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TALAR FRACTURES: CLINICAL AND RADIOLOGICAL DIAGNOSIS: REVIEW ARTICLE

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Abstract

Background: The stability and joint mobility of the ankle depend heavily on the talus. Although though talar fractures make up just around 1% of all fractures, they are often complicated injuries that are linked to long-term morbidity.

Objective: This review article to evaluation, and management of talus fracture and clinical and radiological diagnosis.

Methods: PubMed, Google scholar and Science direct were searched using the following keywords: Talar Fractures, Foot and ankle, CT and MRI Talar Fractures. In addition, the investigators screened references from the related literature, comprising all the identified researches and reviews, the novel or complete researches were only comprised.

Conclusion: The anatomy and biomechanics of the talus are intricate. The first line of procedure for assessing a probable talar fracture is conventional radiography; however, to effectively diagnose and categorise talar fractures, CT scans with MPR and VRT reconstructions are required. In order to enhance treatment results, effective management decisions must be guided by a timely and accurate diagnosis.

Keywords: Talar Fractures, Foot and ankle, CT and MRI.

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Introduction

Being the osseous connection between the leg and the foot, the talus is the 2nd-largest tarsal bone and has distinctive anatomic features. It plays a significant role with regard to the mobility of the feet and ankles. The subtalar joint (STJ), which has three faces, is one of three different articulations that make up the complex anatomy of the talus. The head, neck, and body of the talus are separated. Unsurprisingly, there aren't many muscle or tendon attachments because articular cartilage covers around two-thirds of the surface [1].

Hyaline cartilage covers the convex talar head, which articulates with the navicular at the anterior/distal surface, connecting the ankle and midfoot. The anterior facet at the inferior border of the talar head [anterior section of the STJ] also articulates with the calcaneus. By utilizing the middle [anteromedial] and posterior [posterolateral] facets, the talar body connects inferiorly to the calcaneus. The middle facet articulates with the sustentaculum tali, whereas the posterior facet is the bigger of the two making up the posterior STJ. Interestingly, 45% of tarsal coalitions involve the central facets of the STJ (occasionally comprised). The tibiotalar joint is where the talar dome, also known as the trochlea, articulates with the tibia. Without an articular surface or cartilage, the neck is the section of the talus that connects the head to the body. Along the inferior neck edge are the sinus tarsi and tarsal canal [1].

The medial and lateral tubercles make up the body's posterior process. Between these two tubercles, there is a tendon called the flexor hallucis longus. Elongation of the lateral tubercle is the anatomical form known as a Stieda process. Because to the lateral tubercle ossification center's non-fusion, the os trigonum is another typical variation. In pathologies ranging from fracture to os trigonum syndrome, both of these normal variations may be present [1].

The lateral side of the talus's body is where the lateral process begins. The anterolateral section of the posterior facet of the posterior STJ is developed by this process, which articulates superiorly with the fibula. Snowboarder's fracture, or fracture of the lateral process, is frequently overlooked on first radiographs. Ankle AP radiographs are the best for evaluating the lateral talar process [1-2].

Three arteries—the posterior tibial, dorsalis pedis, and perforating peroneal arteries—provide the talus with vascular support. Avascular necrosis or osteonecrosis can result from displaced fractures or dislocations since the blood supply is mostly extraosseous due to the considerable articular cartilage covered [3–4].

Etiology

High intensity traumas, which include that from motor vehicle collision (MVC) or fall from height (FFH), is linked to head and neck fractures. Snowboarding, inversion, or eversion injuries in sports can result in osteochondral injuries and fractures of the lateral talar process, whereas MVC or FFH could be associated with traumatic damage to the talus body [1-4].

Epidemiology

In general, talar fracture is uncommon and represents between 3% and 6% of foot fractures and less than 1% of entire human fractures [1]. These fractures most likely do not have an age preference, despite the link with MVC suggesting a higher occurrence in younger patients. Moreover, there is a clear gender preference, with males accounting for up to 73% of talar fractures [5]. These sorts of traumas [particularly extensive pattern of fractures] are more frequently observed due to higher survivability after significant injuries, even though the possibility of such fractures is probably not increasing [1].

