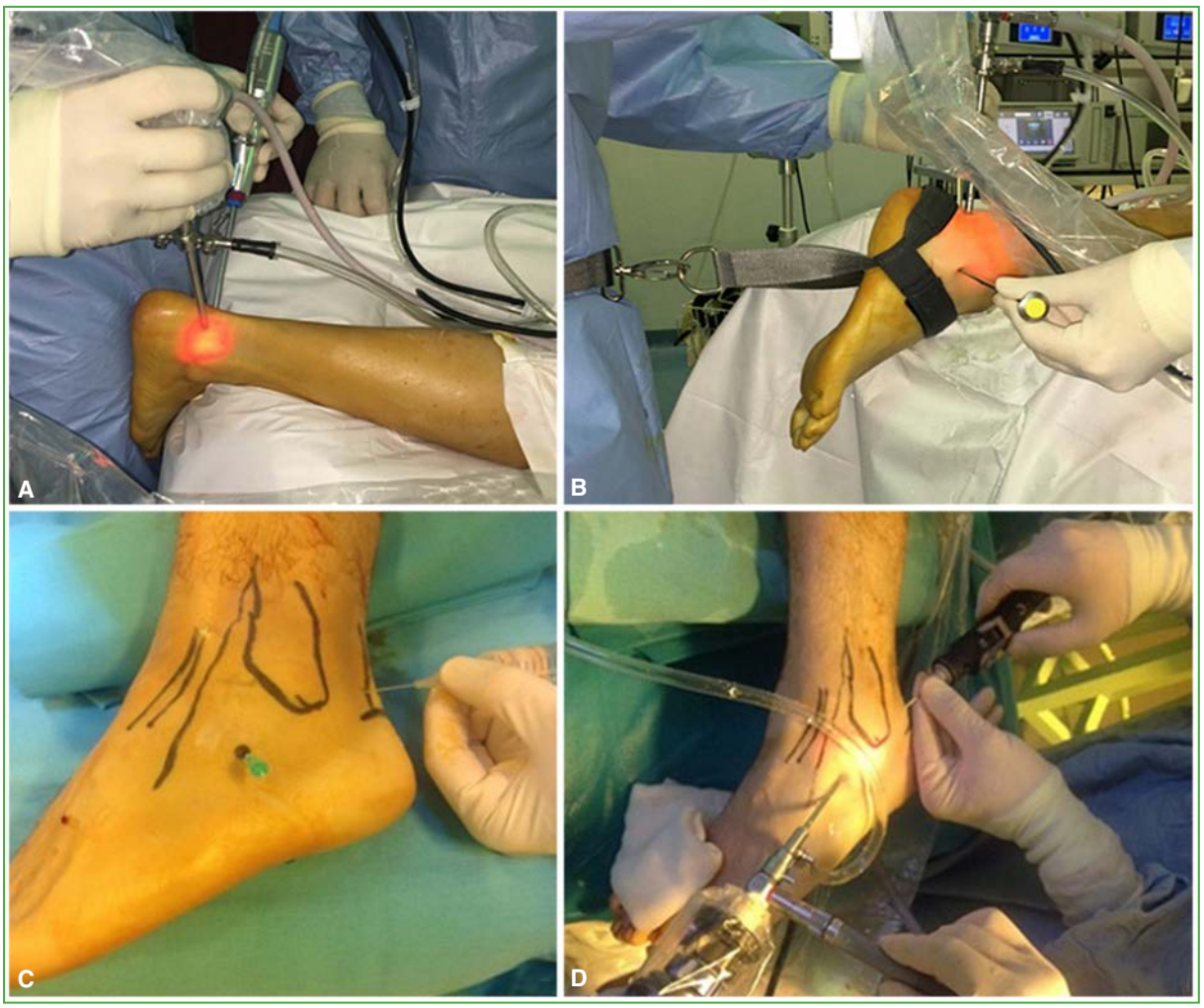

Figure 7. Arthroscopic approaches to the subtalar joint. **A and B.** Combined posterior and lateral arthroscopic approach with gentle distraction (**B**) to access difficult-to-reach areas. **C and D.** Lateral arthroscopic approach to the subtalar joint using an accessory lateral portal.

