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Research Paper – Araştırma Makalesi

FREQUENCY OF OS TRIGONUM AND STIEDA PROCESS, DETERMINATION OF ITS RELATION WITH POSTERIOR ANKLE PAIN AND TENDINOPATHY BY ANKLE MRI

OS TRIGONUM VE STİEDA PROSESİ GÖRÜLME SIKLIĞI, AYAK BİLEĞİ MRG İLE POSTERIOR AYAK BİLEĞİ AĞRISI VE TENDİNOPATİ İLİŞKİSİNİN BELİRLENMESİ

Suheyl POCAN[1], Levent KARAKAS[2]

Özet

Bu çalışmanın amacı posterior ayak bileği ağrısı olan hastalarda Os trigonumun görülme sıklığını ve manyetik rezonans görüntüleme (MRG) ile saptanan diğer patolojiler ile ilişkisini araştırmaktır. Çalışmamız, Ocak 2017 ile Mayıs 2023 tarihleri arasında elde edilen MRG görüntülerinin yeniden incelenmesiyle yapılan retrospektif bir çalışmadır. Çalışmaya posterior veya posterolateral ayak bileği ağrısı nedeniyle tanısal amaçlı ayak bileği MRG yapılan 482 hasta (496 ayak bileği) dahil edildi. MRG görüntüleri şu parametreler açısından yeniden incelendi: kırıklar, kontüzyon, tendinozis, bağ yaralanması, artrit, efüzyon, Stieda prosesi varlığı, posterior ayak bileği bursa sıkışması, Os trigonum, retrokalkaneal bursit, ganglion. kist, yaygın osteofitler, aksesuar naviküler kemik, osteokondritis dissekanların varlığı ve derecesi ve Aşil tendon patolojisinin varlığı ve tipi. Katılımcıların yaş ortalaması 41,96 ± 15,89 (7–83 yaş) ve %51,04'ü (n=246) erkekti. Os trigonum 17 hastada (%3.43) saptandı ve hiçbir olgu bilateral değildi. Os trigonum olasılığı erkeklerde anlamlı olarak daha yüksekti (p = 0,016, OR: 4,725, %95 GA: 1,341 - 16,655). Stieda prosesi 186 hastada (%37.5) saptandı. Aksesuar navikular kemik 8 (%1,61) hastada tespit edildi. Patolojik metatarsal kırığı olan hasta yüzdesi Os trigonumlu hastalarda anlamlı olarak daha yüksekti (p=0.034). Os trigonumlu hastalarda Stieda prosesi sıklığı anlamlı olarak daha düşüktü (p = 0,013, OR: 0,099, %95 GA: 0,013 - 0,755). Os trigonum grubunda önemli ölçüde daha az talotibial efüzyon vakası vardı (p = 0.030). Os trigonum erkeklerde anlamlı olarak daha sık görülürken, Stieda prosesi ve talotibial efüzyon varlığında daha az sıklıkta görülmektedir.
Anahtar Kelimeler: Manyetik rezonans görüntüleme, Os trigonum, Posterior ayak bileği ağrısı, Talotibial efüzyon

Abstract

The aim of this study is to investigate the frequency of Os trigonum and Stieda process and the relationship of Os trigonum with other pathologies detected by magnetic resonance imaging (MRI) in patients with posterior ankle pain. This was a retrospective study conducted by re-examining MRI images obtained between January 2017 and May 2023. The study included 482 patients (496 ankles) who underwent ankle MRI for diagnostic purposes due to posterior or posterolateral ankle pain. MRI images were re-examined for the following parameters: fractures, contusion, tendinosis, ligament injury, arthritis, effusion, presence of Stieda process, posterior ankle bursa impingement, Os trigonum, retrocalcaneal bursitis, ganglion cyst, widespread osteophytes, accessory navicular bone, presence and grade of osteochondritis dissecans, and presence and type of Achilles tendon pathology. The mean age of the participants was 41.96 ± 15.89 (7–83 years), and 51.04% (n = 246) were male. Os trigonum was detected in 17 patients (3.43 %), and none of the cases were bilateral. The likelihood of Os trigonum was significantly higher in males (p = 0.016, OR: 4.725, 95% CI: 1.341 - 16.655). Stieda process was detected in 186 patients (37.5 %). The accessory navicular bone was detected in 8 (1.61%). The percentage of patients with pathological metatarsal fractures was significantly higher in patients with Os trigonum (p = 0.034). The frequency of Stieda process was significantly lower in patients with Os trigonum (p = 0.013, OR: 0.099, 95% CI: 0.013 - 0.755). There were significantly fewer cases of talotibial effusion in the Os trigonum group (p = 0.030). While Os trigonum appears to be significantly more frequent among males, it is less frequent in the presence of the Stieda process and talotibial effusion.
Keywords: Magnetic resonance imaging, Os trigonum, Posterior ankle pain, Talotibial effusion

Geliş Tarihi (Received Date): 16.08.2023, Kabul Tarihi (Accepted Date): 11.09.2023, Basım Tarihi (Published Date): 30.09.2023. [1] Nişantaşı University, Faculty of Medicine, Department of Radiology, Istanbul, Türkiye, [2]University of Health Sciences, Gaziosmanpaşa Training and Research Hospital, Department of Radiology, Istanbul, Türkiye. **E-mail:** suheyl.pocan@nisantasi.edu.tr **ORCID ID's:** S.P.; https:/orcid.org/0000-0002-3932-2272, L.K.; https:/orcid.org/0000-0001-5485-9337.

