Foot and Ankle Disorders

A Comprehensive Approach in Pediatric and Adult Populations

Posterior Ankle Impingement

Daniel Baumfeld and Tiago Baumfeld

Synopsis

Posterior Ankle Impingement (PAI) refers to a chronic painful mechanical limitation of ankle motion caused by soft-tissue or osseous abnormality affecting the posterior tibiotalar joint. Impingement can be associated with single traumatic event or repetitive microtrauma. This syndrome is one of the possible etiologies of persistent ankle pain. Nowadays, arthroscopic approach to this pathology, when indicated, is consider as the gold standard with its high safety and low complication rates. In this chapter, we describe the clinical and potential imaging features, as well as the arthroscopic/endoscopic management strategies for PAI.

Key Points

- Posterior Ankle Impingement is a clinical syndrome of end-range joint pain or motion restriction caused by the direct mechanical impact of bone or soft tissues.
- Imaging studies can show osseous and soft-tissue diseases and anatomic variations that can help diagnose and treat impingement syndromes.
- Soft-tissue impingement occurs more frequently on the lateral side as a consequence of synovial scarring, inflammation, and hypertrophy in the anterolateral recess of the tibiotalar joint, but it can also occur in PAI.
- Advantages of the arthroscopic treatment over open arthrotomy include reduced recovery time and earlier return to sports activities.

D. Baumfeld (✉)
Federal University of Minas Gerais, Felicio Rocho Hospital, Belo Horizonte, MG, Brazil

T. Baumfeld
Felicio Rocho Hospital, Belo Horizonte, MG, Brazil

1107
E. Wagner Hitschfeld, P. Wagner Hitschfeld (eds.), *Foot and Ankle Disorders*, https://doi.org/10.1007/978-3-030-95738-4_49

1 Introduction

Posterior Ankle Impingement (PAI) refers to a chronic painful mechanical limitation of the ankle caused by soft-tissue or osseous abnormalities [1]. Posttraumatic synovitis, intra-articular fibrous bands/scar tissue, capsular scarring, or developmental and acquired bony spurs or prominences are the most common causes [2]. Single traumatic event or repetitive microtrauma are also associated with this syndrome [1]. Although PAI is largely a clinical diagnosis, imaging is often used to evaluate suspected ankle impingement in order to confirm the presence of typical changes and as a tool for preoperative planning. Imaging can also help differentiate impingement from alternative diagnoses that may have overlapping clinical presentations [3]. Currently, the surgical approach to this pathology, when indicated, is performed with arthroscopic/endoscopic assistance. This method provides a highly accurate means of locating and treating intra-articular abnormality [3, 4].

In this chapter, we describe the clinical and potential imaging features, as well as the arthroscopic/endoscopic management strategies for PAI.

2 Etiology

Posterior impingement arises from compression of the soft tissues between the posterior process of the calcaneus and the posterior tibial border on plantar flexion of the ankle [5–7]. The soft tissues compressed include the tibiotalar capsule, posterior talofibular, intermalleolar, and tibiofibular ligaments. The flexor hallucis longus (FHL) and the lateral posterior process of the talus are also important because additional bony impingement with these structures can occur as a consequence of prominent os trigonum [8, 9] (Fig. 1a–c).

The lateral process of the talus initially forms as a secondary ossification center between the ages of 7–13 years and usually fuses with the main body of the talus within 1 year [7, 8, 10, 11]. If there is a failure of fusion, the ossicle is known as an os trigonum and articulates with the talus via a synchondrosis (incidence 7–14%) [12]. If the lateral talar process is unusually large or prominent, it is termed as Stieda process.