Arthroscopy allowed complete resection of the affected tissue and retrieval of at least one specimen of pathological synovium for histopathological examination in every case. Consequently, all patients underwent arthroscopic surgery with complete resection of the pathological tissue.

The portals were closed with 4-0 nylon sutures. A posterior below-knee plaster splint was applied, and patients were instructed to remain non-weight-bearing with crutches until the first postoperative visit, which took place 3 days after the procedure. At that time, the splint was removed, progressive weight-bearing was allowed as tolerated, and range-of-motion exercises were encouraged. Sutures were removed at 3 weeks.

Statistical Analysis

Data were entered into Microsoft Excel® and analyzed using SPSS version 23. Descriptive statistics (mean and standard deviation) and the paired Student's *t* test were used to compare preoperative and postoperative AOFAS and VAS scores. A p value <0.05 was considered statistically significant.

RESULTS

The study included 7 patients with a mean age of 44.86 ± 11.60 years (range, 29–62 years). Five patients (71.43%) were male and two (28.57%) were female. Five patients (71.43%) had right-sided involvement and two (28.57%) had left-sided involvement. Four patients (57.14%) had D-TGCT, and three (42.86%) had L-TGCT. Joint involvement was distributed as follows: two cases (28.57%) with isolated subtalar involvement, two (28.57%) with isolated ankle involvement, and three (42.86%) with simultaneous involvement of both the ankle and subtalar joints. The patients' presenting symptoms are summarized in Table 1. The mean follow-up was 57.42 months (range, 24–132 months).

Table 1. Characteristics of the study patients.

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Age (years)	54	45	37	62	36	29	51
Gender	Male	Female	Male	Male	Male	Male	Female
Side	Right	Right	Left	Right	Left	Right	Right
Shape	Diffuse	Localized	Diffuse	Diffuse	Localized	Diffuse	Localized
Location	Ankle and subtalar joint	Subtalar joint	Ankle and subtalar joint	Ankle	Ankle	Ankle and subtalar joint	Subtalar joint
Symptoms	Swelling and pain	Swelling and pain	Swelling and pain	Swelling and pain	Swelling, pain, stiffness	Swelling, pain, limited range of motion	Swelling and pain
Follow-up	36 months	30 months	96 months	132 months	48 months	36 months	24 months
Recurrence	No	No	No	No	No	No	No

No intraoperative or postoperative complications, either early or late, were observed. No recurrences were detected on MRI at the final follow-up.

A statistically significant and clinically meaningful improvement was observed in the clinical outcome scores after surgery. The mean AOFAS score improved from 63.43 ± 14.63 (range, 51–87) preoperatively to 94.57 ± 3.78 (range, 91–100) postoperatively (Table 2).

Similarly, the mean VAS pain score improved from 5.71 ± 1.50 (range, 3–7) preoperatively to 0.43 ± 0.53 (range, 0–1) postoperatively, indicating substantial pain relief (Table 3).

Table 2. Statistical analysis of preoperative and postoperative AOFAS scale scores.

Descriptive statistics - AOFAS			
		Preoperative	**Postoperative**
Mean		63.43	94.57
Median		56.00	93.00
Mode		51	93
Standard deviation		14.63	3.78
Percentiles	25	51.00	92.00
	50	56.00	93.00
	75	79.00	100.00

AOFAS = American Orthopaedic Foot and Ankle Society.

Table 3. Statistical analysis of preoperative and postoperative visual analog scale scores.

Descriptive statistics - VAS			
		Preoperative	**Postoperative**
Mean		5.71	0.43
Median		6.00	0.00
Mode		5*	0
Standard deviation		1.60	0.53
Percentiles	25	5.00	0.00
	50	6.00	0.00
	75	7.00	1.00

*There are multiple modes. The smallest value is shown. VAS = visual analog scale.

Preoperative and postoperative scores were compared using the paired Student's *t* test. Both the AOFAS and VAS scores showed statistically significant improvements after surgery (p <0.001), demonstrating a clinically relevant postoperative benefit (Table 4, Figures 8 and 9).

All patients stated that they would choose to undergo the procedure again, reflecting a high level of satisfaction with the surgical outcome.

Table 4. Statistical analysis of pre- and postoperative AOFAS and VAS scores.