1. INTRODUCTION

Posterior ankle pain is a cause of chronic pain and disability and is particularly common among athletes and dancers (Wong and Tan, 2016, pp. 2238-2256). One of the most common causes of posterior ankle pain is posterior ankle impingement (Wong and Tan, 2016, pp. 2238-2256), which can be caused by certain anatomic variations or abnormalities, including soft tissue and/or bone compression, talar compression, and Os trigonum (Maquirriain, 2005, pp. 365-371; Tokgöz et al., 2020, pp. 469-472).

The Stieda process is an enlargement of the posterolateral talar process. It was first described in 1869 (Stieda, 1869, pp. 108-111) and Barbedelen first used the term "os trigonum" (OT) in 1885. The Os trigonum is an accessory bone located posterior to the talus (laterally to the groove of the flexor hallucis longus tendon) (Figure 1).

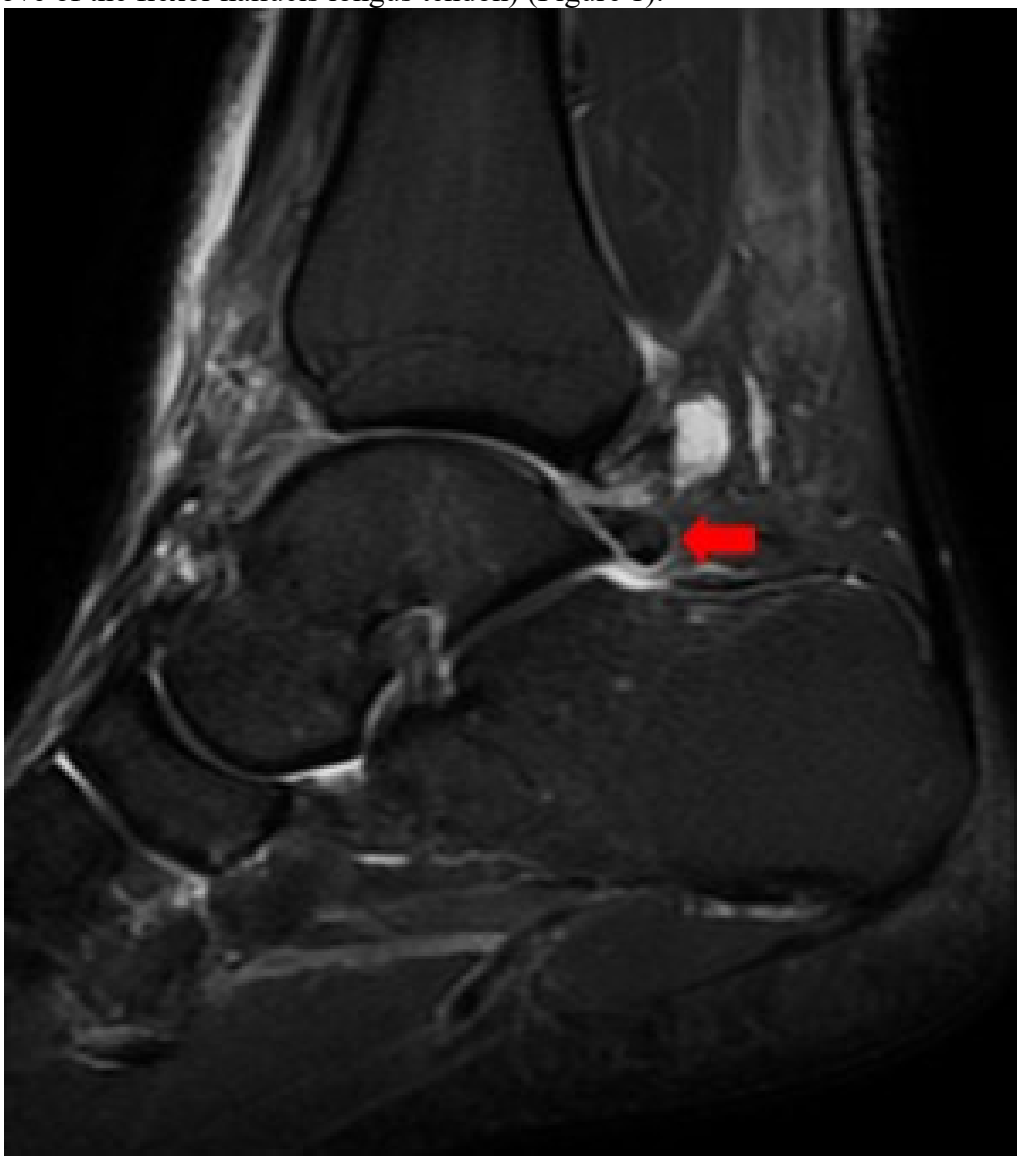

Figure 1. Os trigonum (red arrow): Sagittal STIR image

It emerges when the secondary ossification center of the talus fails to unite with the main talus bone (Bureau et al., 2000, pp. 497-503; Nault et al., 2014, pp. 545-553); therefore, it can be reliably identified around 11-13 years of age in boys and 8-10 years in girls (Nault et al., 