The posterior ankle impingement can develop after a significant acute injury such as avulsion of the posterior talo-fibular ligament, talar fracture, or fracture of the os trigonum [13]. However, this is relatively rare and the syndrome usually arises insidiously in predisposed athletes. It is believed that repetitive forced plantar flexion of the foot results in chronic injury to the posterior osseous and soft tissues [14]. Ballet dancers are especially prone to this injury, as the ankle is commonly at the extremes of its full range of movement and is maintained in these positions for relatively prolonged periods [13, 15]. Professional soccer players are also at increased risk because ball kicking leads to repeated sudden forced plantar flexion [4].

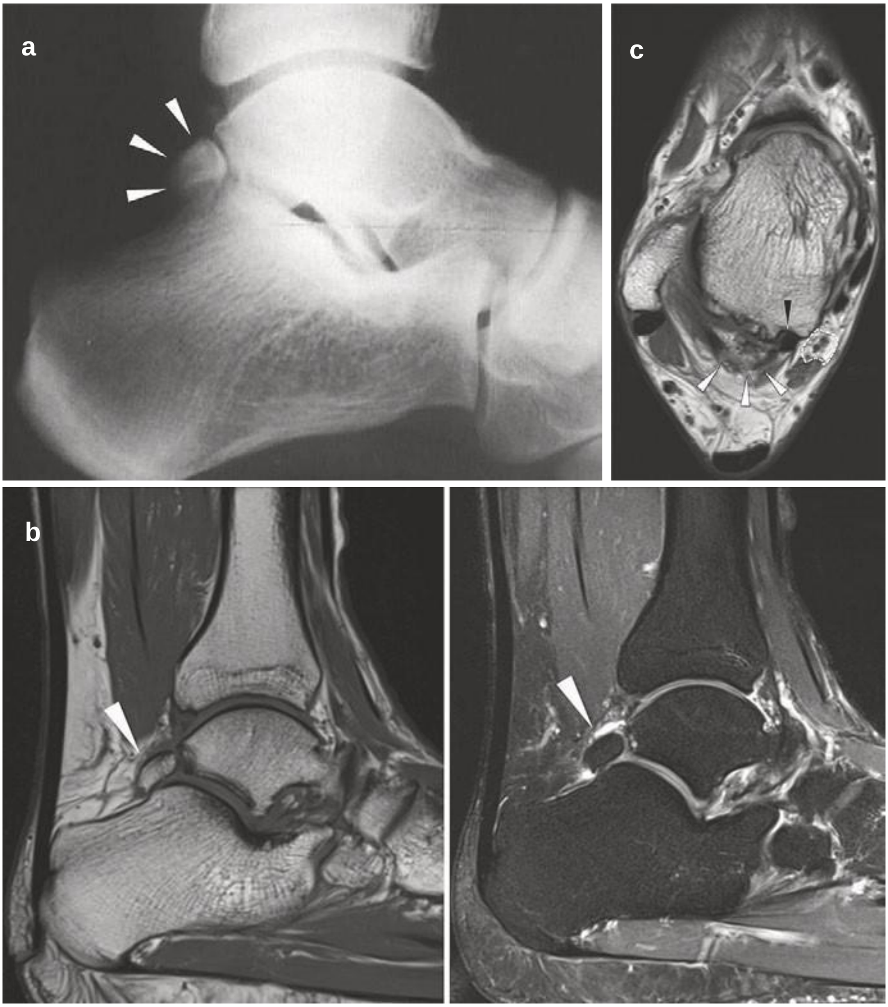

Fig. 1 (**a**) *Os trigonum* syndrome. (**b**) Sagittal MRI (T1 and T2) images. The arrowheads point to the *os trigonum*. (**c**) T1 cross section. White arrowheads point to *os trigonum*; the black arrowhead points at the FHL tendon and the dashed line circumscribes the NAV bundle

3 Imaging Studies

The imaging assessment of PAI initiates with conventional radiography. Anteroposterior (AP) ankle view typically does not reveal abnormalities related to posterior impingement. On the lateral view, a prominent Stieda's process or os trigonum may be identified in the posterolateral aspect of the ankle; however, these findings are commonly seen in asymptomatic individuals [4, 9].

