



ISSN 2674-8169



Latindex



DOI



DIAPHYSEAL TIBIOFIBULAR SYNOSTOSIS: A TRAPEZOIDAL BONEY BRIDGE BETWEEN THE TIBIA AND FIBULA — ANATOMICAL, BIOMECHANICAL, AND CLINICAL CORRELATIONS

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<https://doi.org/10.36557/2674-8169.2026v8n6p5-17>

Artigo recebido em 1 Maio e publicado em 1 de Junho de 2026

ARTIGO ORIGINAL

RESUMO

Resumo

Introdução: A sinostose tibiofibular (ST) é uma alteração anatômica rara caracterizada pela fusão óssea entre tibia e fibula. Quando localizada na região diafisária, denomina-se sinostose tibiofibular diafisária (STD). A ST pode estar associada a osteocondromas múltiplos, condição autossômica dominante rara, e constituir causa de dor no compartimento anterior da perna, especialmente em atletas, decorrente de microfraturas repetitivas e alteração biomecânica da fíbula durante a marcha. **Objetivo:** Relatar um caso de sinostose tibiofibular diafisária (STD) de morfologia trapezoidal em ossos secos, correlacionando com suas implicações anatômicas, biomecânicas e clínicas. **Relato de Caso:** Durante atividade acadêmico-científica no Laboratório de Anatomia da Universidade Federal de Sergipe, foi identificada uma STD no membro inferior esquerdo, localizada no terço médio da perna. A ponte óssea trapezoidal originava-se na superfície lateral da tibia com altura máxima de 28 mm, afinando-se progressivamente para 23 mm na porção intermediária e 21 mm na inserção fibular. As larguras superior, média e inferior eram de 15 mm, 12 mm e 7 mm, respectivamente, totalizando área aproximada de 261 mm². A margem superior apresentava curvatura regular com concavidade cranial; a margem inferior exibia contorno irregular com espícula óssea adjacente à fíbula. Foram observadas áreas de calo ósseo sugestivas de fraturas prévias, indicando etiologia pós-traumática. **Conclusão:** A STD é uma condição rara, relevante em atletas, cujo conhecimento é essencial para o diagnóstico diferencial e manejo clínico da dor na

região anterior da perna.

Palavras-chave: Sinostose; Ossificação Heterotópica; Variação Anatômica; Traumatismos da Perna; Sindesmose Tibiofibular; Consolidação da Fratura.

DIAPHYSEAL TIBIOFIBULAR SYNOSTOSIS: A TRAPEZOIDAL BONEY BRIDGE BETWEEN THE TIBIA AND FIBULA — ANATOMICAL, BIOMECHANICAL, AND CLINICAL CORRELATIONS

ABSTRACT

Introduction: Tibiofibular synostosis (TS) is a rare anatomical variation characterized by bony fusion between the tibia and fibula. When located in the diaphyseal region, it is termed diaphyseal tibiofibular synostosis (DTS). TS can be associated with multiple osteochondromas, a rare autosomal dominant condition, and can cause anterior leg compartment pain, especially in athletes, due to repetitive microfractures and biomechanical alterations of the fibula during gait. **Objective:** To report a case of diaphyseal tibiofibular synostosis (DTS) with a trapezoidal morphology in dry bones, correlating it with its anatomical, biomechanical, and clinical implications. **Case Report:** During academic-scientific activities at the Anatomy Laboratory of the Federal University of Sergipe, a DTS was identified in a left lower limb, located in the middle third of the leg. The trapezoidal bony bridge originated from the lateral surface of the tibia with a maximum height of 28 mm, progressively tapering to 23 mm in its intermediate portion and 21 mm at the fibular insertion. The superior, middle, and inferior widths were 15 mm, 12 mm, and 7 mm, respectively, totaling an approximate area of 261 mm². The superior margin presented a regular curvature with cranial concavity; the inferior margin exhibited an irregular contour with a bony spicule adjacent to the fibula. Areas of bone callus suggestive of previous fractures were observed, indicating a post-traumatic etiology. **Conclusion:** DTS is a rare condition, highly relevant in athletes, whose understanding is essential for the differential diagnosis and clinical management of anterior leg pain.

