ORIGINAL ARTICLE

Nr 2025;15 (1):11-17

Dislocation/Fracture of Proximal 5th Metatarsal: New Protocol with Self-Assessment Scale and Specific Plantar Orthosis

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DOI:
10.32098/mltj.01.2025.02

LEVEL OF EVIDENCE: 5

SUMMARY

Background. Metatarsal dislocations/fractures represent a significant proportion of foot injuries. There has been conflicting literature on the management of proximal 5th metatarsal injury, due to inconsistency concerning the classification of these conditions. Various patterns of metatarsal injuries exist and the resultant impact on function and quality of life is not negligible. A complete clinical and radiological assessment is needed to propose treatment options tailored to the clinical and functional needs of the individual metatarsal dislocation/fracture. Proximal 5th metatarsal dislocations/fractures generally occur in active young men involved in organized sports in their second to third decades of life, but not only; the condition often affects even middle-aged adults with a very active life and with strong demands functional (*e.g.* dance, running, hunting).

Aims. 1) To develop a new clinical-functional scale that allows patients to self-assess the severity of their injury and monitor its progression. 2) To design an innovative foot orthosis for the non-surgical management of mild to moderate proximal 5th metatarsal dislocations/fractures.

Methods. Critical evaluation of the literature for understanding the topic at hand with subsequent design of the proposed rating scale and orthosis.

Expected Results. The introduction of a patient-centric scale and a custom orthosis could enhance the self-management of proximal 5th metatarsal injuries, potentially improving the quality of life and functional outcomes for patients.

Conclusions. Addressing the gap in the management of proximal 5th metatarsal injuries, this study aims to contribute a practical scale and a novel orthotic device, fostering patient empowerment and offering a non-operative alternative treatment.

KEY WORDS

5th metatarsal base; conservative approach; dislocation/fracture; plantar orthosis; self-assessment scale.

INTRODUCTION

In 1902, Sir Robert Jones published seminal case series “Fracture of the base of the fifth metatarsal bone by indirect violence” in The Annals of Surgery (1). This work stemmed from his personal experience, as a foot injury that he sustained while dancing. Jones’ rationale challenged the prevailing belief that all metatarsal fractures resulted from direct trauma. He presented 6 cases of metatarsal fractures occurring without direct violence, accompanied by reproductions of the corresponding radiographs. While the