Computed Tomography (CT) allows evaluation of anatomical details of osseous structures of the posterior ankle and detection of fractures, loose bodies, and osteochondral lesions that may be associated with posterior impingement. Ultrasound has its main role as a tool for ultrasound-guided therapeutic injection of steroids and anesthetics. In most patients, ultrasound will show hypoechoic, nodular capsular thickening localized on the lateral aspect of the lateral talar process or the os trigonum [5].

Nuclear medicine bone scintigraphy has been used as an adjunct to radiography since it shows increased radiotracer uptake due to hyperemia and bone repair in the posterior ankle in the setting of impingement. Although highly sensitive, bone scintigraphy lacks specificity and cannot distinguish between radiotracer uptake related to fracture, pseudarthrosis, bone contusion, or posterior subtalar arthritis. In comparison to bone scintigraphy, SPECT-CT allows superior anatomical correlation of radiotracer activity and symptoms. Use of SPECT-CT has been described for posterior ankle pain [16].

Magnetic Resonance Imaging (MRI) is the optimal modality as it can define osseous and non-osseous abnormalities. Osseous findings associated with posterior impingement include bone marrow edema pattern within a Stieda process or os trigonum and the adjacent talus and/or fluid signal at the synchondrosis in the context of an os trigonum. MRI in the sagittal plane using T1-weighted and fatsuppressed PDW or STIR sequences can afford optimal visualization of an os trigonum, a Stieda process. Soft-tissue abnormalities can consist of prominent fluid distending the posterior joint recess, posterior ganglia, posterior synovial thickening, edema- like signal within the surrounding soft tissues, and FHL tenosynovitis. MRI imaging also allows accurate assessment of the remainder of the tibiotalar joint and surrounding tendons, which can aid treatment and surgical planning [17, 18].

4 Clinical Presentation

The diagnosis of PAI is based primarily on the clinical history and physical exam. The patient usually reports chronic or recurrent posterior pain caused by forced plantar flexion or push-off activities, such as dance, kicking sports, walking or running downhill, and wearing high heels. The pain is usually deep and may have a mechanical component. Symptoms can develop 4–6 weeks after the initial ankle injury, in which presumably thickening of the posterior capsule and adjacent soft tissues develop. It may also arise secondary to loose avulsion fragments of bone posterolaterally following a previous ligamentous injury. PAI syndrome more commonly arises in individuals with the previously described osseous anatomical variants who are exposed to repetitive forced plantar flexion resulting in compression of the osseous and soft tissues behind the ankle [19–23].

On physical examination, there typically is posteromedial or posterolateral tenderness. Passive terminal plantar flexion may reproduce the patient's symptoms. The Posterior Impingement test consists of quickly forced hyper plantar flexion causing the posterior talar process or the os trigonum to be compressed between the posterior rim of the tibia and the calcaneus. A positive result causes pain-r eproducing symptoms; there may be a block to full plantar flexion [24].

If passive hallux motion causes pain, flexor hallucis longus abnormality may also be present. Many patients being treated for an os trigonum can have symptomatic involvement of the FHL. Patients with posterior ankle impingement syndrome secondary to FHL problems usually report posteromedial ankle pain during forced plantar flexion of the ankle. Clinically, the pain may be reproduced by asking the patient to repeatedly flex and extend the great toe with the ankle in 20-degree equinus while palpating the tendon behind the medial malleolus. In more chronic cases, crepitus and occasionally a nodule within the tendon may be felt. Triggering can be also found [25].

It was described that athletes affected by posterior impingement may attempt to compensate for the loss of plantar flexion by assuming an inverted foot position. This may predispose to frequent ankle sprains, calf strains and contractures, plantar foot pain, and toe curling [26].