Keywords: Synostosis; Heterotopic Ossification; Anatomical Variation; Leg Injuries; Tibiofibular Syndesmosis; Fracture Healing.



Diaphyseal tibiofibular synostosis: A trapezoidal bony bridge between the tibia and fibula — anatomical, biomechanical, and clinical correlations.

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Introduction

Tibiofibular synostosis (TS) is a rare anatomical variation with a low prevalence in the population, characterized by the formation of a bony bridge between the tibia and the fibula (Kawanishi *et al.*, 2026). When present, it can be located at either the proximal or distal tibiofibular joints; more rarely, it occurs in the diaphyseal region, establishing a bony bridge between the diaphyses of the tibia and fibula, a condition termed diaphyseal tibiofibular synostosis (DTS) (Kobayashi *et al.*, 2013). TS frequently occurs in the context of multiple osteochondromas (MO), a rare autosomal dominant condition affecting approximately 1 in 50,000 live births (Bovée, 2008). Osteochondroma is characterized by cartilaginous proliferation that ossifies at the interface between the growth plate and the perichondrium. In the long bones of the leg, these lesions can establish contact with each other, configuring what is known as "kissing osteochondromata," ultimately leading to the formation of bony bridges and, consequently, TS (Frick, Shoemaker, Mubarak, 2001; Bessler *et al.*, 1997).

This peculiar anatomy can be responsible for intense pain in the anterior compartment of the leg and ankle during physical exercise, with relief occurring only at rest (Sonnerly-Cottet *et al.*, 2016). The pain originating from DTS arises from repetitive microfractures in the region of the synostosis, with subsequent intramuscular bleeding and increased pressure in the anterior compartment, as well as alteration of the downward and medial movement of the fibula during gait (Sferopoulos, 2018). TS can have a congenital etiology, be acquired through trauma, iatrogenesis, or therapy, or be classified as idiopathic (Umesan, 2013). It is important to highlight that pain in the anterior region of the leg is more frequently associated with chronic exertional compartment syndrome, stress fractures, or medial tibial stress syndrome—conditions that do not stem from TS, since most cases of synostosis are asymptomatic (Magnusson *et al.*, 2001). When congenital or established before the closure of the epiphyseal plates, TS can progress to complications such as ankle valgus, prominence of the fibula at the knee, and shortening of the lateral malleolus (Frick, Shoemaker, Mubarak, 2001).