2014, pp. 545-553). Os trigonum is one of the most common accessory ossicles in the distal lower extremity, with a prevalence ranging from 1.7% to 50% (Burman and Lapidus, 1931, pp. 936-975; Mann and Owsley, 1990, pp. 536-539; Coskun et al., 2009, pp. 19-24; Uygur et al., 2016, pp. 147-151; Guo et al., 2019, pp. 465-478; Kalbouneh et al., 2019, pp. 1433-1439; Derin Cicek and Bankaoglu, 2020, pp. 894-898). Although Os trigonum is largely asymptomatic, it can entrap the surrounding soft tissues (causing Os trigonum syndrome) and is susceptible to fracture due to its location (Kalbouneh et al., 2019, pp. 1433-1439) (Figure 2).

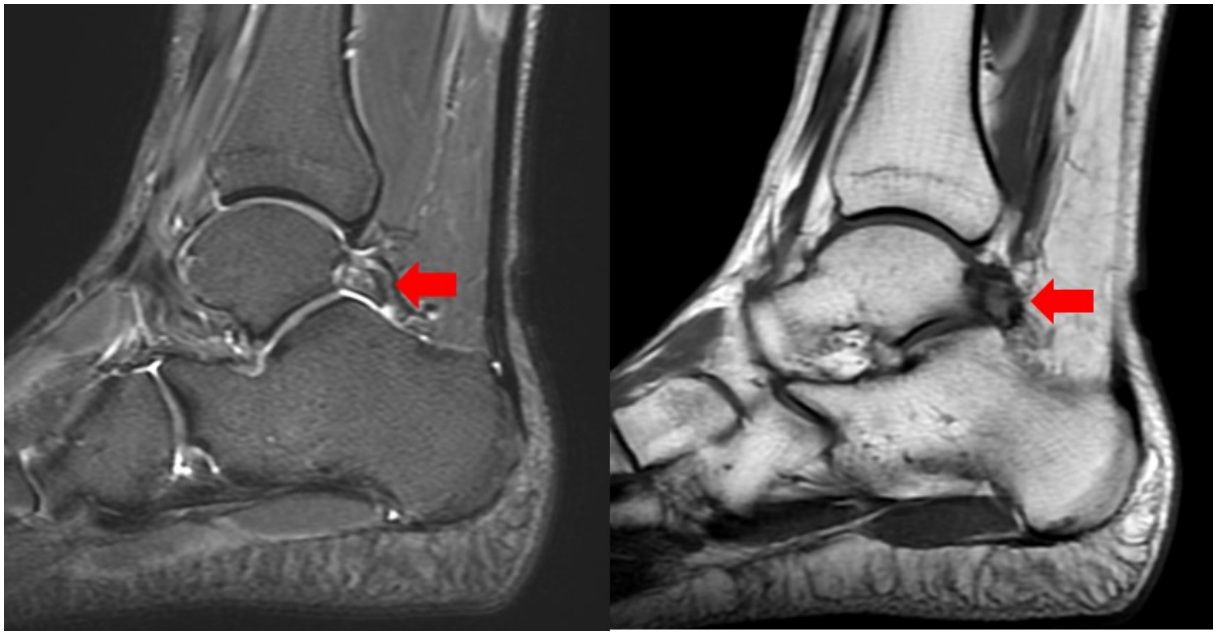

Figure 2. Fracture of Os trigonum (red arrow): Sagittal Fat Suppression Proton Density image on the left and sagittal Spin Echo T1-Weighted image on the right.

During plantar flexion, the Os trigonum and surrounding soft tissue are compressed between the calcaneus and tibia. Repetitive and/or forceful plantar flexion of the ankle can cause an Os trigonum fracture. In relation with these risks, Os trigonum is one of the most common causes of posterior ankle impingement (Robinson and White, 2002, pp. 1457-1469; Derin Cicek and Bankaoglu, 2020, pp. 894-898).