5 to 10% of entire talar fractures are talar head fractures, the least frequent kind [5-7]. Talar neck fractures, which represent approximately 5% of talar fractures, had generally been thought to be the most prevalent form of fracture. They were originally observed in WW1 pilots, but current research shows otherwise [5]. Differences in how the neck and body are defined anatomically [explained below] may be the cause of discrepancies. It is important to remember that calcaneal and spine fractures correlate with talar neck and body fractures. The reported prevalence of body fractures varies significantly from 13% to 61% [5, 8].

Pathophysiology

The talar vascular supply and absence of muscle attachments make it vulnerable to a serious damage in a traumatised state. As a sizable section of the bone's surface is covered with cartilage, there is a finite amount of bone that may get circulatory supply. Moreover, as talar fractures are linked to high-energy accidents, musculoskeletal and vascular problems may also occur as a result. Osteonecrosis that follows displaced fractures and dislocations occurs more frequently, as expected. These factors make it possible for talar fractures to cause considerable morbidity and long-term impairment if they are not treated properly [1, 8].

Talar Neck Fractures: Classification

In his groundbreaking work, Hawkins [9] established a categorization scheme that may be connected to prognosis. He categorises fractures into I, II, and III categories. The long-term results of Canale and Kelly's talus fracture series were reported in 1978. The four Hawkins groupings were referred to as "types," along with a fourth, unnamed "type IV" [10].

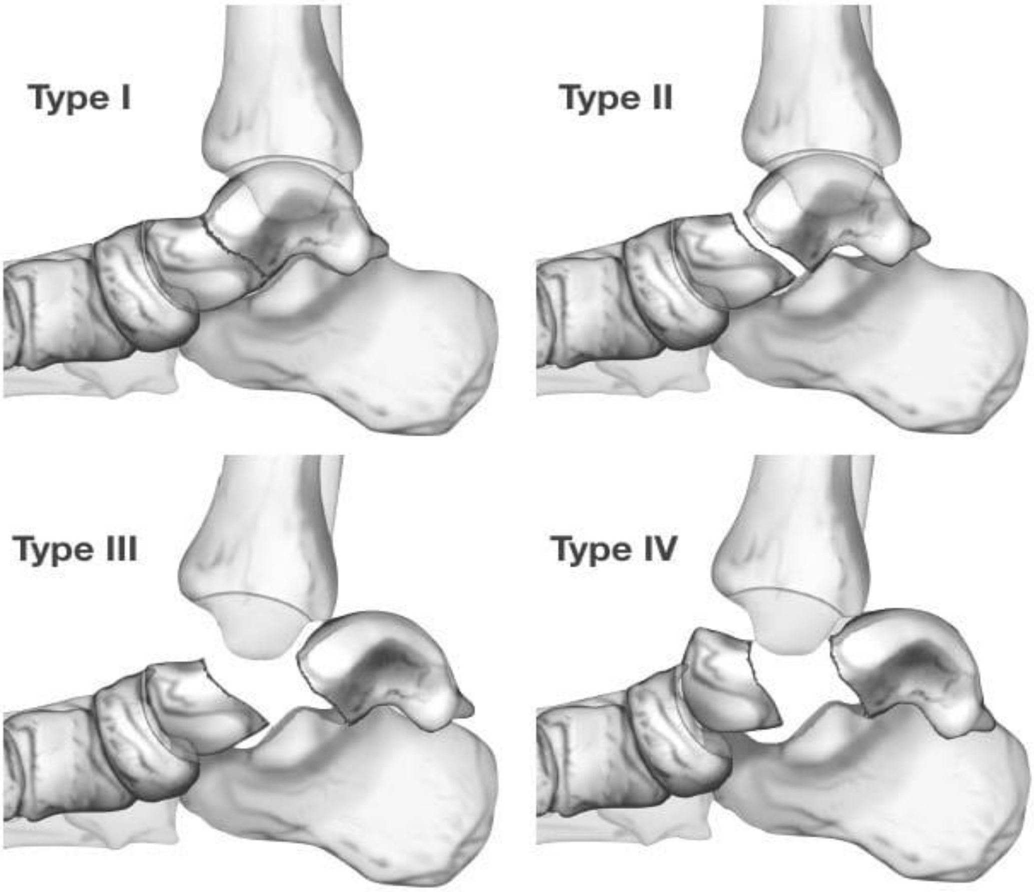

Figure [1]: Hawkins classification **[11]**.