5 Approaches to Treatment

The initial treatment of choice for PAI is generally conservative [27, 28]. Potential options include rest, physical therapy, ankle bracing or taping, shoe modification, local corticosteroid injection, and the avoidance of extreme ankle plantar flexion. Immobilization is indicated if there is evidence of an acute fracture. Subsequent physical therapy and protective dorsiflexion taping may be helpful. Frequently, conservative treatment fails and surgery is recommended.

Open surgical techniques have been used with moderate success, but current guidelines consider endoscopy as the gold standard surgical approach with its high safety and low complication rates [26]. Open approach can be either posteromedial or posterolateral, being the first the choice when FHL pathology has to be addressed. It has been well documented with 75% successful results and a mean time to return to sporting activities or dancing at 3–5 months but has a complication rate of 15– 24%. With improvements in endoscopy techniques, arthroscopic treatment now offers improved success rates with a shortened recovery time (average resumption of sporting activities at 9 weeks) and reduced complication rate (1–9%).

6 E ndoscopic Anatomy of the Posterior Ankle

Endoscopic approach for diagnosis and treatment of posterior ankle pathology has been proven to be an effective and safe procedure for bony posterior ankle impingement due different causes. The knowledge of particular anatomy of the posterior ankle joint is imperative to achieve good results and perform a safe procedure. There are some particular anatomic issues of the posterior ankle joint that may help [25, 29] (Fig. 2a-f):

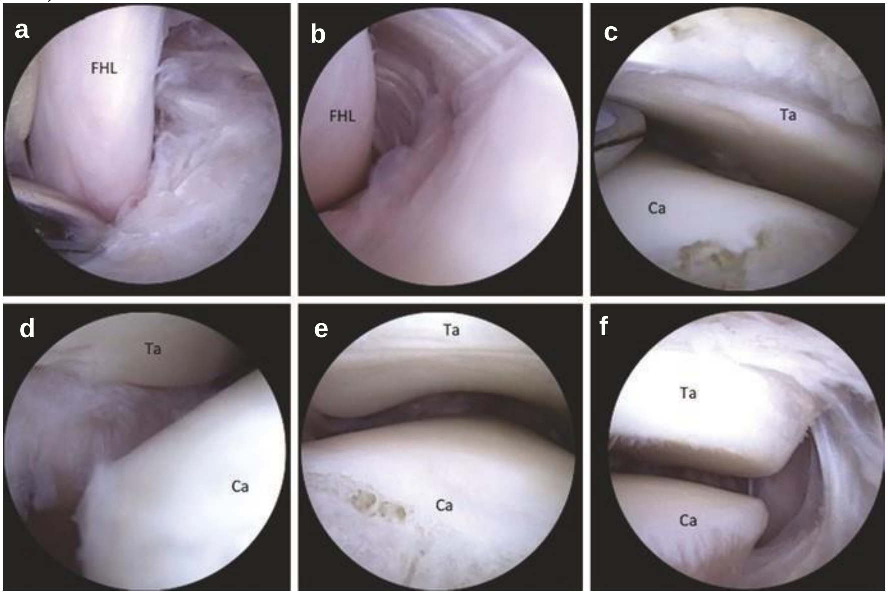

Fig. 2 Posterior ankle endoscopy: (**a**) The most important safety and reference point for posterior ankle arthroscopy is the FHL. The tibial nerve bundle beam is 2 mm from this reference point in the medial direction. (**b**) FHL can be arthroscopically evaluated distally within its own sheath. (**c**) The central portion of the subtalar joint. (**d**) The medial "shoulder" of the calcaneus at the subtalar joint. (**e**) The concavity of the talar articular surface and the convexity of the calcaneal articular surface at the subtalar joint. (**f**) The lateral "shoulder" of the calcaneus at the subtalar joint. Legends: FHL flexor hallucis longus, Ta talus, Ca calcaneus

1. The synchondrosis of the os trigonum may vary in orientation from coronal to oblique sagittal plane.
2. There are unusual muscles that can cause posterior impingement including peroneus quartus, flexor accessories digitorum longus, accessory soleus, peroneus- calcaneus internus muscle, tibiocalcaneus internus, and low-lying flexor hallucis longus muscle belly; all of those can be identified by arthroscopic procedures.
3. The deep transverse ligament of the posterior inferior tibiofibular ligament is considered a true labrum of the posterior ankle joint and has been implicated in posterior ankle impingement.
4. When a tight and thickened crural fascia is present, this can hinder the free movement of instruments. It can be helpful to enlarge the portals deep in the fascia by means of a punch or shaver.

