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Conservative Treatment of a Symptomatic Os Vesalianum Pedis in a Professional Soccer Player: A Case Report

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Abstract

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Conservative Treatment of a Symptomatic Os Vesalianum Pedis in a Professional Soccer Player: A Case Report

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ABSTRACT

Objectives: Symptomatic os vesalianum pedis (OVP), a small accessory bone located adjacent to the base of the 5th metatarsal of the foot, rarely affects individuals who participate in sports. The condition typically is treated with surgical intervention. This case report documents the examination, evaluation, and treatment approach for a professional soccer player treated conservatively with a symptomatic OVP. **Methods:** A nineteen-year-old professional soccer player presented with pain to the base of the left 5th metatarsal. Physical examination and imaging resulted in a diagnosis of a symptomatic OVP. The player underwent a 5-stage criterion-based rehabilitation program. **Results:** The player successfully completed a 7.5-week rehabilitation program that included a comprehensive return-to-play progression. The player received clearance for return to play and has continued to play professionally without restriction. **Conclusion:** This case report outlined the conservative management of a professional soccer player with OVP. It has provided guidance for the conservative treatment of a rare injury.

Keywords: foot, soccer, rehabilitation, return-to-sport

INTRODUCTION

Os vesalianum pedis (OVP) is a small accessory ossicle adjacent proximally to the base of the fifth metatarsal.[1] It is one of the most uncommon of the 30 described pedal accessory bones.[2-5] This anatomic variation typically is asymptomatic and detected incidentally on routine foot radiographs. Cilli et al studied 464 radiographs of males between the ages of 20 and 46 years and reported a 5.9% incidence of OVP.[4] Coskun et al evaluated radiographs on 984 male and female subjects and found a 0.4% incidence of OVP.[2] OVP was equally present in both males and females; 7.6% of subjects had OVP bilaterally.

Though rare, OVP can become a source of lateral foot pain.[5] Individuals with symptomatic OVP have described debilitating foot pain and reported the inability to perform activities of daily living.[5] The mechanism by which OVP become symptomatic is poorly understood. Symptomatic OVP may result from either repetitive microtrauma or traumatic causes such as an inversion ankle sprain or lateral foot contusion.[5-10]

Very few case reports exist for athletes with OVP.[6,8,9,11] Two of the four cases described involved soccer players.[8,11] In both cases, subjects failed conservative treatment and required surgical intervention. The purpose of this case report is to describe the conservative management for a professional soccer player with a symptomatic left OVP. We describe the clinical decision-making process of analyzing clinical and radiological markers to make the diagnosis. We also detail the conservative intervention and return-to-play (RTP) progression that was paramount for the successful return to professional soccer.

PATIENT INFORMATION

The patient in this case report was a nineteen-year-old right footed male professional soccer player. At the time of this report, the individual was a player on a major league soccer club.

Player Presentation

The player reported gradual insidious onset of left lateral foot pain while playing a soccer match. His only previous injury was a similar onset of left lateral foot pain two years prior while playing at the youth national team level. At this time, the foot pain resolved very quickly and without treatment intervention.

The player underwent a comprehensive examination the next day. He reported pain with ambulation, rated 7/10 on a VAS, and walked with decreased stance time on the left lower extremity. Erythema and mild edema were observed near the proximal aspect of the 5th metatarsal bone. The player experienced pain to the area with palpation and tuning fork vibration. Based on these findings, a radiological referral was made.

Imaging

Left foot radiographs revealed what appeared to be a chronic, minimally displaced fracture on the base of the 5th metatarsal (Figure 1)**.** Follow-up MRI confirmed a chronic, well-corticated, minimally displaced fracture through the base of the 5th metatarsal (Figure 2). MRI also showed a small amount of bone marrow edema, suggesting mild acute-on-chronic inflammatory changes, and minimal adjacent acute soft tissue edema. Interestingly, the radiologist noticed an asymptomatic os trigonum.

Initial Treatment

The player was treated conservatively with rest, a 10-day course of oral anti-inflammatories, and physiotherapy. He also wore a walking boot for comfort. Acute symptoms were treated for 1 week and consisted of lymphatic drainage, micro-current electrical stimulation, low-level laser, dry needling, and cryotherapy. Afterward, he transitioned to a graded weight-bearing running progression, foot and ankle rehabilitation exercises, and a stepwise RTP progression. After 26 days from the initial onset of pain, he resumed full training and returned for match selection.