Although pathologies associated with Os trigonum are more common among athletes and ballet dancers, they can also occur in other populations (Nault et al., 2014, pp. 545-553). Although radiography and ultrasound have been used to evaluate posterior ankle pain, magnetic resonance imaging (MRI) is the imaging modality of choice because of its superior anatomical resolution and clear visualization of both soft tissue and bone. MRI also reveals bone marrow edema and contusions that cannot be detected using X-ray, ultrasound, or computed tomography (Wong and Tan, 2016, pp. 2238-2256). Therefore, MRI is crucial for detecting soft tissue pathologies accompanying Os trigonum (Tokgöz et al., 2020, pp. 469-472).

Some researchers have stated that early diagnosis and treatment of osseous impingement contribute to a decrease in morbidity (Kudaş et al., 2016, pp. 649-654; Yasui et al., 2016, pp. 657-663). Although the prevalence of Os trigonum and its impact on anatomic characteristics have been investigated in various populations, few comprehensive studies have explored potential relationships with other pathologies or imaging findings (Mc, 1955, pp. 257-265). Therefore, we aimed to investigate the frequency of Os trigonum and the Stieda process and identify pathologies that were potentially associated with Os trigonum in the examined population via re-examination of MRI images of patients suffering from posterior ankle pain.

2. METHODS

2.1. Ethics, design, and population

This study was conducted in compliance with the Declaration of Helsinki 1975, as revised in 2008, and was approved by the Scientific Research Ethics Committee of Istanbul Nişantaşı University. As the study had a retrospective design and re-examination of images was performed anonymously, the requirement for written informed consent was waived. All steps of the research were carried out in the Department of Radiology of BHTCLINIC Istanbul Tema Hospital. The study included 482 patients who underwent ankle MRI for posterior or posterolateral ankle pain between January 2017 and May 2023. The images of patients who underwent ankle MRI for diagnostic purposes (such as trauma, deformity, surgery, and infection) were re-examined to detect Os trigonum. Subjects for whom MRI images were of very poor quality (thereby preventing definitive detection) were excluded from the study. A total of 482 patients (including MRI images of a total of 496 ankles and feet) were identified to meet these criteria according to a review of digital records. The only information recorded was patient age and sex. Groups were created based on the presence or absence of Os trigonum, and comparisons were made with respect to the re-examination of images.

2.2. Routine MRI protocol

MRI scans were conducted using a 3 Tesla Signa Architect MRI scanner (GE Healthcare, USA). The patients were positioned supine with the use of an extremity coil. Standard sequences for ankle MRI were implemented, encompassing sagittal, axial, and coronal proton density fat-suppressed images; axial fast-spin-echo T2-weighted fat-suppressed images; and axial and coronal fast-spin-echo T1-weighted images.

T1-weighted images were acquired with a configuration of TR/TE set at 500/20, utilizing a 320 × 288 acquisition matrix, featuring a field of view of 16 cm, and employing two excitations. For the acquisition of proton density fat-suppressed images, a TR/TE of 2840/42 was applied, in conjunction with a 320 × 256 acquisition matrix, and a field of view of 16 cm, also employing two excitations. In the case of T2-weighted images, a TR/TE of 3550/60 was used, employing a 320 × 256 acquisition matrix, a field of view of 16 cm, and two excitations. Across all instances, the slice thickness was consistently maintained at 3 mm, and an interslice gap of 1 mm was employed.

Digital storage of the MRI images was facilitated using a picture archiving and communication system (PACS). The MRI results were evaluated using the PACS software.

Ankle MRIs were blindly reviewed by two radiologists, who have 10 and 15 years of experience in evaluating and reporting musculoskeletal radiological examinations.

2.3. Re-examination of images

The MRI images were re-evaluated (by the researchers) focusing on the identification and localization of specific parameters, including the presence and location of pathological fracture(s), contusion, tendinosis, ligament injury, arthritis, and effusion. Additionally, the assessment included the determination of the presence of the Stieda process (**Figure 3**), impingement of the posterior ankle bursa, Os trigonum, retrocalcaneal bursitis, ganglion cyst, widespread osteophytes, miscellaneous tendinopathies (**Figure 4**), and accessory navicular bone. The analysis also encompassed the identification and grading of osteochondritis dissecans and the presence and categorization of Achilles tendon pathology. Osteochondritis dissecans lesions of ankle were graded using the Berndt and Harty classification (Berndt and Harty, 1959, pp. 988-1020).

2.4. Outcomes

The primary outcome of this study was to investigate the frequency of Os trigonum detected on MRI in patients with posterior or posterolateral ankle pain of unknown cause. The secondary outcome of this study was to investigate the relationship of Os trigonum with age, sex, and other variations and pathologies detected on MRI.

2.5. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows (version 25.0; IBM Corp., Armonk, NY, USA). Statistically significant results were considered in the presence of $p < 0.05$. To assess distribution normality, histograms and Q-Q plots were examined. Continuous variables are presented as mean ± standard deviation (range) due to normal distribution, while categorical variables are expressed as frequency (percentage). Between-group comparisons of age were performed using Student's t-test, and categorical variables were analyzed using chi-square tests or Fisher's exact test (and its extension, Fisher-Freeman-Halton). Risk assessment involved the calculation of odds ratios.