7 Endoscopic Treatment of the Posterior Ankle Impingement

When addressing posterior ankle impingement, hindfoot conventional endoscopic portals with the patient in prone position are recommended [25]. This consists of the posterolateral and posteromedial portals located at the junction of the tip of the lateral malleolus and the medial and lateral borders of the calcaneal tendon. Creation of these portals does not have a risk for injuries when performed close to the Achilles tendon; however, the creation of a working area during hindfoot endoscopy has a high potential risk of injury to the posterior neurovascular structures. A systematic technique when creating this space and working lateral to the flexor hallucis longus tendon are both recommended in order to avoid complications.

The initial posterior ankle debridement is often done in a blind fashion. Once the bone can be visualized, the arthroscope and shaver can be advanced medially to identify the FHL tendon. There is often a large amount of fibrous soft tissue and capsule that makes initial visualization difficult. The key is to be patient with shaver dissection and to always be aware of instrument position in the posterior ankle, especially in relation to the FHL tendon. The safe initial working zone is midline to lateral to avoid the tendon and deeper rather than superficial to avoid the Achilles tendon. After the fatty tissue overlying the posterior ankle capsule, lateral from the FHL tendon is resected, the possible posterior anatomic structures causing impingement can be identified [12, 26]:

- Hypertrophic posterior joint capsule
- Synovitis

- Os trigonum
- Hypertrophic posterior talar process
- Entrapment of the flexor hallucis longus

A 4.0-mm aggressive soft-tissue shaver is typically used for soft-tissue debridement and a 3.5 or 4.0 mm barrel burr is typically used for bony resection. Synovectomy may be safely performed with the shaver and a radio frequency ablation instrument. The surgeon should be careful with radio frequency when working around the flexor hallucis longus tendon to avoid thermal injury to the tibial nerve and vascular structures. If there is also FHL tenosynovitis, or a distal insertion of the FLH muscle belly, then the shaver or a punch can be used to release the flexor retinaculum from the medial border of the talus and to resect the distal portion of the muscle belly. The FHL can be thoroughly debrided, and a smooth excursion of the tendon can be directly verified with the arthroscope. Identifying the os trigonum or Stieda process before initiating burring is also an important recommendation [13, 22] (Fig. 3a–f).

8 Specific Condition Regarding Posterior Impingement Syndrome

Approaches described above are the usual treatment that surgeons can follow to manage this pathology, but there are special presentations in daily practice that make the decision hard and, in many times, different than usual.