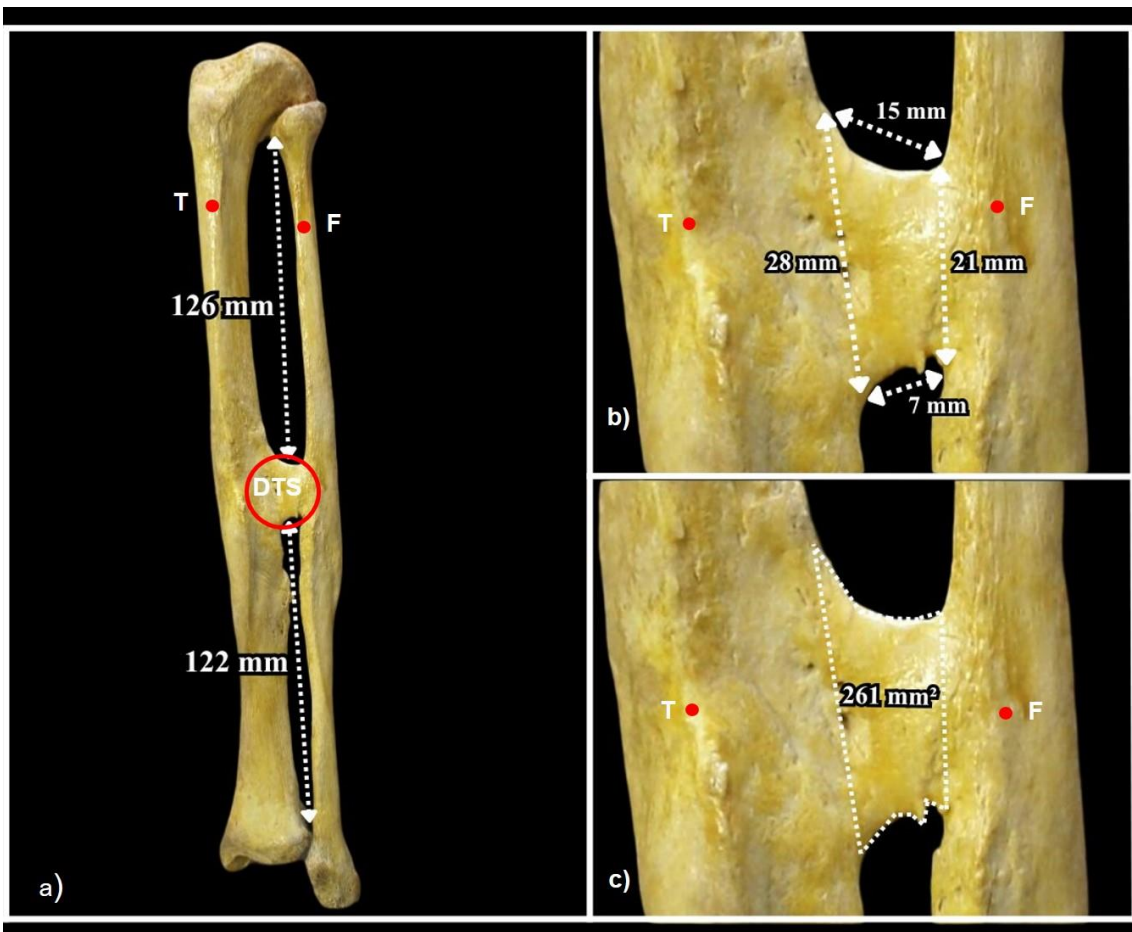
It is noteworthy that, for an accurate diagnosis of TS, magnetic resonance imaging with paramagnetic contrast is indispensable to rule out the possibility of a bone tumor, particularly in children, due to the higher incidence of osteosarcoma in this age

group (Bölling, Harges, Dirksen, 2013). The present study aims to report a case of DTS with a trapezoidal morphology in dry bones, correlating it with its anatomical, biomechanical, and clinical implications.

CASE REPORT

During routine academic-scientific activities conducted at the Anatomy Laboratory of the Department of Morphology at the Federal University of Sergipe, a DTS was identified in a left lower limb. It was located in the middle third of the leg and characterized by the formation of a bony bridge between the diaphyses of the tibia and the fibula (**Figure 1**).

Figure 1. Diaphyseal tibiofibular synostosis



Legend

DTS - Diaphyseal tibiofibular synostosis

T – Tibia

F - Fibula

The bony fusion was positioned 126 mm from the proximal tibiofibular joint and 122 mm from the distal tibiofibular joint (**Figure 1a**). Morphometrically, the DTS, which originated from the lateral surface of the tibia, presented a maximum height of 28 mm, with progressive tapering in its intermediate portion (23 mm), extending toward the fibula, where it reached a height of 21 mm. Regarding width, the superior margin measured 15 mm, the midpoint of the synostosis 12 mm, and the inferior margin 7 mm (**Figure 1b**).

Macroscopic analysis revealed peculiar morphological characteristics. The superior margin presented a regular curvature with a cranially oriented concavity, whereas the inferior margin exhibited an irregular contour associated with the presence of a discrete bony spicule adjacent to the fibular surface.