3. RESULTS

The mean age of the participants was 41.96 ± 15.89 (7 - 83) years. Males represented 51.04% (n = 246) of the population. Ankle pain was on the right side in 247 (51.24%), on the left in 221 (45.85%), and bilateral in 14 (2.90%) patients. Os trigonum was detected in 17 patients (3.43%), none of whom had bilateral Os trigonum. Stieda process was detected in 186 patients (37.5 %). The accessory navicular bone was detected in 8 (1.61%) (Table 1).

Table 1. Summary of individuals' characteristics and radiological findings (496 ankles of 482 patients)

Age	41.96 ± 15.89 (7 - 83)
Sex	
Male	246 (51.04%)
Female	236 (48.96%)
Side	
Right	247 (51.24%)
Left	221 (45.85%)
Bilateral	14 (2.90%)
Fracture [(1)]	53 (10.69%)
Tibia	17 (3.43%)
Fibula	10 (2.02%)
Talus	19 (3.83%)
Calcaneus	8 (1.61%)
Navicular	2 (0.40%)
Cuneiform	1 (0.20%)
Cuboid	4 (0.81%)
Metatarsal	1 (0.20%)
Contusion [(1)]	172 (34.68%)
Tibia	52 (10.48%)
Fibula	27 (5.44%)
Talus	92 (18.55%)
Calcaneus	71 (14.31%)
Navicular	21 (4.23%)
Cuneiform	12 (2.42%)
Cuboid	23 (4.64%)
Metatarsal	11 (2.22%)
Tendinosis [(1)]	175 (35.28%)
Tibialis anterior	8 (1.61%)
Tibialis posterior	88 (17.74%)
Peroneus longus	69 (13.91%)
Peroneus brevis	58 (11.69%)
Flexor digitorum longus	73 (14.72%)
Flexor hallucis longus	94 (18.95%)
Extensor digitorum longus	7 (1.41%)
Extensor hallucis longus	4 (0.81%)
Stieda process	186 (37.50%)
PAB impingement	162 (32.66%)
Osteochondritis dissecans	49 (9.88%)
Grade 1	24 (4.84%)
Grade 2	4 (0.81%)
Grade 3	15 (3.02%)
Grade 4	6 (1.21%)
Achilles tendon pathology	54 (10.89%)

Calcification	1 (0.20%)
Degeneration	29 (5.85%)
Partial rupture	15 (3.02%)
Operated rupture	1 (0.20%)
Os trigonum	17 (3.43%)
Retrocalcaneal bursitis	37 (7.46%)
Ganglion cyst	31 (6.25%)
Ligament injury (1)	119 (23.99%)
Anterior talofibular ligament	99 (19.96%)
Posterior talofibular ligament	13 (2.62%)
Deltoid ligament	10 (2.02%)
Dorsal talonavicular ligament	10 (2.02%)
Anterior tibiotalar ligament	1 (0.20%)
Anterior tibiofibular ligament	2 (0.40%)
Posterior tibiofibular ligament	3 (0.60%)
Arthritis (1)	19 (3.83%)
Talotibial joint	10 (2.02%)
Talocalcaneal joint	6 (1.21%)
Talonavicular joint	3 (0.60%)
Calcaneocuboid joint	3 (0.60%)
Intertarsal joint	1 (0.20%)
Tarsometatarsal joint	1 (0.20%)
Widespread osteophytes	4 (0.81%)
Effusion (1)	139 (28.02%)
Tibiofibular	27 (5.44%)
Talotibial	107 (21.57%)
Talofibular	9 (1.81%)
Talocalcaneal	22 (4.44%)
Talonavicular	7 (1.41%)
Subtalar	1 (0.20%)
Posterior talar	1 (0.20%)
Tarsal sinus	1 (0.20%)
Around Os trigonum	1 (0.20%)
Accessory navicular bone	8 (1.61%)

Data are given as mean ± standard deviation (minimum - maximum) for continuous variables due to normality of distribution and as frequency (percentage) for categorical variables. (1) Individuals may have more than one of the followings.
Abbreviations; PAB: Posterior ankle bursa

The results of the comparison of patients with and without Os trigonum are presented in Table 2. There was no significant difference in the mean age between patients with [37.65 ± 12.67 (19 – 65)] and without [42.13 ± 15.92 (7 - 83)] Os trigonum (p = 0.252). The male sex ratio among patients with Os trigonum was significantly higher (p = 0.016, OR: 4.725, 95% CI: 1.341 - 16.655). The percentage of patients with pathological metatarsal fractures was significantly higher in patients with Os trigonum (p = 0.034, OR incalculable due to a lack of pathological metatarsal fracture in the non-Os trigonum group). Stieda process frequency was

significantly higher in patients without Os trigonum (p = 0.013, OR: 0.099, 95% CI: 0.013 - 0.755), indicating that the risk of Os trigonum was 10.101 times lower among individuals with Stieda process. The frequency of talotibial effusion was significantly higher in patients without Os trigonum (p = 0.030, OR incalculable due to lack of talotibial effusion in the non-Os trigonum group). Notably, effusion around the Os trigonum was detected in only one patient.