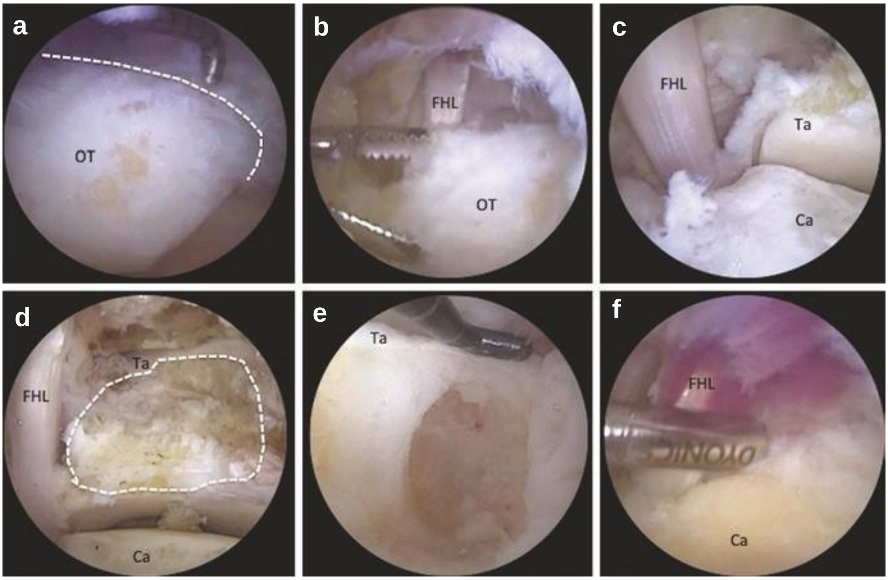

Fig. 3 Posterior ankle impingement – *os trigonum* syndrome: (**a**) Regularly the limits between the talus and the *os trigonum* are not so easy to find (dotted line). (**b**) After removal the fibrous tissue (symphysis) or cartilage (synchondrosis) existing in the contact zone the *os trigonum* can be removed. (**c**) After the *os trigonum* removal, the FHL runs completely free. (**d**) The dotted white line delimits the area from which the *os trigonum* was removed. (**e**) Osteochondral lesions of the posterior aspect of the talus could be accessed from the posterior arthroscopy. (**f**) Symptoms of posterior impingement may be due to low FHL muscle belly implantation. These fibers can be removed with the aid of soft-tissue shaver. Legends: OT *os trigonum*, FHL flexor hallucis longus,

Ta talus, Ca calcaneus

Athletes during season can be conducted with non-validated biological treatments such as PRP or PRF, with injection solution of homeopathic combination drugs or even with lidocaine just allowing them to participate during training or official games. During season, we usually start with lidocaine and/or homeopathic injection; if this option presents with a relatively good result that allows the athlete to play, 10 days later a PRP or PRF injection is planned. Another possibility that may help is Percutaneous Electrolysis Therapy (PET); this treatment involves applying a modulated direct electrical current directly to damaged soft tissue via an acupuncture needle, that may induce tissue's recovery. Shock wave therapy is also another possibility that can be used. Both of these modalities intend to stimulate fast softtissue healing and pain relief, but, until now, they do not have prospective studies.

Normally, the decision to move on the treatment to surgery is discussed with the team executive, coaches, and the athlete. Regarding posterior ankle impingement, the most common seen scenario is the management of a typical ballet dancer with posterior pain. How do we manage this? Inject or not? How often? Corticoid injections should be used as single shots or be avoided; first of all, they are considered doping in some sports, and second they may lead to local consequences as tendon ruptures, skin problems, and local adhesion[41]. It is preferable to use shock wave therapies, injections with hyaluronic acid, PRP, or PRF and even homeopathic substances as Arnica Montana. The use of PET or shock wave therapy can also be used as nonsurgical treatments.

9 Evidence and Final Considerations

Endoscopic management of posterior ankle impingement is associated with a low morbidity, a short recovery time, and provides good/excellent results at 2 years follow- up in 80% of patients [6, 20, 26, 27]. The theoretical advantages of posterior ankle arthroscopy include better visualization of the posterior ankle and subtalar joint, earlier return to activity due to less dissection and smaller incisions, and lower complication rates. The disadvantages are that this technique is complex and demanding with a steep initial learning curve and longer operating times. Comparing open and arthroscopic os trigonum excision, there was no significant difference in American Orthopaedic Foot and Ankle Society (AOFAS) visual analog scale scores reported in the literature; however, the time for return to sports was almost 6 weeks earlier for the arthroscopic patients (6 vs 11.9 weeks) [22, 26, 28]. The overall complication rate was reported to be 3.8–8.5% after posterior hindfoot endoscopy for posterior ankle impingement, FHL tenosynovitis, os trigonum syndrome, or a fractured Stieda process while the rate of complications in open posterior hindfoot and ankle surgery for the same pathologies ranged from 10% to 24% [25, 26]. The potential for nerve injury appears to be similar for both open and arthroscopic techniques. Ribbans et al. [29] compared open and arthroscopic debridement. Open cases had a 4.2% incidence of nerve injury and a wound complication and infection rate of 2.8%. Arthroscopic cases had a 3.7% incidence of nerve injury and 0.96% incidence of wound complication and infection rate. Although rare, injury to the tibial nerve and its branches for procedures around the posterior talar process has been reported [13, 22]. This procedure has proven to be particularly effective in patients with overuse injuries that have frequent plantar flexion activities, such as dancers and soccer players. The main complication, sural nerve neuropraxia, can be minimized by correct portal placement and instrumentation.