Comparison of the contralateral healthy side and the operated side					
Scale	**Preoperative**	**Postoperative**			
	M (SD)	M (SD)	t	p	d
AOFAS	63.43 (14.63)	94.57 (3.78)	7.30	<0.001	2.76
VAS	5.71 (1.60)	0.43 (0.53)	-8.21	<0.001	-3.10

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

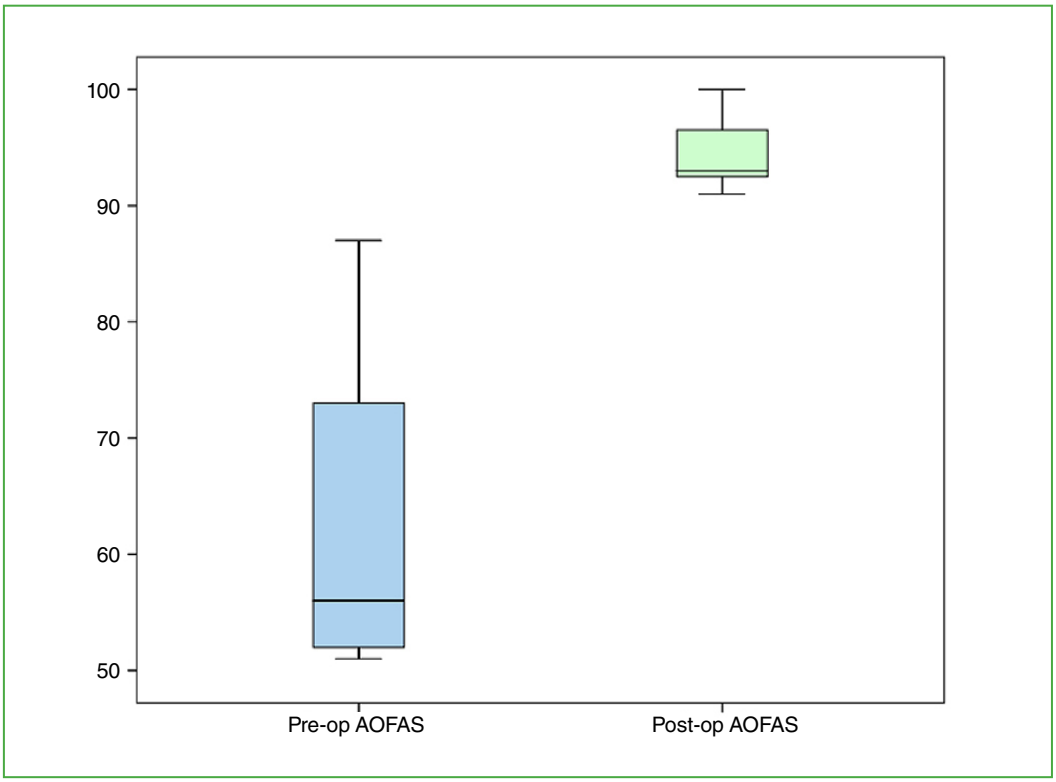

Figure 8. Pre- and postoperative changes in the *American Orthopaedic Foot and Ankle Society* (AOFAS) score.