In anterior view, the DTS presented a trapezoidal configuration, with its larger base facing the tibia and its smaller base directed toward the fibula, corresponding to an approximate area of 261 mm² (**Figure 1c**). Additionally, areas compatible with bone callus formation were observed in both involved bony structures, likely resulting from old fractures of both the tibia and fibula, suggesting a prior process of bone remodeling related to the development of the tibiofibular fusion. The observed anatomical findings reinforce the morphological rarity of DTS and highlight the importance of detailed macroscopic analysis of these anatomical variations, especially due to their potential clinical, biomechanical, and surgical implications.

Discussion

TS can occur as a congenital defect, frequently accompanied by deformities such as the distal positioning of the proximal tibiofibular joint, leg length discrepancy, bowing of the fibula, or knee valgus deformity (O'Dwyer, 1991). The absence of all these anomalies in our case, combined with the presence of excessive bone callus formation in the middle third of the tibia and fibula, supports a post-traumatic etiology. This suggests that the TS occurred as a consequence of a fracture in the middle third of both bones. Although the more distal variety of TS is mostly acquired and reported almost exclusively as a

post-traumatic injury (McMaster, Scranton, 1975; Gamble, 1984), in our case, it represents an incidental finding located in the middle third of the tibia and fibula.

DTS is a poorly documented condition in the literature, despite its high clinical relevance as a potential cause of anterior leg compartment pain. Most reports associate this anatomical variation with complaints in athletes. Sonnery-Cottet *et al.* (2016) described cases of two professional players with pain due to diaphyseal tibiofibular ossification treated with ultrasound-guided steroids; conservative treatment was insufficient only for the patient who presented a fracture of the synostosis, which culminated in surgical intervention for excision of the bony bridge. DTS was also reported by James, Carpenter, and Fairclough (2007) in association with calcification of the lateral collateral ligament of the ankle joint, in which a tibiofibular bony bridge with an extremely irregular, tree-leaf-like contour was observed—a condition sufficient to prevent a professional soccer player from completing his training sessions.

During the foot-flat and push-off phases of running, the fibula is normally pulled distally by the foot flexors as they absorb the impact force and subsequently initiate propulsion (Weinert, McMaster, Ferguson, 1973; Scranton, McMaster, Kelly, 1976). This downward movement deepens the ankle mortise and tenses the interosseous membrane, stabilizing the ankle during maximum weight-bearing and stress (Weinert, McMaster, Ferguson, 1973). A TS disrupts this normal movement by preventing the descent of the fibula during weight-bearing and restricting the increase in the width of the ankle mortise that occurs during dorsiflexion of the talus. These alterations in the dynamic function of the ankle produce restricted dorsiflexion, abnormal gait, and pain.

Damage to the distal tibiofibular syndesmosis is a common complication in ankle injuries, which can occur following a fracture or a high ankle sprain. The latter is difficult to diagnose, presents a substantial recovery period, and can compromise joint function. Effective evaluation and treatment of this injury require an understanding of the functional anatomy of the region and the etiological factors involved (Ogilvie-Harris, Reed, Hedman, 1994; Ogilvie-Harris, Reed, 1994; Norkus, Floyd, 2001; Margulis *et al.*, 2020).

It is estimated that the incidence of tibial stress fractures varies between 18.9% and 63% of all fractures in athletes (Bennell, Brukner, 1997). Running, jogging, and track activities

have been associated with the majority of these fractures (Brukner *et al.*, 1996; Matheson *et al.*, 1987). However, DTS following a fracture is an uncommon complication, with limited published data. Many reports of proximal and distal TS have addressed its incidence after fractures and ankle sprains, primarily in skeletally mature patients, especially athletes. Vincelette *et al.* (1972) identified distal TS as an incidental radiographic finding in 32% of professional American football players evaluated during training camp, whereas calcification in this area was present in only 2% of the control population. Despite this, the effect of DTS on ankle function has rarely been reported.