Reinjury

Three-and-a-half weeks later, the player sustained a significant contusion from a disqualifying tackle during match play. The injury occurred in the same area where he reported pain the month prior. The player was examined for a possible acute 5th metatarsal fracture. He presented with exquisite tenderness to touch, edema, and inability to bear weight on his left foot. He reported pain at the 5th metatarsal area with ankle inversion and plantar flexion and peroneal muscle testing. The player was immobilized and referred for further imaging studies.

Reinjury Imaging and Referral

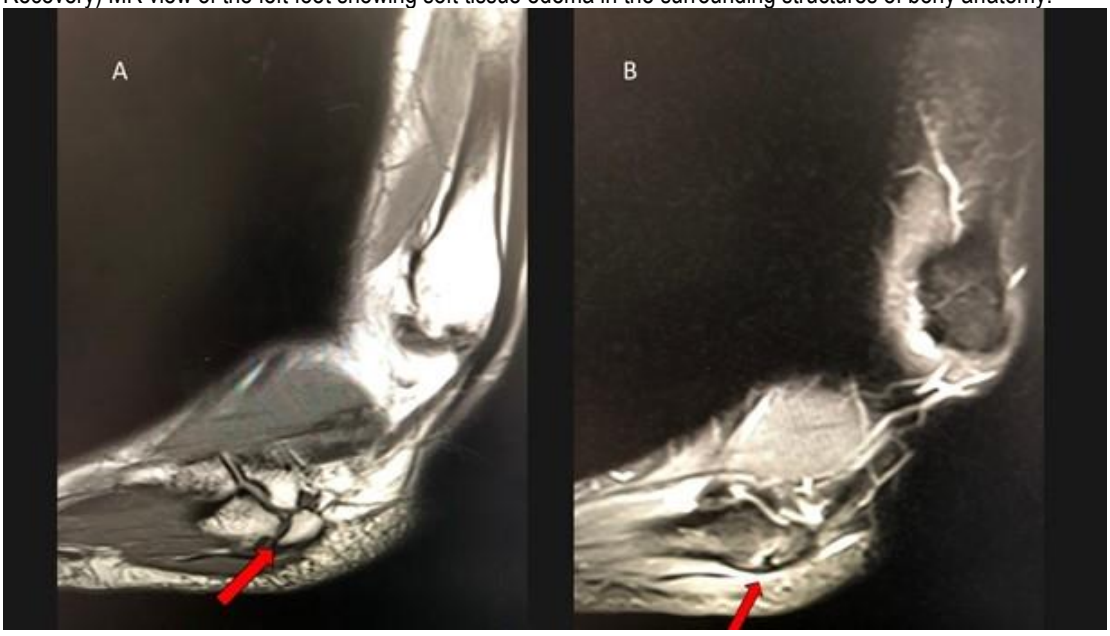
The team physician ordered radiographs of both the left and right feet as well as a repeat left foot MRI study. Radiographs of the right foot (non-involved side) showed a chronic, minimally displaced ossification through the base of the 5th metatarsal like the left symptomatic side (Figure 3). The repeat left foot MRI showed no acute fracture of the 5th metatarsal bone. However, the scan

identified mildly increased bone marrow edema at the previously identified chronic ossification and soft tissue edema compared to the initial study (Figure 4). Based on bilateral radiographic views, and the acute changes on the left ossicle (compared to the prior MRI), the differential diagnosis shifted from a fracture at the base of the 5th metatarsal to a possible symptomatic OVP.

Subsequently, the player received a foot and ankle specialist referral. The specialist agreed with the diagnosis of a symptomatic left OVP. He recommended conservative treatment due to the successful RTP following the prior episode of symptomatic OVP.

Figure 1. An oblique view radiograph of the left foot. The arrow shows what appeared to be a chronic, minimally displaced fracture on the base of the 5th metatarsal.