image quality limits the ability to definitively discern the fracture lines, Jones convincingly argued for the fractures' completeness.
The first case in Jones' series was his own, a metatarsal fracture documented by the published radiograph. The image revealed a fracture line traversing the lateral cortex towards the proximal aspect of the articulation between the fourth and fifth metatarsals. Jones observed that weight-bearing with the heel off the ground shifted weight distribution onto the fifth metatarsal, causing it to slightly rotate inward. Since the lateral Lisfranc complex is stabilized by strong ligaments (*i.e.*, capsular ligaments, dorsal and plantar cubometatarsal ligaments, lateral band of the plantar aponeurosis, and the broad insertion of the peroneus brevis tendon) Jones hypothesized that a dislocation of the metatarsal should be more common than a fracture (1, 2).
It seems that an adductor moment across the relatively fixed fourth and fifth metatarsal base causes an acute fracture of the base of the fifth metatarsal at the area between the insertion of the peroneus brevis and tertius tendons (3, 4).
Jones reported another case presenting with a more distally located fracture line. Radiographs showed thickening of the cortices and evidence of sclerosis within the intra-medullary canal. Since the publication of Jones' series, there has been growing recognition that fractures in this metatarsal region frequently, but not invariably, represent stress fractures (5-7). Repetitive varus forces applied distally on the bone are thought to be the primary culprit in these stress fractures. At x-ray imaging these fractures have a lateral rather than plantar direction; thus, the force vector seems more directed in this direction (8).
The tarsometatarsal (TMT) joints collectively form the Lisfranc joint complex, a highly interconnected group of articulations (9). These joints are partially stabilized by the intermetatarsal ligaments from the second ray to the fifth. These ligaments do provide dynamic joint motion but are sufficiently taut to prevent excessive joint laxity. The TMT joints are further stabilized by the dorsal and plantar TMT ligaments that connect the anterior and posterior surfaces of the joint. The plantar TMT ligaments are stronger than their dorsal counterparts and require more force to disrupt them (10). The lateral Lisfranc complex is comprised of the bases of the fourth and fifth metatarsal bones, which articulate with the distal surface of the cuboid. The lateral Lisfranc complex comprises the bases of the fourth and fifth metatarsals articulating with the cuboid's distal surface. This complex derives stability from the dorsal and plantar cuboideometatarsal ligaments, intermetatarsal ligaments, the peroneus brevis tendon, and the lateral band of the plantar fascia, collectively contributing to the overall stability of the lateral midfoot region (11).
Direct or indirect trauma may injure the cuboideometatarsal ligaments. Direct trauma can sever the ligament, most often by a crushing injury to the foot. Indirect trauma is more common and occurs by either of two mechanisms. The first mechanism is forced abduction of the forefoot, causing a Lisfranc-type disruption of the TMT joints which cascades laterally with increasing force eventually affecting the fifth ray. The second mechanism is forced plantar flexion of the forefoot (12).
Several publications have highlighted the significance of the blood supply of the fifth metatarsal for optimal fracture healing (13-15). Similar to potential differences between individuals in the location of the anatomic zones, so there may be slight variances in the contour of the blood vessels. However, the nutrient artery to the fifth metatarsal typically enters medially in the middle third of the bone. It courses slightly proximally through the medial cortex and quickly divides into a distal branch and a shorter proximal branch. There is an abundance of very small metaphyseal vessels at each end of the bone. Injuries to the proximal diaphysis of the metatarsal are likely to injure the proximal branch of the intraosseous nutrient vessel and to impair the blood supply to the distal portion of the proximal fragment of the bone (16).

Classification and most frequent etiologies

The most frequent etiologies result in fractures being divided into 3 groups:

- traumatic fracture: due to a sudden direct impact on the 5th metatarsal; it is especially common in sports (*i.e.*, football, basketball, combat sports such as karate, kickboxing) (17);
- tear fracture: the most common condition; it occurs, for example, in inversion ankle sprain when a parcel portion of the bone is torn due to the traction of the peroneus brevis muscle on the tuberosity of the metatarsal bone. The sudden traction is the due to the stretching and consequent reflex contraction of the muscle trying to contain the extent of the sprain;
- stress fracture: bones are a dynamic structure in continuous remodeling; normally, there is a delicate balance between the osteoblast-mediated bone formation and the remodeling action of the osteoclasts. Continuous bone remodeling is the result of hormonal action, phospho-calcium metabolism, nutrition and tractive and compressive forces exerted on the bones. Mechanical stresses, such as frequent impacts on the ground with most of the load on the outside area of the foot, can stimulate remodeling activity. Thus, these fractures arise without significant

trauma, but because of the progressive weakening of the bone structure (18).

Another way to classify fractures of the fifth metatarsal concerns the area in which they occur. There are several classifications that have categorized fractures according to this criterion.

Lawrence and Botte proposed a classification in 1993, dividing the proximal metatarsal in three zones (**figure 1**) (2, 19). Nowadays this is the most used one:

- tuberosity avulsion fracture (Zone 1): with or without involvement of the tarsometatarsal articulation;
- Jones fracture (Zone 2): extending into the fourth-fifth intermetatarsal facet distal to the articulation between the cuboid and the base of the fifth metatarsal ("Jones" fractures);
- stress fracture (Zone 3): typically located distal to the Lisfranc joint and distal to the fourth-fifth intermetatarsal facet (within the proximal 1.5 cm of the metatarsal shaft).