Type I fracture: The most frequent kind of talus fracture is a nondisplaced talus neck fracture. When there is enough displacement, type I fractures change into non-type I fractures. The fracture line crosses the STJ somewhere near the centre or back of the tibia. Talias remains in the STJ and the ankle joint in its original place. The anterolateral neck which is a main blood supply channel is affected in theory [12].

True type I fractures may go undetected by radiographs unless they are verified by a CT or MRI scan. Type II fractures should be examined rather than type I fractures if the displacement is even 1 to 2 mm [12].

Dislocation or subluxations of the STJ are two instances of Type II fractures. In 10 of Hawkins' 24 cases, the posterior side of the talus was dislocated; a medial STJ dislocation was typically to blame in these instances. Two significant factors have interfered with blood flow to the talus. Vessels that enter via the neck as well as those that enter through the tarsal canal foramen and sinus tarsus. The third blood flow pathway, the foramina on the medial body aspect, is normally unharmed but can sustain injury [12].

Type III: A broken neck is associated with talus body displacement from the ankle and STJ in Type III injuries. According to Hawkins' anatomical observations, the talus body had protruded from the medial and posterior side and was positioned between the Achilles tendon and the tibial neurovascular networks. One might consider the skeleton of the talus as a whole. The talus head stays in alignment with the navicular even while the talus rotates within the ankle mortise. Blood circulation to the talus is usually hampered by this kind of injury. Type III injuries frequently include open wounds with neurological, vascular and/or dermal consequences [13].

Around 80% of persons are thought to have Type IV. Along with the ankle and STJ being displaced, type IV fractures also involve the subluxation or dislocation of the talus head from the talonavicular joint. Four percent of the 71 talar fractures in the Canale and Kelly sample were type IV injuries, and all 3 had poor outcomes [13].

Signs and Symptoms:

In other words, talus fractures don't happen very often. Injuries to the lower extremities account for 2% of all bone fractures, while fractures of the foot represent about 3% of entire fractures. If talus lesions aren't found early, they may go undetected. Among young, active persons, thigh bone fractures are prevalent [1].

It is of great importance to have a high level of suspicion when identifying talar process fractures, particularly when they are connected to ankle sprain-like processes which entail inversion or eversion. More sophisticated imaging is necessary for the detection of small fractures. Talus fractures can be caused by high-energy processes or severe traumas, and they could have life-altering consequences if not managed right once [1].

Soft tissue injury is typically present in talar fractures. Since the talar body could protrude posteromedially and wrap around the deltoid ligament, an open talus fracture frequently results in a Hawkins Type III fracture dislocation [9]. Despite the fact that not all high-energy talar fractures breach the skin, they always cause severe soft tissue envelop degeneration. It is more more dangerous if the talus fracture is open. The talar body may occasionally be fully extruded, entirely eliminating the soft tissues of the bone [14].

It might be difficult to treat an injury such an extruded or missing talus. The hindfoot's soft tissue envelope is at danger when a dislocation develops, thus quick reduction is required to prevent more soft tissue damage and necrosis. The misplaced talus must be decreased as soon as practical with regard to talus fracture management [15].

Neurovascular damage can result from talus fractures. Owing to the flexor hallucis longus tendon's protective actions on the neurovascular bundle, the posterior tibial nerve and artery can continue to function normally even when the talus is moved posteromedially [16]. As a secondary result of osteonecrosis of the talus, the talus is more susceptible to vascular injury. When the talus is displaced laterally, the deltoid ligament frequently supplies the talar body with blood [15].

Although it has been shown that talar fractures have minimal impact on feet perfusions, this isn't often the case. Based on the way of damage, which include FFH or being engaged in a serious MVC, talus fractures could be connected to a variety of midfoot and forefoot fractures. Significant soft tissue injury from fractures may result in severe neurovascular dysfunction. The vascular and neurological systems of the foot must be thoroughly examined in order to treat these injuries [16].