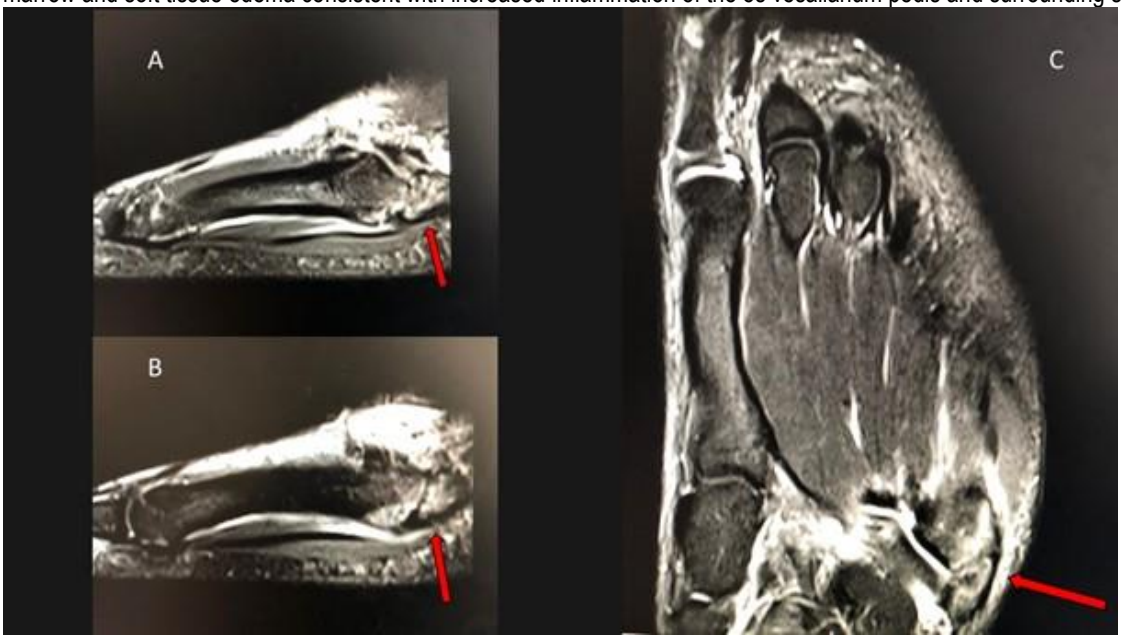
Figure 2. A) T1- Weighted, non-Fat-Sat sagittal magnetic resonance (MR) view of the left foot showing a chronically appearing, well-corticated, minimally displaced fracture through the base of the 5th metatarsal. B) Sagittal STIR (Short-TI Inversion Recovery) MR view of the left foot showing soft tissue edema in the surrounding structures of bony anatomy.



The specialist recommended a follow up visit for re-assessment and evaluation for surgical intervention if conservative treatment failed.

Figure 3. Oblique radiographic views comparing the symptomatic (left) and asymptomatic (right) feet demonstrating the presence of bilateral os vesalianum pedis accessory bones.

Figure 4. A), B) Sagittal and C) axial STIR (Short-TI Inversion Recovery) MR views of the left foot demonstrating increased bone marrow and soft tissue edema consistent with increased inflammation of the os vesalianum pedis and surrounding structures.



Reinjury intervention

The player began a 5-stage criterion-based treatment program based on our clinical experience and the available evidence-based literature (Table). Stage 1 focused on reducing the impairments associated with an acute injury. Intervention strategies included therapeutic modalities, gait normalization, and aerobic conditioning. The player exhibited normal, pain-free gait 11 days later and transitioned to Stage 2. Stage 2 introduced foot/ankle-specific rehabilitation exercises, gradual weight-bearing running progression, and continued global aerobic and strength training. The player continued in Stage 2 until he demonstrated normal running, full foot

and ankle range of motion, and minimal tenderness with palpation to the injury site. He transitioned to Stage 3, the RTP progression, 5 weeks after beginning the treatment program. The player successfully passed the RTP in 1 week and then moved to Stage 4, a modified full team training program, six-and-a-half weeks after the reinjury. One week later, he was deemed fit for full team training with no restrictions and available for match selection.