Correct diagnosis and treatment are essential on the management of PAI, especially in professional athletes. Endoscopic treatment is minimally invasive and suitable for athletes and nonathletes who desire an early return to sports and a lower complications rate.

References

1. Lavery KP, McHale KJ, Rossy WH, Theodore G. Ankle impingement. J Orthop Surg Res. 2016;1–7 https://doi.org/10.1186/s13018- 016- 0430-x .
2. Tol JL, van Dijk CN. Anterior ankle impingement. Foot Ankle Clin N Am. 2006;11(2):297– 310. https://doi.org/10.1016/j.fcl.2006.02.002.
3. Ross KA, Murawski CD, Smyth NA, et al. Current concepts review: arthroscopic treatment of anterior ankle impingement. Foot Ankle Surg. 2017;23(1):1–8. https://doi.org/10.1016/j. fas.2016.01.005.
4. LiMarzi GM, Khan O, Shah Y, Yablon CM. Imaging manifestations of ankle impingement syndromes. Radiol Clin NA. 2018;56(6):893–916. https://doi.org/10.1016/j.rcl.2018.06.005.
5. Robinson P. Impingement syndromes of the ankle. Eur Radiol. 2007;17(12):3056–65. https:// doi.org/10.1007/s00330- 007- 0675- 1.
6. Niek van Dijk C. Anterior and posterior ankle impingement. Foot Ankle Clin N Am. 2006;11(3):663–83. https://doi.org/10.1016/j.fcl.2006.06.003.
7. Dimmick S, Linklater J. Ankle impingement syndromes. Radiol Clin NA. 2013;51(3):479– 510. https://doi.org/10.1016/j.rcl.2012.11.005.
8. Zbojniewicz AM. Impingement syndromes of the ankle and hindfoot. Pediatr Radiol. 2019:1–11. https://doi.org/10.1007/s00247- 019- 04459-5 .
9. Donovan A, Rosenberg ZS. MRI of ankle and lateral hindfoot impingement syndromes. AJR Am J Roentgenol. 2010;195(3):595–604. https://doi.org/10.2214/AJR.09.4199.
10. Hess GW. Ankle impingement syndromes: a review of etiology and related implications. Foot Ankle Spec. 2011;4(5):290–7. https://doi.org/10.1177/1938640011412944.
11. Larciprete M, Giudice G, Balocco P, Faletti C. [Ankle impingement syndrome]. Radiol Med. 2000;99(6):415–19.
12. Buchhorn T, Koch M, Weber J, Ziai P. [Ankle impingement. Indications and arthroscopic therapy]. Unfallchirurg. 2016;119(2):115–19. https://doi.org/10.1007/s00113- 015- 0135- 3.
13. Heier KA, Hanson TW. Posterior ankle impingement syndrome. YOTSM. 2017;25(2):75–81. https://doi.org/10.1053/j.otsm.2017.03.005.
14. Hayashi D, Roemer FW, D'Hooghe P, Guermazi A. Posterior ankle impingement in athletes: pathogenesis, imaging features and differential diagnoses. Eur J Radiol. 2015:1–11. https:// doi.org/10.1016/j.ejrad.2015.07.017.
15. Kudaş S, Dönmez G, Işık Ç, Çelebi M, Çay N, Bozkurt M. Posterior ankle impingement syndrome in football players: case series of 26 elite athletes. Acta Orthop Traumatol Turc. 2016;50(6):649–54. https://doi.org/10.1016/j.aott.2016.03.008.
16. Zwiers R, Baltes TPA, Opdam KTM, Wiegerinck JI, van Dijk CN. Prevalence of os trigonum on CT imaging. Foot Ankle Int. 2018;39(3):338–42. https://doi.org/10.1177/1071100717740937.