Torg further subdivided Zones 2 and 3 into three categories based on radiological appearances and healing status to formulate a better treating plan: Type I (acute), Type II (delayed union), Type III (non-union) (20).

Lastly, Polzer proposed another classification in 2012 based on treatment strategies (21):

- Metaphyseal fractures: they don't extend beyond the distal end of the fourth-fifth intermetatarsal articulation and they should be treated functionally.
- Meta-diaphyseal fractures: they are located at the distal end of the fourth-fifth intermetatarsal articulation or just distally, they require operative treatment.

The prognostic and clinical role of Lawrence and Botte classification has emerged in a recent study by Pettersen *et al.*: authors retrospectively analyzed 834 fractures (510 in zone 1, 157 in zone 2, and 167 in zone 3; almost all were treated nonoperatively), with a minimum follow up period of five years. The study concluded suggesting the use of the Classification in the usual clinical practice (22).

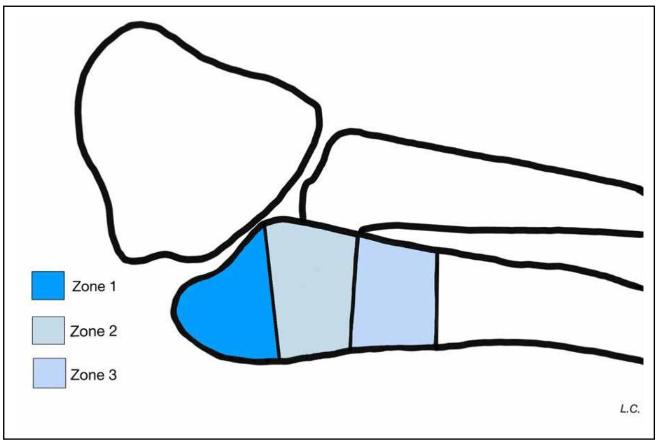

Figure 1. Lawrence and Botte 3 Zones classification.

Clinical features, diagnostic approach and treatment of dislocation/fracture of the fifth metatarsal

A dislocation or a fracture of the proximal fifth metatarsal typically presents with a constellation of symptoms. The most prominent feature is lateral foot pain which worsen with weight-bearing activities. Additionally, patients often experience edema and potential tissue bruising at the injury site. These symptoms usually arise suddenly following a traumatic event but may also appear suddenly or progressively through weeks. A careful analysis of the medical history along with a detailed clinical examination can sometimes be sufficient for diagnosis. During a physical examination, tenderness to palpation, swelling, and bruising might be noticed where the injury occurred. Eversion stress testing, which involves attempting to turn the foot outward against resistance, may also elicit pain. X-ray imaging on anteroposterior, lateral and oblique projections can show the fracture line or the dislocation. In the case of a stress fracture, a CT or MRI may be necessary to highlight the presence of edema and the potential fracture gap (23, 24).

The treatment could be conservative or surgical (25, 26). The best treatment approach is decided upon consideration of location of the dislocation/fracture, medical history and imaging. The classifications described above guide clinicians in choosing an operative or non-operative protocol.

These fractures have a high tendency for inadequate bone healing, which has prompted many studies to understand the underlying etiology of this complication. This underscores the importance of improving the treatment protocol to achieve better outcomes (27).

Role of individual rehabilitation project for the person with dislocation/fracture of the fifth metatarsal

A significant number of dislocations/fractures of the fifth metatarsal go unnoticed or are misdiagnosed, leading to prolonged pain and a diminished quality of life for patients. Physical and Rehabilitation Medicine (PRM) specialists can play a crucial role in patients' assessment and functional evaluation, shortening the time to diagnosis and improving performances and outcomes. Moreover, once diagnosed conservative treatment is usually the first choice for metatarsal dislocation/fractures (28). Therefore, an Individual Rehabilitation Project (IRP) is pivotal to improve the management of this conditions and people independence after the injury occurred (29, 30).