Table 2. Summary of individuals' characteristics and radiological findings with regard to presence of os trigonum (496 ankles)

	Os trigonum		
	Absent (n=479)	Present (n=17)	p
Age	42.13 ± 15.92 (7 - 83)	37.65 ± 12.67 (19 - 65)	0.252
Sex			
Male	238 (49.69%)	14 (82.35%)	**0.016**
Female	241 (50.31%)	3 (17.65%)	
Side			
Right	252 (52.61%)	9 (52.94%)	1.000
Left	227 (47.39%)	8 (47.06%)	
Fracture [(1)]	51 (10.65%)	2 (11.76%)	0.701
Tibia	17 (3.55%)	0 (0.00%)	1.000
Fibula	10 (2.09%)	0 (0.00%)	1.000
Talus	19 (3.97%)	0 (0.00%)	1.000
Calcaneus	8 (1.67%)	0 (0.00%)	1.000
Navicular	2 (0.42%)	0 (0.00%)	1.000
Cuneiform	1 (0.21%)	0 (0.00%)	1.000
Cuboid	3 (0.63%)	1 (5.88%)	0.131
Metatarsal	0 (0.00%)	1 (5.88%)	**0.034**
Contusion [(1)]	167 (34.86%)	5 (29.41%)	0.838
Tibia	52 (10.86%)	0 (0.00%)	0.238
Fibula	27 (5.64%)	0 (0.00%)	0.615
Talus	88 (18.37%)	4 (23.53%)	0.534
Calcaneus	70 (14.61%)	1 (5.88%)	0.488
Navicular	21 (4.38%)	0 (0.00%)	1.000
Cuneiform	12 (2.51%)	0 (0.00%)	1.000
Cuboid	23 (4.80%)	0 (0.00%)	1.000
Metatarsal	10 (2.09%)	1 (5.88%)	0.321
Tendinosis [(1)]	170 (35.49%)	5 (29.41%)	0.797
Tibialis anterior	8 (1.67%)	0 (0.00%)	1.000
Tibialis posterior	87 (18.16%)	1 (5.88%)	0.330
Peroneus longus	67 (13.99%)	2 (11.76%)	1.000
Peroneus brevis	56 (11.69%)	2 (11.76%)	1.000
Flexor digitorum longus	71 (14.82%)	2 (11.76%)	1.000
Flexor hallucis longus	92 (19.21%)	2 (11.76%)	0.752
Extensor digitorum longus	7 (1.46%)	0 (0.00%)	1.000
Extensor hallucis longus	4 (0.84%)	0 (0.00%)	1.000
Stieda process	185 (38.62%)	1 (5.88%)	**0.013**

PAB impingement	154 (32.15%)	8 (47.06%)	0.305
Osteochondritis dissecans	46 (9.60%)	3 (17.65%)	0.231
Grade 1	22 (4.59%)	2 (11.76%)	
Grade 2	4 (0.84%)	0 (0.00%)	0.151
Grade 3	15 (3.13%)	0 (0.00%)	
Grade 4	5 (1.04%)	1 (5.88%)	
Achilles tendon pathology	53 (11.06%)	1 (5.88%)	1.000
Calcification	1 (0.21%)	0 (0.00%)	
Degeneration	29 (6.05%)	0 (0.00%)	0.406
Partial rupture	15 (3.13%)	0 (0.00%)	
Complete rupture	7 (1.46%)	1 (5.88%)	
Retrocalcaneal bursitis	35 (7.31%)	2 (11.76%)	0.367
Ganglion cyst	30 (6.26%)	1 (5.88%)	1.000
Ligament injury (1)	116 (24.22%)	3 (17.65%)	0.773
Anterior talofibular ligament	97 (20.25%)	2 (11.76%)	0.544
Posterior talofibular ligament	12 (2.51%)	1 (5.88%)	0.368
Deltoid ligament	10 (2.09%)	0 (0.00%)	1.000
Dorsal talonavicular ligament	10 (2.09%)	0 (0.00%)	1.000
Anterior tibiotalar ligament	1 (0.21%)	0 (0.00%)	1.000
Anterior tibiofibular ligament	2 (0.42%)	0 (0.00%)	1.000
Posterior tibiofibular ligament	3 (0.63%)	0 (0.00%)	1.000
Arthritis (1)	18 (3.76%)	1 (5.88%)	0.491
Talotibial joint	10 (2.09%)	0 (0.00%)	1.000
Talocalcaneal joint	6 (1.25%)	0 (0.00%)	1.000
Talonavicular joint	2 (0.42%)	1 (5.88%)	0.100
Calcaneocuboid joint	3 (0.63%)	0 (0.00%)	1.000
Intertarsal joint	1 (0.21%)	0 (0.00%)	1.000
Tarsometatarsal joint	1 (0.21%)	0 (0.00%)	1.000
Widespread osteophytes	4 (0.84%)	0 (0.00%)	1.000
Effusion (1)	137 (28.60%)	2 (11.76%)	0.172
Tibiofibular	27 (5.64%)	0 (0.00%)	0.615
Talotibial	107 (22.34%)	0 (0.00%)	**0.030**
Talofibular	9 (1.88%)	0 (0.00%)	1.000
Talocalcaneal	21 (4.38%)	1 (5.88%)	0.544
Talonavicular	7 (1.46%)	0 (0.00%)	1.000
Subtalar	1 (0.21%)	0 (0.00%)	1.000
Posterior talar	1 (0.21%)	0 (0.00%)	1.000
Tarsal sinus	1 (0.21%)	0 (0.00%)	1.000
Around Os trigonum	0 (0.00%)	1 (5.88%)	**0.034**
Accessory navicular bone	8 (1.67%)	0 (0.00%)	1.000