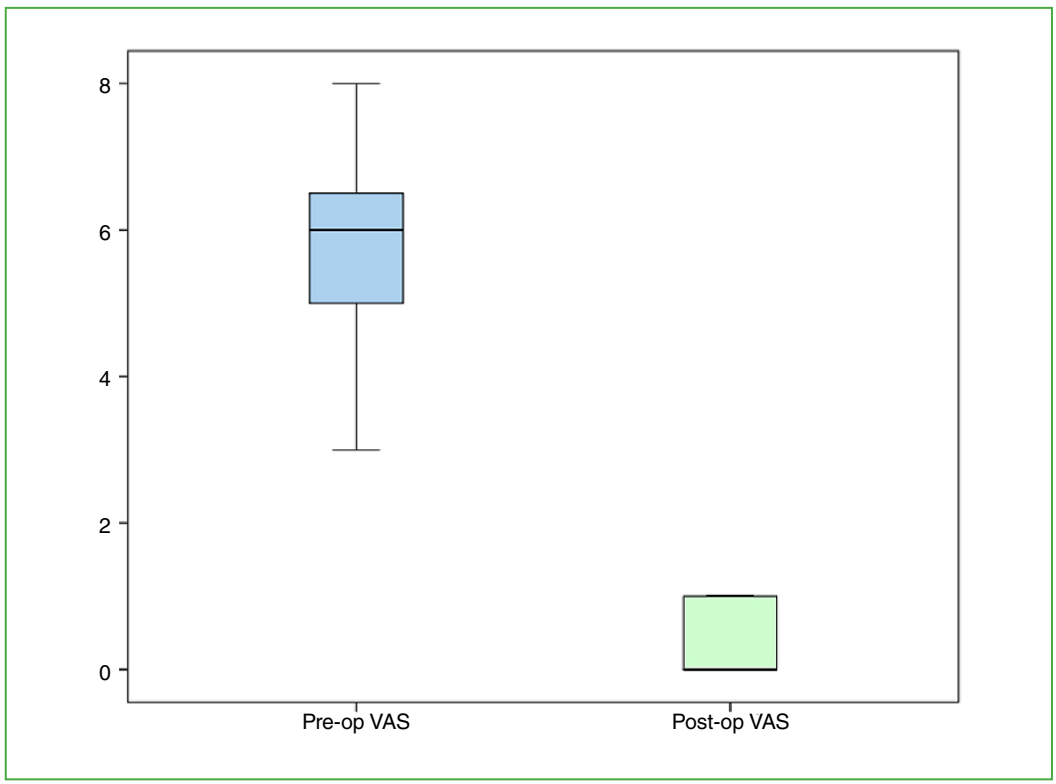

Figure 9. Preoperative and postoperative visual analog scale (VAS) scores.

DISCUSSION

TGCT was first described by Chassaignac in 1852, who identified it as a condition affecting the flexor tendon sheaths, although he initially suggested that it might represent a malignant neoplastic process. Subsequently, in 1941, Jaffe described the clinical presentations of the disease, reported 20 cases involving both joints and tendons, and proposed a classification based on anatomical location and histopathological findings.[6] Granowitz et al. later conducted studies that contributed to the reevaluation and more precise classification of this disease as it is currently understood.[7]

Two main clinical forms have been described: localized TGCT (L-TGCT), characterized by the presence of small nodules with or without a pedicle, and diffuse TGCT (D-TGCT), in which the entire synovium and joint capsule are involved. Although both forms share similar macroscopic and histopathological features, including hemosiderin deposition within the synovial tissue, their biological behavior differs considerably. L-TGCT can usually be resected with adequate surgical margins and is associated with a lower recurrence rate. In contrast, surgical treatment of D-TGCT can be challenging because complete resection is often difficult to achieve. Consequently, this form may behave in a locally aggressive manner, with reported recurrence rates ranging from 9% to 49%, depending on factors such as duration of follow-up, the affected joint, completeness of resection, and the use of adjuvant radiotherapy.[7–10]

Historically, TGCT was considered a condition arising from chronic inflammatory processes of the synovium. However, more recent studies suggest that its origin may be neoplastic. Sciot et al. demonstrated a clear association between TGCT and clonal chromosomal abnormalities involving the 1p11–13 region. In subsequent studies, they identified colony-stimulating factor 1 (CSF-1), located at the 1p13 breakpoint, which encodes the CSF-1 cytokine responsible for the proliferation and differentiation of monocytes and macrophages. This evidence supports the hypothesis that TGCT is of neoplastic origin, representing a significant shift in the understanding of its pathogenesis.[11,12]

West et al. reported that 77% of patients with L-TGCT and 63% of those with D-TGCT exhibited CSF-1 overexpression, generating autocrine and paracrine signals that stimulate the proliferation of neoplastic macrophages. In addition, CSF-1 may induce other inflammatory cells, including histiocytes, lymphocytes, and osteoclasts, to express its receptor. These findings were confirmed by Nilsson et al., who reported that 92% of patients with TGCT had a breakpoint involving chromosome 1p11–13, frequently associated with a translocation involving 2q35–37. Both studies describe clonal abnormalities and trisomies involving chromosomes 5 and 7, further supporting the hypothesis of a neoplastic origin for this disease.[13,14]

According to Myers et al., the annual incidence of TGCT is 1.8 cases per million population. It affects men and women equally and occurs predominantly during the first three decades of life.[15]