Injuries which could happen owing to the accidents:

The presence of systemic trauma and other musculoskeletal ailments is often accompanied by talus fractures. As the fractures arise from high-energy sources, treating the talus fracture in a patient who has multiple injuries might be challenging. Emergent reduction of dislocated joints is still a fundamental idea, wherever it is practical. Stabilizing fractures and dislocations facilitates the soft tissue treatment [17, 18]. The treatment for talus fractures must be suspended in certain cases because multisystem damage are so severe. A successful prognosis for a talus fracture is still conceivable, even if the beginning of appropriate orthopaedic therapy is postponed.

First and foremost, it's crucial to do a full clinical evaluation of the patients who has many injuries and to follow the ATLS guidelines. If the patients are still alive, an emergency reduction of dislocated joints could be done, then the implantation of an external fixator, or internal fixation if it is possible [19–21]. Foot injuries are among the most often ignored conditions in individuals with multiple traumas [22]. As a result, it is once more necessary to have a high degree of distrust. According to several studies including collections of more than seventy talar fractures from a level I trauma centre, individuals with talar fractures have a higher tendency to be associated with polytraumas, such as cases with the ipsilateral lower limb and those with an ISS higher than sixteen [23].

Talus fracture dislocation together with different high-energy foot traumas may go hand in hand, especially in those who have had many injuries, have FFH, or have experienced significant MVC. High-energy foot injuries and talus fractures have to be treated as quickly as feasible in order to minimise and stabilise any displaced joints [24, 25]. Early joint stabilisation is advised, if at all feasible, for cases with joint dislocation and soft tissue injuries since they couldn't have the ability to undergo internal fixation or final fixation of fractures [26]. Due partially to the growing usage of air bags in cars, high-energy foot injuries seem to be significantly increased. The prevalence of severe injuries to the feet, ankles, and lower limbs has grown as cases who could have died from chest, head, or visceral trauma have a better chance of survival. Such foot injuries could have devastating long-term effects on the patient [26–27].

Foot and ankle fractures and talar neck and body fractures are strongly correlated [28].

Tibial plafond or malleolar injuries are frequently seen in association with tufa fractures. Prior investigations indicated concomitant malleolar damage in at least 19% of the patients [29]. Distal tibia and fibula fractures can be treated together with talar fractures, and the malleolar damage may even make it easier to access the talar body. A 10% probability of a calcaneal fracture is linked to talar neck fractures [30].

Plain radiological views are as the followings:

Sequences of routine ankle radiology may often be used to identify talar neck or body fractures. The likelihood of missing nondisplaced talar neck fractures is decreased when the medial and lateral shoulders of the talar body are overlaid on an actual lateral image of the talus. Nonetheless, in the event of a nondisplaced talar neck fracture, CT could be necessary [CT]. To better visualise the talus' unique structure and related processes, a collection of fundamental radiography pictures is required. Talar body and neck fractures and associated pathologies must be diagnosed using the standard ankle AP, lateral (Lat), and mortise views [31].

Surgical reduction of talar fractures is detected using specialised X-ray pictures like Canale and Broden's views. The talar neck can be examined from an AP viewpoint in the Canale view to identify talar varus malalignment. You must totally plantar-flex the ankle, pronate the foot fifteen degrees, and tilt the imaging tube seventy five degrees cephalad from horizontal in order to obtain the Canale image. This picture is especially helpful for determining if varus malalignment has been avoided and for intraoperative assessment of the repair of a talar neck fracture with accompanying medial comminution [31].

Computed Tomography:

A CT has been considered as a good tool in the context of cases with talar fractures and dislocations. The degree of detail is substantially higher and the congruity of the STJ reduction is easily seen with CT imaging. CT scans are useful in a number of situations, particularly in the context of comminuted and subtalar fractures challenging to detect conventional films. CT is of minimal efficacy with regard to identifying the talus' overall alignment because of the talus' distinctive form. Routine computed tomography is to some extent helpful in the context of comminuted talar fractures and subtalar dislocations [32].