Data are given as mean ± standard deviation (minimum - maximum) for continuous variables due to normality of distribution and as frequency (percentage) for categorical variables. (1) There may be more than one in the same foot.
Abbreviations; PAB: Posterior ankle bursa

4. DISCUSSION

Accessory bones, typically arising from unfused accessory ossification centers, can manifest as various structures, including the Os trigonum, accessory navicular, Os supranaviculare, Os peroneum, Os intermetatarseum, and Os calcaneus secundarius (Nwawka et al., 2013, pp. 581-593; Guo et al., 2019, pp. 465-478). While frequently displaying no symptoms, these accessory bones can lead to degenerative alterations, stress-related discomfort, and painful syndromes as a consequence of exerting pressure on neighboring soft tissues, and in more severe cases, they may even result in fractures or fracture-like appearances (Guo et al., 2019, pp. 465-478). This retrospective cohort study revealed that the incidence of Os trigonum in patients with posterior ankle pain of unknown cause was 3.43% (n = 17). Bilateral Os trigonum was not detected in any patient, but the frequency was significantly higher in males. The proportion of patients with pathological metatarsal fractures was significantly higher in the Os trigonum group. Stieda process and talotibial effusion were significantly more common among individuals without Os trigonum.

There is a wide discrepancy in the literature regarding the prevalence and bilaterality of Os trigonum. To the best of our knowledge, the lowest reported frequency is 1.7% (Mann and Owsley, 1990, pp. 536-539), and the highest is described in an almost-century-old study with 49.3%, as found in X-rays (Burman and Lapidus, 1931, pp. 936-975). In a two-center retrospective study from Turkey, Çiçek et al. determined the prevalence of Os trigonum (ankle radiographs) to be 9.3% in patients with a history of mild-to-moderate trauma (Derin Cicek and Bankaoglu, 2020, pp. 894-898). In other studies in Turkey, the prevalence of Os trigonum detected by radiography was 15.4% (Uygur et al., 2016, pp. 147-151) and 2.7% (Coskun et al., 2009, pp. 19-24). In a recent study consisting of 1256 ankles, the incidence of Os trigonum was reported as 32.5% (Zwiers et al., 2018, pp. 338-342). When specific populations are examined, such as those with ankle impingement, the impact of Os trigonum is demonstrated by the fact that it was present in 70.1% of patients with posterior ankle impingement syndrome compared to 1.7% in patients without impingement. The relationship with injuries was also evidenced by a study by Kalbouneh et al., who identified Os trigonum in 20.4% of individuals with a history of ankle sprains (Kalbouneh et al., 2019, pp. 1433-1439). Bilateral Os trigonum has been reported to have a frequency of up to 14.3% (Zwiers et al., 2018, pp. 338-342); however, similar to our results, several studies have reported a very low frequency of bilaterality, which has been ascribed to various factors (Mann and Owsley, 1990, pp. 536-539; Zwiers et al., 2018, pp. 338-342). These include different diagnostic tools, unclear definitions of separation, and differences between the studied populations. While some studies have examined patients with any type of ankle pain, others have investigated posterior ankle impingement, and few studies have tried to explore the whole population. However, Os trigonum ratios may differ in these populations, with particularly high frequencies reported in studies examining impingement (Zwiers et al., 2018, pp. 338-342). Additionally, age differences may have affected the results. Inconsistent definitions may also impact the interpretation of imaging findings. Indeed, some authors classify partially separated or even enlarged posterior processes as Os trigonum.