Table. Return-to-Sports Criteria and Progression Protocol for a Symptomatic Os Vesalianum Pedis

Phase	Criteria for Progression	Activities	Clinical Reasoning
Stage 1: Acute protection phase		• Reduction/rest from impact activities	Symptom control, pain reduction
		• DME: Walking boot	Symptom control, injury protection
		• NSAIDs	Inflammation and pain control
		• Therapeutic modalities: o Manual therapy- joint and soft tissues mobilization	To reestablish ankle and foot mechanics[12]
		o Lymphatic drainage (Hivamat)	Soft and bony tissues edema absorption[13]
		o Micro-current electrical stimulation (Avazzia)	Pain management[14] Increased circulation/promotion of healing[15]
		o Therapeutic laser	Decrease peroneal muscle tension and anti-inflammatory effect[16,17]
		o Dry needling o Cryotherapy	Inflammation control, pain management[18]
		• Aerobic conditioning: o Upper body strength circuits o Cycling (pain-free)	Fitness preservation under unloaded activities
Stage 2: Sub-acute protection phase	• Pain-free shoe ambulation • Normal gait pattern	• Continued therapeutic modalities	Pain management Continue to establish ankle and foot mechanics Increased circulation and promotion of healing Edema control of bony and soft tissues Inflammation control
		• DME: shoe and soccer boot custom-built orthotics- Total contact with a medial fill orthotic using a (UCBL) University of California Berkeley- Laboratories design	Improve foot and ankle biomechanics during walking and running[19,20]
		• Graded weight-bearing running progression: o Anti-gravity (Alter G) treadmill training (5-10% BW increase per session)	Introduction and graded progression of high impact activities[21]

Phase	Criteria for Progression	Activities	Clinical Reasoning
		• Rehabilitation exercises: o Intrinsic feet muscle strength[22] o Global ankle strength program[23] o Proprioceptive activities[24] o Gluteal/Lumbo-pelvic muscle exercises	To improve foot and ankle muscle strength and function, considering the inclusion of the whole lower body chain such as the gluteal and core muscles
		• Aerobic conditioning and strength training including Cross-training[21] o Upper and lower body gym program- per strength and conditioning coaches-modified if needed o Cycling	Fitness preservation and symptom control
Stage 3: On-the-field return to sport phase	• Pain-free ambulation • No noted running antalgic gait • Minimal tenderness to touch around the area of injury • Full ankle ROM Normal ankle strength	• Treatment strategies/Rehabilitation o Therapeutic modalities only as needed and previously outlined o DME: Orthotics – same design as stage 2 o Rehabilitation exercises as previously outlined	Symptom management and foot and ankle mechanics preservation
		• Conditioning: GPS, HR, RPE monitoring o Running volume to high-speed running	Fitness improvement to prepare the player to participate of modified and full team training[25]
		• Technical progression: GPS, HR, RPE monitoring[25,26] o Ball skills o Position specific training	Preparation for the player to perform sports specific activities and position specific activities individualized to the demands for this player
		• Strength training: o Upper and lower body gym program- per strength and conditioning coaches	Fitness program specific for this player
		• Recovery: o Intermittent compression- Normatec o Pilates Reformer o Cold water immersion	Recovery strategies specific for this player and per team protocol
Stage 4: Modified full team training phase	• Completion of on-the-field return to sport program • No reported symptom increase	• Treatment, rehabilitation, and recovery strategies o DME: Orthotics o As needed and previously outlined	Symptom management and foot and ankle mechanics preservation. Proper recovery from session to session
		• Modified and full team training: GPS, HR, RPE monitoring[25,26] o 2:1 training day ratio (train for 2 days, deload for 1 day)	Achievement of pre-injury fitness status necessary to compete in soccer matches
		• Fitness Program: o Supplemental cycling fitness session on deload days	Fitness program specific for this player

Phase	Criteria for Progression	Activities	Clinical Reasoning
		○ Upper and lower body gym program- per strength and conditioning coaches	
Stage 5: Match availability phase	• Full team training with no reported symptom increase • Normalized training load specific to the player via GPS, HR, and RPE tracking and monitoring	• Treatment and Recovery strategies ○ DME: Orthotics ○ Treatment/Recovery as needed	Symptom management and recovery
		• Unrestricted team training • Match selection	Return to match competition
		• Prevention exercises: ○ Global ankle program, intrinsic foot muscle strength, ankle ROM, proprioception	Injury prevention and mitigation specific to the foot
		• Strength training: ○ Upper and lower body gym program- per strength and conditioning coaches	Fitness program specific for this player to include overall injury prevention

+++ The frequency and volume of rehabilitation and training sessions for the player were according to the team's schedule. Therefore, he was treated approximately 6 days per week. The frequency of daily rehabilitation and treatment sessions averaged 2 times per day (1 session before and 1 session after either the running, return to sport, or training session) depending on what phase the player was completing.