17. Spiga S, Vinci V, Tack S, et al. Diagnostic imaging of ankle impingement syndromes in athletes. Musculoskelet Surg. 2013;97 Suppl 2(S2):S145–53. https://doi.org/10.1007/ s12306- 013- 0280- 1.
18. Hayashi D, Roemer FW, D'Hooghe P, Guermazi A. Posterior ankle impingement in athletes: pathogenesis, imaging features and differential diagnoses. Eur J Radiol. 2015;84(11):2231– 41. https://doi.org/10.1016/j.ejrad.2015.07.017.
19. Hong C, Pearce C, Ballal M, Calder JDF. Management of sports injuries of the foot and ankle. Bone Joint J. 2016;98(B):1–13. https://doi.org/10.1302/0301-620X.98B10.
20. Berman Z, Tafur M, Ahmed SS, Huang BK, Chang EY. Ankle impingement syndromes: an imaging review. Br J Radiol. 2017;90(1070):20160735. https://doi.org/10.1259/bjr.20160735.
21. Epstein DM, Black BS, Sherman SL. Anterior ankle arthroscopy. FCL. 2015;20(1):41–57. https://doi.org/10.1016/j.fcl.2014.10.001.
22. Carreira DS, Vora AM, Hearne KL, Kozy J. Outcome of arthroscopic treatment of posterior impingement of the ankle. Foot Ankle Int. 2016;37(4):394–400. https://doi.org/10.1177/1071100715620857.
23. Dalmau-Pastor M, Vega J, Malagelada F, Manzanares MC. Surgical arthroscopic anatomy. In: Arthroscopy and endoscopy of the foot and ankle, Principle and practice, vol. 21. 2nd ed. Singapore: Springer Singapore; 2019. p. 13–27. https://doi.org/10.1007/978- 981- 13- 0429- 3_2.
24. Templeton-Ward O, Solan M. Posterior ankle and hind foot arthroscopy – how do you responsibly learn this new technique? Foot Ankle Surg. 2014;20(4):229–30. https://doi.org/10.1016/j.fas.2014.09.005.
25. Lui TH. Arthroscopy and endoscopy of the foot and ankle: indications for new techniques. Arthroscopy. 2007;23(8):889–902. https://doi.org/10.1016/j.arthro.2007.03.003.
26. Beimers L, Frey C, van Dijk CN. Arthroscopy of the posterior subtalar joint. Foot Ankle Clin N Am. 2006;11(2):369–90. https://doi.org/10.1016/j.fcl.2006.03.006.
27. Wang L, Gui J, Gao F, et al. Modified posterior portals for hindfoot arthroscopy. Arthroscopy. 2007;23(10):1116–23. https://doi.org/10.1016/j.arthro.2007.04.015.
28. Calder JD, Sexton SA, Pearce CJ. Return to training and playing after posterior ankle arthroscopy for posterior impingement in elite professional soccer. Am J Sports Med. 2017;38(1):120–4. https://doi.org/10.1177/0363546509346390.
29. Ribbans WJ, Ribbans HA, Cruickshank JA, Wood EV. The management of posterior ankle impingement syndrome in sport: a review. Foot Ankle Surg. 2014:1–10. https://doi. org/10.1016/j.fas.2014.08.006.