Similar to the uncertainty surrounding the prevalence of Os trigonum, the association between this anatomical variation and age and sex remains ambiguous. In our study, despite

observing a slightly younger average age among patients with Os trigonum, this disparity did not yield statistical significance. However, we did identify a noteworthy 4.725-fold higher risk of Os trigonum occurrence in males compared than in females. Prior investigations have often indicated that the detection of Os trigonum through imaging methods is more prevalent in younger individuals (Zwiers et al., 2018, pp. 338-342; Kalbouneh et al., 2019, pp. 1433-1439). Kalbouneh et al. reported an increased rate of Os trigonum syndrome in the 18–35 age range (Kalbouneh et al., 2019, pp. 1433-1439). In a study by Çiçek et al., the prevalence of Os trigonum was 13.7% in men and 4.3% in women, demonstrating significance (Derin Cicek and Bankaoglu, 2020, pp. 894-898). Uygur et al. also reported a significantly higher prevalence of Os trigonum in men than in women (Uygur et al., 2016, pp. 147-151). Despite these findings, there are studies that have not detected differences between the sexes (Coskun et al., 2009, pp. 19-24). More data are needed to clarify the relationships among Os trigonum, age, and sex.

There are a wide variety of sesamoids and accessory ossicles in the ankle and foot (Kalbouneh et al., 2019, pp. 1433-1439), with Os trigonum being the most common. Although Os trigonum is usually asymptomatic, it can present with a variety of symptoms, clinical findings, and complications (Kalbouneh et al., 2019, pp. 1433-1439). Various radiological imaging methods are used for Os trigonum screening and diagnosis owing to their advantages and disadvantages. Os trigonum hypertrophy and soft tissue swelling around the Os trigonum and curving of fat can be seen on ankle lateral radiographs (Karasick and Schweitzer, 1996, pp. 125-129). Computed tomography is useful for demonstrating acute os trigonum fractures and degeneration in synchondroses (Wong and Tan, 2016, pp. 2238-2256). Ultrasound is helpful in visualizing posterior tibiotalar joint synovitis or flexor hallucis longus tenosynovitis (Pesquer et al., 2014, pp. 89-97). MRI facilitates the assessment of various aspects related to Os trigonum, including bone marrow edema in the Os trigonum and the contralateral talar process, synchondrosis evaluation, adjacent synovitis, and the identification of degenerative changes associated with flexor hallucis longus tenosynovitis (Wong and Tan, 2016, pp. 2238-2256).

The second important aim of the current study was to detect pathologies that can accompany Os trigonum and can be detected by MRI. The results showed that pathological metatarsal fractures were significantly more common in patients with Os trigonum, whereas talotibial effusion and Stieda process were more common in the non-Os trigonum group. The risk of Os trigonum in patients with Stieda process was 10.101 times lower. While talotibial effusion was not present in any patient with Os trigonum, it was detected in 22.34% of patients without Os trigonum.

Os trigonum is associated with some tissue pathologies. In the present study, the incidence of Stieda process was found to be considerably higher than Os trigonum. This suggests that the Stieda process may be a likely cause of ankle pain, indicating the need for further studies. On the other hand, Os trigonum must be considered in the differential diagnosis of Stieda process fractures since they have similar radiographic appearance (Mellado et al., 2003, pp. L164- L177). However, the relationship between hypertrophic talar process and Os trigonum is not clearly known. In our study, we found that pathological metatarsal fractures were more common, whereas talotibial effusion was less common in patients with Os trigonum. However, considering that these two parameters can be affected by many other variables, it is evident that multivariable analyses should be performed with the inclusion of a higher number of patients with these characteristics, which necessitates extremely large studies owing to the rarity of these conditions. Unfortunately, despite the large cohort, the size of our study was insufficient. The relationships between pathological metatarsal fracture, talotibial effusion and

Os trigonum appear to be topics worth investigating in future studies. In addition, other studies have described that Os trigonum may be associated with flexor hallucis longus tenosynovitis, degeneration, and partial tear (Corte-Real et al., 2012, pp. 1108-1012; Tokgöz et al., 2020, pp. 469-472). Interestingly, no significant association was found between flexor hallucis longus tendinosis and the presence of Os trigonum in this study. This may have been due to the selection of the study population.

The external validity of this study is limited because of its single-center design. Retrospective analyses also restricted the inclusion of crucial data such as physical activity levels and occupational information. Despite determining the frequency of Os trigonum in the targeted population, the small number of patients with this variation hindered analyses of its relationship with other pathologies and variations. In addition, the study did not include information on the size and type of Os trigonum. Notably, significant differences in variables, such as pathological metatarsal fractures, were observed, but the occurrence was rare, affecting the reliability of the analyses. The absence of a control group with posterior ankle pain further restricted the exploration of the association of Os trigonum with related pathologies and pain. Lastly, due to low counts of certain variables with significant differences, multivariable analysis could not be performed.

5. CONCLUSION

In conclusion, the frequency of Os trigonum detected by MRI was determined to be 3.43% in our patient population who had posterior and posterolateral ankle pain due to unknown etiology. The incidence of Os trigonum in males was significantly higher than in females. There was an inverse relationship between the presence of the Stieda process and talotibial effusion. According to the literature and the present results, it can be assumed that male patients are at higher risk, while patients with Stieda process and talotibial effusions are at lower risk. However, more comprehensive studies are needed to define the incidence of Os trigonum and its relationship with age, sex, and other complications and variations.

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