A personalized person-centered approach should take into account the patient's wishes and the environmental context in which he or she lives. This is essential to establish a collaborative relationship between the patient and the PRM specialist to define a common goal. Under this perspective familiar support has a key role for regaining independence in social, sport-related, and work context even in this apparently mild disability.

An IRP should be focused on restoring a person's independence, activity and mobility. In the first weeks, bone stress removal and pain control should be the priorities; weight bearing should be limited, and patients could use crutches, hard sole shoes, or a walking cane. In the following weeks, post-pain resolution, the focus should be on conditioning and strengthening the injured extremity, progressing from walking to jogging in pool training. Ultimately, stress on the affected bone should be gradually increased through running, functional activities, and progressing to plyometrics for mature osteocytes and periosteum development. Such an IRP allows bone remodeling and helps in restoring functioning (31).

Aims of this paper

Given the high level of misdiagnosis and the need for second-level examinations, with a great impact on social and health-care costs. This paper addresses this critical issue with two key aims: the main aim of this paper is to propose a novel replicable and cost-effective self-assessment scale. This user-friendly tool could be even administered remotely during tele-rehabilitation consultations, potentially reducing unnecessary in-person visits and associated healthcare costs.

Considering the importance of the nonoperative approach and of the IRP, a secondary aim is to propose a treatment protocol based on metatarsal-supported plantar orthosis.

A NEW SELF-ASSESSMENT SCALE

The main IRP's purpose is to reduce swelling, mobilize the ankle joint and the structures close to the fracture. IRP plays a very important role but depends greatly on the condition of the limb after the immobilization, where it has been carried out. In fact, the physician should often manage a series of complications that always deserve a careful approach in order to not delay a normal recovery. Furthermore, the recovery of muscle trophism and walking training will be contextual and necessary in order to restore the injured functions.

Different classification systems and management strategies were described in the literature. The aim of this study is to propose a new simple clinical tool (**table I**), useful to allow the patient to self-assess the severity of the condition and monitoring the follow-up.

Table I. Clinical-functional self-assessment scale of dislocation/fracture of proximal 5th metatarsal.

Name and Last Name of the patient: .... Date: ....

Stance	Pain in the injured foot	
Bipodal 50% Body weight	a) Impossible b) Possible	• 6 (impossible) • 5 (less than 3 seconds) • 4 (more than 3 seconds, less than 10 seconds)
Unipodal 100% Body weight	a) Impossible b) Possible	• 3 (impossible) • 2 (less than 3 seconds) • 1 (more than 3 seconds, less than 10 seconds) • 0 (without pain)

Score:

- 5-6: acute damage or DD other lesions (avoid sports or physical activity; physical therapy and drugs needed)
- 3-4: acute damage (avoid sports or physical activity; physical therapy and drugs needed)
- 1-2: subacute damage (walking; adapted physical activity, physical therapy and drugs)
- 0: recovery (reconditioning)

____Total Pain Points/6 points

The assessment scale is addressed to people with physical disability due to dislocation/fracture of the proximal region of the fifth metatarsal and could be used in the acute and post-acute phases of the disease. In our idea, the scale is useful to monitor the evolution of pain and patient's functional performance through the IRP as well.

The scale is based on a simple, repeatable and functional test that the subject can also perform at home. This feature allows a PRM doctor to assess person's condition even in tele-rehabilitation. In order to not distort the assessment, it is necessary for the person to rest period for at least 30 minutes before carrying out the test. No analgesic/anti-inflammatory drugs should have been taken in the previous 48 hours.

The test is as follows:

1. patient put the plantar side of the imaginary line passing through the five metatarsal bases in contact with a wedge-shaped, hard and blunt linear surface (*e.g.*, the edge of a step with a minimum height of 4 cm); this results in forefoot suspension;
2. upper limbs must be placed along the hips; knee and hip should be positioned in slight extension;
3. subject gradually have to add on own body weight in orthostatic position (first unipodal and then bipodal stance), to test pain in the injured foot;
4. it is recommended to carry out the test near a handle or support, to reduce falling risk due to instability or excessive pain;
5. finally, the subject marks the pain values on a scale with values from 0 to 5 (**table I**). The pain has to be evaluated first on the bipodal position and then, when possible, on the unipodal stance (on the injured foot) (**figure 2**).