Abbreviations: DME, durable medical equipment; NSIADS, non-steroidal anti-inflammatory drugs; UCBL, University of California Berkeley- Laboratories; BW, body weight; GPS, global positioning system; HR, heart rate; RPE, rate of perceived exertion

Outcome

The player participated in Stage 5 of the rehabilitation program 7.5 weeks after the reinjury. Stage 5 focused on conditioning and rehabilitation exercises as a preventive strategy. At a 3.5-year follow up, the player reported no setbacks and continued to play professional soccer at a highly competitive level.

DISCUSSION

OVP is a very uncommon injury in soccer that typically requires surgical intervention.[8,11] This case report is unique because it describes a successful return to professional soccer player following a conservative intervention. Important aspects for the conservative management include the appropriate differential diagnosis, comprehensive imaging, and a criterion-based rehabilitation plan.

Differential Diagnosis

Typically, the differential diagnosis for lateral foot pain includes 5th metatarsal base fracture, an os peroneum, or Iselin's disease in skeletally immature individuals.[5,8,27] Due to its rarity, the process of diagnosing a symptomatic OVP can be difficult as most cases are incidentally detected without any symptoms or problems.[28-30] This challenge highlights the importance of imaging.

Imaging Considerations

Radiographic examination, specifically lateral oblique views, can help identify discrete features of the OVP ossicle and its articulation. Usually, a thin cartilaginous line separates the OVP from the 5th metatarsal base. The most remarkable radiographic finding of an OVP is that it is adjacent to the base of the 5th metatarsal bone and articulates with both the 5th metatarsal and cuboid bones.[2,4,8,29] This feature is not commonly observed in acute 5th metatarsal fractures (e.g., avulsion or Jones fractures). One key consideration is that avulsion fractures are located at a relatively more distal and adjacent location on the base of the 5th metatarsal

compared to an OVP. Another consideration is an os peroneum, which also is in close to proximity of the 5th metatarsal. The os peroneum lies within the substance of the peroneus longus tendon at the level of the calcaneocuboid joint and is not adjacent to the base of the 5th metatarsal. Although OVP is not always present bilaterally, knowing if an individual has an OVP on the contralateral side may help diagnose a symptomatic OVP. Confirming that the athlete in this case has OVP bilaterally provides confidence in diagnosing the left side symptomatic OVP.

Treatment Options and Rehabilitation Implications

Symptomatic OVP has been rarely documented in both the elite athlete and regular population.[3,5-9,11,31,32] All reported cases failed conservative treatment and underwent surgical intervention. While these findings suggested surgical intervention as the most valid option, most authors initially recommended conservative treatment.[3,5-9,11,31] Failed conservative treatment typically included rest, activity modification, immobilization, shoe inserts, stretching exercises, non-steroid anti-inflammatory medications, and corticosteroid injection.[3,5-9,33] However, these cases provided little detail on the extent or quality of conservative care utilized for the failed cases. Reported treatment strategies, such as prolonged rest, immobilization, and unsupervised return to activity progression, may not have been the most appropriate for the high-level athlete.

In our case, we described the treatment for an athlete with a symptomatic OVP who successfully returned to professional soccer after completing a conservative intervention. Due to the small number of reported cases of OVP, limited data provided treatment guidelines and criteria for the progression of those with a symptomatic OVP. Our integration of clinical experience and basic rehabilitation science principles provided a framework for the development and implementation for a successful treatment plan.

As described in the Table, the athlete's treatment included specific goals and criteria for progression. Over the course of rehabilitation, the athlete worked closely with the rehabilitation team to ensure appropriate progress. This relationship emphasized ongoing communication to ensure proper tissue response over the course of rehabilitation. Most important was the attention devoted not only to completing the RTP progression, but the ongoing maintenance program described in Stage 5.