Heterotopic ossification consists of bone formation outside the skeleton. The most typical form, unrelated to surgical procedures, neurological injuries, or tumors, is myositis ossificans circumscripta, which usually occurs after trauma but can be triggered by multiple minor injuries or develop spontaneously (McCarthy, Sundaram, 2005). Ossification of the interosseous membrane (IOM) of the leg can present characteristics similar to those of myositis ossificans. Histological analyses of TS can demonstrate an osteocartilaginous composition, frequently associated with microtrauma and microavulsions at tendon insertion sites. Kobayashi *et al.* (2013) observed, in slides of resected DTS, fibrocartilaginous tissue compatible with pseudoarthrosis, possibly resulting from repetitive microfractures. Thus, ossification can result from the simple act of walking as well as from iatrogenic, traumatic, or congenital causes (Sonnery-Cottet *et al.*, 2016; Kobayashi *et al.*, 2013).

Although metaphyseal tibial fractures rarely occur in association with fibular fractures (Court-Brown, Caesar, 2006), fibular fractures associated with distal diaphyseal tibial fractures—located primarily in the supratubercular or middle diaphyseal regions—exhibit an incidence greater than 75% (Bonnevialle *et al.*, 2010). The presence of TS may also indicate more complex clinical scenarios, such as Potocki-Shaffer Syndrome (PSS). This condition is caused by deletions on chromosome 11, and its manifestation occurs through the concomitant presence of MO, enlarged parietal foramina, intellectual disability, and craniofacial anomalies (Swarr *et al.*, 2010). These findings are closely related, as the presence of MO is a risk factor for the development of TS, which is present in approximately 50% of patients with MO (Bessler, 1997). Thus, the identification of TS, especially when associated with multiple bone masses, should serve as an alert for clinicians to investigate other skeletal and systemic abnormalities, aiming for the



differential diagnosis of complex genetic disorders that require multidisciplinary management.

The accurate diagnosis of TS frequently requires the use of magnetic resonance imaging, which is widely employed in patients with suspected interosseous ossification to exclude the possibility of bone tumors, with the use of paramagnetic contrast being indicated in these cases. Furthermore, the treatment of anterior leg pain must initially be conservative, with subsequent consideration of steroid injection and surgical intervention. Santa Maria *et al.* (2015) and Bölling, Harges, and Dirksen (2013) presented a case with a bony bridge area similar to that of the present study, which was managed entirely through conservative methods.

In the case described herein, the ossification is well-developed and trapezoidal in shape, with a slightly irregular pattern of its margins in dry bones, which differentiates it from previously described reports in the literature. This study provides a new perspective on DTS—one that is more direct and highly reliable, without the need for imaging examinations with approximate measurements—while also alerting healthcare professionals to the causes, management, and differential diagnosis of anterior leg compartment pain.

Conclusion

A DTS with a trapezoidal configuration was identified, with its larger base facing the tibia and its smaller base directed toward the fibula, corresponding to an approximate area of 261 mm². The presence of bone callus in both involved structures suggests a post-traumatic etiology, resulting from previous fractures of the tibia and fibula with subsequent bone remodeling. Knowledge of this anatomical variation, its morphology, and its etiology is fundamental for differential diagnosis and appropriate clinical management.

FUNDING

This research did not receive any specific funding from funding agencies in the



public, commercial, or not-for-profit sectors.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.

ACKNOWLEDGMENTS

We thank Marcelo Diaz Nascimento, Gladson Gomes de Souza, and Luís Henrique Santos Fortes, anatomy laboratory technicians in the Federal University of Sergipe, for their support in preparing the cadavers, since without their collaboration, this work could not have been accomplished. The authors wish to sincerely thank those who donated their bodies to science so that anatomical re-search could be carried out. The results of this research can potentially improve patient care and increase the overall knowledge of humanity. Therefore, these donors and their families deserve our utmost gratitude. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

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