The total score is obtained by adding the bipodal stance value to the unipodal one. The self-assessment scale acquires a clinical-functional significance, useful for the physician's evaluation of the clinical outcome, even in tele-medicine mode.

Because of the persistence of pain, the management of Zone 1, Zone 2 and Zone 3 Type 1 and Type 2 fractures is based on weightbearing as tolerate from week 1 to week 7, time at which a resolution is expected. Thus, we consider our scale useful not only for diagnosis but also to follow up pain evolution, whether administered by clinicians or as a self-assessment procedure (32).

NON-OPERATIVE TREATMENT WITH A NEW SPECIFIC PLANTAR ORTHOSIS (SPO)

Fifth metatarsal fractures and dislocations are frequently treated with non-operative interventions, with the specific approach tailored to the anatomical location of the injury, the patient's medical history, and radiological findings (29).

Traditionally, plantar orthoses with medial arch support have been used for these injuries. However, recent studies suggest that such orthoses may not be optimal, as they can transfer load to the lateral column of the foot (33).

The aim of this study is to propose a novel specific plantar orthosis (SPO) for dislocation/fractures of the fifth metatarsal.

SPO is composed of a suitable discharge material, applied on the support area of proximal fifth metatarsal. It takes advantage of the possibility of composing the orthosis with materials of different densities and various damping capacities and allows for the creation of a "discharge bridge" between the cuboid and the fifth metatarsal head (**figure 3**).

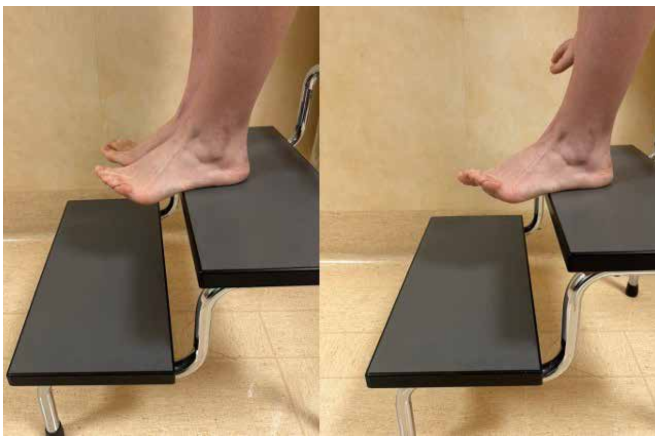

Figure 2. Test procedure on bipodal and unipodal stances.

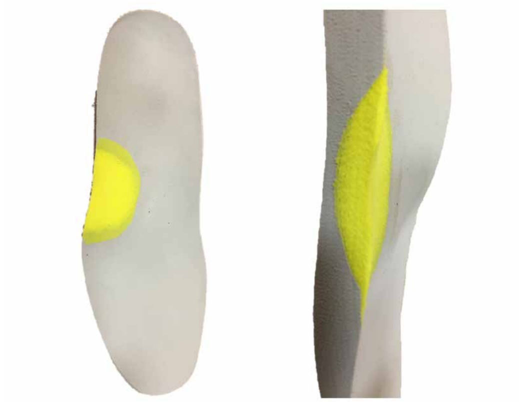

Figure 3. Prototype of right specific plantar orthosis, with a yellow "discharge bridge" on proximal 5th metatarsal.
Overhead view (left); right side view (right).