With regard to foot and ankle involvement, few studies have been published, most consisting of small case series or isolated case reports. In 2006, Sharma et al. reported the largest series (14 cases), nine of which involved the ankle: six with extra-articular synovial tumor masses, two with intra-articular involvement, and one with isolated subtalar involvement. Rochwerger et al. published a series of eight cases: four involving the ankle and hindfoot joints, one involving the tarsometatarsal joints, and three involving the toes. Ghert et al. reported six cases: two involving the ankle and four involving multiple joints (subtalar, midfoot, and forefoot).[16–18]

In the early stages of the disease, radiographs may be normal. In more advanced stages, erosions, cysts with sclerotic margins, osteochondral lesions, mineralization, and involvement of the articular surfaces may be identified.

Diagnostic studies such as ultrasound, computed tomography, and bone scintigraphy are not definitive for establishing the diagnosis. MRI provides the most characteristic imaging findings, demonstrating hypointense signals on both T1- and T2-weighted sequences due to hemosiderin deposition. Although these findings are not pathognomonic, they are highly suggestive of the disease. MRI is also useful for assessing the extent of synovial involvement and detecting recurrences. It facilitates surgical planning aimed at achieving complete synovectomy and obtaining tissue samples for histopathological examination, thereby establishing the definitive diagnosis.[19]

Treatment of TGCT should be initiated early to prevent progression of joint damage and should be tailored according to variables such as patient age, lesion location, disease subtype, joint involvement, and the affected periarticular tissues. Complete resection may be performed through either an open or an arthroscopic approach. In D-TGCT, when complete resection cannot be achieved, adjuvant radiotherapy may be indicated. Blanco et al. reported favorable results with partial arthroscopic resection combined with low-dose radiotherapy (26 Gy); however, three patients (14%) required repeat arthroscopy because of recurrence.[20]

In a systematic review, Mollon et al. concluded that adjuvant radiotherapy significantly reduced recurrence in patients with D-TGCT and suggested that it should be considered when complete synovectomy cannot be achieved.[10] Reinhard et al. reported that radiotherapy is safe and effective both as an adjuvant treatment and for recurrent disease, with doses ranging from 30 to 50 Gy. In our series, adjuvant radiotherapy was not required because complete arthroscopic resection was achieved in all cases. The available studies agree that arthroscopic synovectomy is effective for localized intra-articular disease and is associated with a low recurrence rate. However, in diffuse ankle disease, TGCT extends through synovial recesses and tendon sheaths, making complete resection difficult and resulting in high recurrence rates following surgery alone (40–60%).[10,21-23]

Case series and cohort studies have shown that combining synovectomy with postoperative radiotherapy achieves local control rates exceeding 80–90% in patients with D-TGCT, whereas recurrence rates remain higher (40–60%) following surgery alone. In this context, adjuvant radiotherapy is primarily reserved for cases with incomplete synovial resection, extensive diffuse involvement, or postoperative recurrence. Baniel et al. reported recurrence rates below 10% after radiotherapy and observed no significant long-term adverse effects, further supporting its therapeutic role in the management of D-TGCT. In contrast, patients with L-TGCT have a favorable prognosis after complete surgical excision, with a low risk of recurrence in both the medium and long term.[23]

In all patients in our series, both those with L-TGCT and those with D-TGCT, complete resection of the pathological tissue was achieved. We believe that this may have contributed to the absence of recurrences during follow-up.

This study has several strengths, including the ability to achieve complete arthroscopic resection of the pathological tissue in every case. No recurrences were detected on MRI during follow-up, and clinical outcomes demonstrated significant improvements in both function and pain, as assessed by the AOFAS score and VAS. However, the study is limited by its retrospective observational design and small sample size, which preclude extrapolation of the results or the establishment of definitive conclusions. Nevertheless, given the rarity of this condition in the hindfoot and the limited literature available, we believe that our series provides clinically relevant information for the management of this uncommon entity.

CONCLUSIONS

In our series, arthroscopic synovectomy achieved satisfactory clinical outcomes, and no recurrences were observed during follow-up. The technique may be considered an effective therapeutic option in selected cases in which complete resection of the pathological tissue is technically feasible. Although the results were favorable, studies including larger patient cohorts and longer follow-up are needed to establish definitive conclusions.

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

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