CONCLUSION

OVP is a rare accessory bone found adjacent to the base of the 5th metatarsal. While mostly an asymptomatic condition, clinicians should recognize it as a source of lateral foot pain following repetitive microtrauma or a known traumatic episode. For suspected OVP, bilateral radiographs can be instrumental in identifying this rare problem. MRI also can identify acute changes to the ossicle and other surrounding structures. An individualized, multidisciplinary conservative treatment should be considered prior to surgical excision of the ossicle. The athletic population is unique due to the high impact physical demands. Providing an environment for graded tissue loading and foot protection is fundamental. Implementing an individualized rehabilitation program based on clinical experience and rehabilitation science can allow an athlete to return to high impact activity at the elite level.

REFERENCES

1. Keles-Celik N, Kose O, Sekerci R, Aytac G, Turan A, Güler F. Accessory ossicles of the foot and ankle: Disorders and a review of the literature. *Cureus.* 2017;9(11):e1881. https://doi.org/10.7759/cureus.1881
2. Coskun N, Yuksel M, Cevener M, et al. Incidence of accessory ossicles and sesamoid bones in the feet: a radiographic study of the Turkish subjects. *Surg Radiol Anat.* 2009;31(1):19-24. https://doi.org/10.1007/s00276-008-0383-9
3. Boya H, Ozcan O, Tandoğan R, Günal I, Araç S. Os vesalianum pedis. *J Am Podiatr Med Assoc.* 2005;95(6):583-585. https://doi.org/10.7547/0950583
4. Cilli F, Akçaoğlu M. The incidence of accessory bones of the foot and their clinical significance. *Acta Orthop Traumatol Turc.* 2005;39(3):243-246.
5. Wilson TC, Wilson RC, Ouzounov KG. The symptomatic os vesalianum as an uncommon cause of lateral foot pain: a case report. *J Am Podiatr Med Assoc.* 2011;101(4):356-359. https://doi.org/10.7547/1010356
6. Petrera M, Dwyer T, Ogilvie-Harris DJ. A rare cause of foot pain with golf swing: symptomatic os vesalianum pedis-a case report. *Sports Health.* 2013;5(4):357-359. https://doi.org/10.1177/1941738113482446
7. Beil FT, Burghardt RD, Strahl A, Ruether W, Niemeier A. Symptomatic os vesalianum: A case report and review of the literature. *J Am Podiatr Med Assoc.* 2017;107(2):162-165. https://doi.org/10.7547/15-160
8. Aykanat F, Vincenten C, Cankus MC, Kose O, Sindel M. Lateral foot pain due to os vesalianum pedis in a young football player; a case report and review of the current literature. *Skeletal Radiol.* 2019;48(11):1821-1828. https://doi.org/10.1007/s00256-019-03190-4
9. Inoue T, Yoshimura I, Ogata K, Emoto G. Os vesalianum as a cause of lateral foot pain: a familial case and its treatment. *J Pediatr Orthop B.* 1999;8(1):56-58.
10. Dorrestijn O, Brouwer RW. Bilateral symptomatic os vesalianum pedis: a case report. *J Foot Ankle Surg.* 2011;50(4):473-475. https://doi.org/10.1053/j.jfas.2011.03.012