Plantar orthosis (PO) is recommended to address several foot issues and discomforts (34, 35). Whatever the pathology of the foot, various types of orthotics are commonly used as part of conservative treatment. PO can be categorized as prefabricated, semicustom, or custom-made. Prefabricated insoles, readily available and constructed from materials like silicone or thermoplastic, come in different sizes primarily based on foot length. Custom-made insoles involve capturing a foot impression through methods such as manual plaster casting, foam impression, or digital 3D scanning. Another cost-effective approach, known as semicustom, relies on metric measurements or modifying prefabricated insoles (36).
While evidence in chronic foot diseases such as clubfoot or flexible flatfoot demonstrates how patients compliance may be low, PO personalization, patient involvement in PO selection, person-center approach could determine better adherence to the IRP (37-39).

Limitations

The main limitation of this paper is it's not being a clinical trial.
While this paper proposes a novel self-assessment scale for fifth metatarsal fractures and dislocations, it is important to acknowledge that this study lays the groundwork for future research. The next crucial step is to validate the scale's effectiveness through a clinical trial.
This validation process would involve recruiting a group of patients with confirmed fifth metatarsal injuries and evaluating the scale's reliability, validity, and responsiveness to change over time. By collecting patient data and analyzing its correlation with clinical outcomes, we can determine the scale's suitability for real-world application in the clinical setting.

CONCLUSIONS

Treatment choice varies by anatomical region, patient history and radiological findings. Evidence based decisions are difficult in this anatomic area as there is a paucity of good-randomized control trials comparing treatment options. Correct diagnoses are frequently misunderstood, often until the symptoms become striking, directing the patient towards wrong therapeutic choices.
The proposed new self-assessment scale should allow to easily frame the condition severity and follow IRP and disability evolution trend over time, even in tele-rehabilitation.
Non-operative treatment is an option with potentially good results, although outcomes are less predictable, not only in dislocations but even in acute fractures.
A Specific Plantar Orthosis is proposed as a valid therapy for dislocations/fractures of mild-medium severity, in order to prevent worsening and chronicization of the disease. The orthosis presents good compliance by the patient, it's easy to implement and to personalize on subject characteristics.

FUNDINGS

None.

DATA AVAILABILITY

Data are available within the paper.

CONTRIBUTIONS

MN: writing - review & editing, conceptualization. FS, VG, CL, SS: writing - original draft. LC: methodology, writing - review & editing. FC: conceptualization, supervision.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

REFERENCES

1. Jones R. I. Fracture of the Base of the Fifth Metatarsal Bone by Indirect Violence. Ann Surg. 1902;35(6):697-700.2.
2. Lawrence SJ, Botte MJ. Jones' Fractures and Related Fractures of the Proximal Fifth Metatarsal. Foot Ankle. 1993;14(6):358-65. doi: 10.1177/107110079301400610.
3. Wamelink KE, Marcoux JT, Walrath SM. Rare Proximal Diaphyseal Stress Fractures of the Fifth Metatarsal Associated With Metatarsus Adductus. J Foot Ankle Surg. 2016;55(4):788-93. doi: 10.1053/j.jfas.2016.03.005.
4. Riegger M, Müller J, Giampietro A, et al. Forefoot adduction, hindfoot varus or pes cavus: risk factors for fifth metatarsal fractures and jones fractures? A systematic review and meta-analysis. J Foot Ankle Surg. 2022;61(3):641-7. doi: 10.1053/j.jfas.2021.11.002.
5. Kavanaugh JH, Brower TD, Mann RV. The Jones fracture revisited. J Bone Joint Surg Am. 1978;60(6):776-82.
6. Byrd T. Jones fracture: relearning an old injury. South Med J. 1992;85(7):748-50.
7. Agrawal U, Tiwari V. Metatarsal Fractures. 2023. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024.
8. Chun D-I, Min T-H, Cho J-H, Won S-H, Shon J-I, Yi Y. Association between Bone Mineral Density and Fracture Characteristics in the 5th Metatarsal Bone Base Fracture in Elderly for Prediction of Osteoporotic Fracture. J Bone Metab. 2021;28(3):231-7. doi: 10.11005/jbm.2021.28.3.231.
9. Martin MP, Patel AH, Cole MW, Gadinsky NE, Collins L, Sherman WF. A Rare Case of a Lisfranc Ligament Transection. Orthop Rev (Pavia). 2023;15:56664. doi: 10.52965/001c.56664.

10. Clare MP. Lisfranc injuries. Curr Rev Musculoskelet Med. 2017;10(1):81-5. doi: 10.1007/s12178-017-9387-6.
11. Bilodeau L, Luijkx T. Lisfranc joint. In: Radiopaedia.org. Radiopaedia.org; 2014. doi: 10.53347/rID-31326.
12. Lee H, Park JH, Lee CH, Kim G-L. Ankle and Foot Injuries Accompanying 5th Metatarsal Fractures. J Korean Foot Ankle Soc 2022;26(4):163-70. doi: 10.14193/jkfas.2022.26.4.163.
13. Smith JW, Arnoczky SP, Hersh A. The Intraosseous Blood Supply of the Fifth Metatarsal: Implications for Proximal Fracture Healing. Foot Ankle. 1992;13(3):143-52. doi: 10.1177/107110079201300306.
14. Shereff MJ, Yang QM, Kummer FJ, Frey CC, Greenidge N. Vascular Anatomy of the Fifth Metatarsal. Foot Ankle. 1991;11(6):350-3. doi: 10.1177/107110079101100602.
15. Carp L. Fracture Of The Fifth Metatarsal Bone: With Special Reference To Delayed Union. Ann Surg. 1927;86(2):308-20. doi: 10.1097/00000658-192708000-00020.
16. Coslick AM, Lestersmith D, Chiang CC, Scura D, Wilckens JH, Emam M. Lower Extremity Bone Stress Injuries in Athletes: an Update on Current Guidelines. Curr Phys Med Rehabil Rep. 2024;1-11. doi: 10.1007/s40141-024-00429-7.
17. Miyazaki Y, Sugizaki R, Kawasaki M, Nakagawa T, Saho Y, Tateishi T. Fifth metatarsal strain distribution during cutting motions in soccer. Sports Biomech. 2023:1-17. doi: 10.1080/14763141.2023.2241839.
18. Turchyn O, Omelchenko T, Liabakh A. Stress Fractures of the Lower Limb in Military Personnel (Literature Review). Terra Orthop. 2023;4(119):32-9. doi: 10.37647/2786-7595-2023-119-4-32-39.
19. Chloros GD, Kakos CD, Tastsidis IK, Giannoudis VP, Panteli M, Giannoudis PV. Fifth metatarsal fractures: an update on management, complications, and outcomes. EFORT Open Rev. 2022;7(1):13-25. doi: 10.1530/EOR-21-0025.
20. Torg JS. Fractures of the Base of the Fifth Metatarsal Distal to the Tuberosity. Orthopedics. 1990;13(7):731-7. doi: 10.3928/0147-7447-19900701-09.
21. Polzer H, Polzer S, Mutschler W, Prall WC. Acute fractures to the proximal fifth metatarsal bone: Development of classification and treatment recommendations based on the current evidence. Injury. 2012;43(10):1626-32. doi: 10.1016/j.injury.2012.03.010.
22. Pettersen PM, Radojicic N, Grün W, Andresen TKM, Molund M. Proximal Fifth Metatarsal Fractures: A Retrospective Study of 834 Fractures With a Minimum Follow-up of 5 Years. Foot Ankle Int. 2022;43(5):602-8. doi: 10.1177/10711007211069123.
23. Smidt KP, Massey P. 5th Metatarsal Fracture. 2023. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.
24. Stiell I, Wells G, Laupacis A, et al. Multicentre trial to introduce the Ottawa ankle rules for use of radiography in acute ankle injuries. BMJ. 1995;311(7005):594-7. doi: 10.1136/bmj.311.7005.594.
25. Sesti FF, Oliva F, Iundusi R. Fifth metatarsal tuberosity avulsion fractures: a new surgical technique without metal implant. Muscles Ligaments Tendons J. 2019;09(2):236-40. doi: 10.32098/mltj.02.2019.12.