11. Plecko M, Bojanic I, Kubat O. Lateral foot pain warrants an extensive diagnostic workup. A case of unilateral foot pain in the setting of bilateral os vesalianum in a soccer player. *FussSprungg.* 2021. https://doi.org/10.1016/j.fuspru.2021.12.002
12. Cruz-Díaz D, Lomas Vega R, Osuna-Pérez MC, Hita-Contreras F, Martínez-Amat A. Effects of joint mobilization on chronic ankle instability: a randomized controlled trial. *Disabil Rehabil.* 2015;37(7):601-610. https://doi.org/10.3109/09638288.2014.935877
13. Reinhold J. Mechanisms of deep oscillation. *J Man Lymphat Drain (UK).* 2017:1-6.
14. Fujiya H, Goto K. New aspects of microcurrent electrical neuromuscular stimulation in sports medicine. *J Phys Fitness Sports Med.* 2016;5:69-72.
15. Farivar S, Malekshahabi T, Shiari R. Biological effects of low level laser therapy. *J Lasers Med Sci.* 2014;5(2):58-62.
16. Dunning J, Butts R, Mourad F, Young I, Flannagan S, Perreault T. Dry needling: a literature review with implications for clinical practice guidelines. *Phys Ther Rev.* 2014;19(4):252-265. https://doi.org/10.1179/108331913x13844245102034
17. Gattie E, Cleland JA, Snodgrass S. The effectiveness of trigger point dry needling for musculoskeletal conditions by physical therapists: a systematic review and meta-analysis. *J Orthop Sports Phys Ther.* 2017;47(3):133-149. https://doi.org/10.2519/jospt.2017.7096
18. Lee H, Natsui H, Akimoto T, Yanagi K, Ohshima N, Kono I. Effects of cryotherapy after contusion using real-time intravital microscopy. *Med Sci Sports Exerc.* 2005;37(7):1093-1098. https://doi.org/10.1249/01.mss.0000169611.21671.2e
19. Elattar O, Smith T, Ferguson A, Farber D, Wapner K. Uses of braces and orthotics for conservative management of foot and ankle disorders. *Foot Ankle Orthop.* 2018;3(3):1-12. https://doi.org/10.1177/2473011418780700
20. Payehdar S, Saeedi H, Ahmadi A, Kamali M, Mohammadi M, Abdollah V. Comparing the immediate effects of UCBL and modified foot orthoses on postural sway in people with flexible flatfoot. *Prosthet Orthot Int.* 2016;40(1):117-122. https://doi.org/10.1177/0309364614538091
21. Liem BC, Truswell HJ, Harrast MA. Rehabilitation and return to running after lower limb stress fractures. *Curr Sports Med Rep.* 2013;12(3):200-207. https://doi.org/10.1249/JSR.0b013e3182913cbe
22. Lee D, Choi JD. The effects of foot intrinsic muscle and tibialis posterior strengthening exercise on plantar pressure and dynamic balance in adults flexible pes planus. *Phys Ther Korea.* 2016;23:27-37. https://doi.org/10.12674/ptk.2016.23.4.027
23. Fourchet F, Gojanovic B. Foot core strengthening: Relevance in injury prevention and rehabilitation for runners. *Swiss Sports Exerc Med.* 2016;64:26-30.
24. Schiftan GS, Ross LA, Hahne AJ. The effectiveness of proprioceptive training in preventing ankle sprains in sporting populations: a systematic review and meta-analysis. *J Sci Med Sport.* 2015;18(3):238-244. https://doi.org/10.1016/j.jsams.2014.04.005
25. Buckthorpe M, Della Villa F, Della Villa S, Roi GS. On-field rehabilitation part 1: 4 pillars of high-quality on-field rehabilitation are restoring movement quality, physical conditioning, restoring sport-specific skills, and progressively developing chronic training load. *J Orthop Sports Phys Ther.* 2019;49(8):565-569. https://doi.org/10.2519/jospt.2019.8954
26. Fournier M. Principles of rehabilitation and return to sports following injury. *Clin Podiatr Med Surg.* 2015;32(2):261-268. https://doi.org/10.1016/j.cpm.2014.11.009
27. Kose O. The accessory ossicles of the foot and ankle; a diagnostic pitfall in emergency department in context of foot and ankle trauma. *J Acad Emerg Med.* 2012;11:106-114. https://doi.org/10.5152/jaem.2012.002
28. Northover J, Milner S. A case report of an accessory bone in the foot. *Foot (Edinb).* 2006;16:172-174. https://doi.org/10.1016/j.foot.2006.02.004
29. Kose O. Os vesalianum pedis misdiagnosed as fifth metatarsal avulsion fracture. *Emerg Med Australas.* 2009;21(5):426. https://doi.org/10.1111/j.1742-6723.2009.01221.x
30. Tiwaria M, Khannaa V, Kodidea U, Vaishyab R. Os vesalianum – A confounding diagnosis. *Apollo Med.* 2015;12(4):285-286.
31. Smith AD, Carter JR, Marcus RE. The os vesalianum: an unusual cause of lateral foot pain a case report and review of the literature. *Orthopedics.* 1984;7(1):86-89. https://doi.org/10.3928/0147-7447-19840101-12
32. Baastrup CI. Os vesalianum tarsi and fracture of tuberositas ossis metatarsi v. *Acta Radiologica.* 1922;1(3):334-348. https://doi.org/10.3109/00016922209137203
33. Mousafeiris VK, Papaioannou I, Kalyva N, Arachoviti C, Repantis T. Os vesalianum pedis in a young adult: a case report and literature review. *Cureus.* 2021;13(5):e14896. https://doi.org/10.7759/cureus.14896