26. Jones MD, Omana-Daniels RV, Sweet KJ. Conservative versus Surgical Management of Fifth Metatarsal Diaphyseal Fractures: A Retrospective Review. J Am Podiatr Med Assoc. 2023;113(1):20-195. doi: 10.7547/20-195.
27. Straus SA, Henry JD, Clements JR. Metatarsal Fractures. Clin Podiatr Med Surg. 2024;41(3):379-89. doi: 10.1016/j.cpm.2024.01.001.
28. Hossain M, Clutton J, Ridgewell M, Lyons K, Perera A. Stress Fractures of the Foot. Clin Sports Med. 2015;34(4):769-90. doi: 10.1016/j.csm.2015.06.011.
29. Pfeifer CG, Grechenig S, Frankewycz B, Ernstberger A, Nerlich M, Krutsch W. Analysis of 213 currently used rehabilitation protocols in foot and ankle fractures. Injury. 2015;46:S51-7. doi: 10.1016/S0020-1383(15)30018-8.
30. Saleh HAA, Al-Imari A. The effect of rehabilitation exercises according to the bio-kinematic analysis of the subtalar joint after recovery from fibrosis resulting from a non-healing fracture in monofin swimming. J App Sport Sci. 2022;12(2):7-14. doi: 10.21608/jass.2022.166978.1091.
31. Romani WA, Gieck JH, Perrin DH, Saliba EN, Kahler DM. Mechanisms and management of stress fractures in physically active persons. J Athl Train. 2002;37(3):306-14.
32. Al-Ashhab ME. Jones fractures outcome measurement: a case series. Current Orthop Prac. 2021;32(1):11-4. doi: 10.1097/bco.0000000000000954.
33. Moisan G, Robb K, Mainville C, Blanchette V. Effects of foot orthoses on the biomechanics of the lower extremities in adults with and without musculoskeletal disorders during functional tasks: A systematic review. Clin Biomec. 2022;95:105641. doi: 10.1016/j.clinbiomech.2022.105641.
34. Hsieh R-L, Peng H-L, Lee W-C. Short-term effects of customized arch support insoles on symptomatic flexible flatfoot in children: A randomized controlled trial. Medicine. 2018;97(20):e10655. doi: 10.1097/MD.0000000000010655.
35. Herchenröder M, Wilfling D, Steinhäuser J. Evidence for foot orthoses for adults with flatfoot: a systematic review. J Foot Ankle Res. 2021;14(1):57. doi: 10.1186/s13047-021-00499-z.
36. Yurt Y, Şener G, Yakut Y. The effect of different foot orthoses on pain and health related quality of life in painful flexible flat foot: a randomized controlled trial. Eur J Phys Rehabil Med. 2019;55(1):95-102. doi: 10.23736/S1973-9087.18.05108-0.
37. Hachisuka A, Hubenig L, Chan KM. Patient compliance with orthotic use - can we do better? An editorial for Zuccarino et al. “Satisfaction with Ankle Foot Orthoses in Individuals with Charcot-Marie-Tooth.” Muscle Nerve. 2021;63(1):3-4. doi: 10.1002/mus.27098.
38. Goksan S. An Analysis of Factors Affecting Adherence with Foot Abduction Orthosis Following the Ponseti Method. Acta Orthop Traumatol Turc. 2015; doi: 10.3944/AOTT.2015.14.0348.
39. Bashir AZ, Dinkel DM, Pipinos II, Johanning JM, Myers SA. Patient Compliance With Wearing Lower Limb Assistive Devices: A Scoping Review. J Manipulative Physiol Ther. 2022;45(2):114-26. doi: 10.1016/j.jmpt.2022.04.003.