Patients with subtalar dislocations frequently have minor but considerable fractures of the inferior talus aspect, which are better seen on CT in comparison with plain radiographs only [32].

Magnetic Resonance Imaging:

has a considerable effect on talar fracture diagnosis [33]. A useful approach to check for osteonecrosis is via an MRI. An artefact that was brought on by the placement of several stainless-steel screws has previously had an impact on MRI. This issue is diminished when fractures are treated with titanium implants. When there is a lot of hardware present, MRI can still provide useful information because to advancements in MRI technology that have decreased metallic artifact [34–36].

Using an MRI, avascular necrosis could be recognized early. Especially among cases of high-energy trauma, cases with a negative Hawkins sign must have MRI 12 weeks after the fractures [36].

Treatment / Management

Treatment for nondisplaced talar head fractures is conservative. Surgery is necessary for displaced talar head fractures to correct the talonavicular joint's misalignment and lower the risk of osteoarthrosis and osteonecrosis [37].

Nonoperative therapy is an option for type I neck fractures. The need for ORIF could arise from even a little displacement of a talar neck fracture, emphasising the need of CT in the assessment of such fractures. Neck fractures of type II need to be surgically reduced and fixed. To reduce skin strain and decrease soft tissue damage, type III and type IV neck fractures could be first managed with a closed reduction at the ED, followed by definitive surgical care ORIF [37].

If undisplaced, talar body fractures could be treated conservatively. Most of body fractures, on the other hand, are displaced, necessitating surgical therapy to realign the fragment and the joint. While removal of the fracture fragment could be required if pain continues in spite of proper conservative therapy, posterior process fractures are often managed nonoperatively [37–38]. Conservative care is used to treat nondisplaced lateral process fractures. If fracture pieces are more than 2 mm out of position or more than 1 cm in size, ORIF is required [39]. The fracture fragments in severely comminuted fractures and fractures linked to articular damage might need to be removed. According to certain theories, Type I Hawkins fractures must generally be managed with ORIF, Type II fractures with excision, and Type III fractures with immobilisation and a non-weight-bearing state [40].

Conclusion

The anatomy and biomechanics of the talus are intricate. The first line of procedure for assessing a probable talar fracture is conventional radiography; however, to effectively diagnose and categorise talar fractures, CT with MPR and VRT reconstructions are required. In order to enhance treatment results, effective management decisions must be guided by a timely and accurate diagnosis.

REFERENCES

1. Melenevsky Y, Mackey RA, Abrahams RB, Thomson NB. Talar Fractures and Dislocations: A Radiologist's Guide to Timely Diagnosis and Classification. Radiographics. 2015 35(3):765-79.
2. Pastore D, Cerri GG, Haghighi P, Trudell DJ, Resnick DL. Ligaments of the posterior and lateral talar processes: MRI and MR arthrography of the ankle and posterior subtalar joint with anatomic and histologic correlation. AJR Am J Roentgenol. 2009; 192(4):967-73.
3. Gelberman RH, Mortensen WW. The arterial anatomy of the talus. Foot Ankle. 1983; 4(2):64-72.
4. Mulfinger GL, Trueta J. The blood supply of the talus. J Bone Joint Surg Br. 1970; 52(1):160-7.
5. Dale JD, Ha AS, Chew FS. Update on talar fracture patterns: a large level I trauma center study. AJR Am J Roentgenol. 2013; 201(5):1087-92.
6. Pennal GF. Fractures of the talus. Clin Orthop Relat Res. 1963;30:53-63.
7. Coltart WD. Aviator's astragalus. J Bone Joint Surg Br. 1952; 34-B(4):545-66.
8. Early JS. Management of fractures of the talus: body and head regions. Foot Ankle Clin. 2004; 9(4):709-22.
9. Hawkins LG. Fractures of the neck of the talus. J Bone Joint Surg Am. 1970; 52(5):991–1002.
10. Santavirta S, Seitsalo S, Kiviluoto O, Myllynen P. Fractures of the talus. J Trauma. 1984; 24(11):986–9.
11. Kenwright J, Taylor R. Major injuries of the talus. J Bone Joint Surg Br. 1970; 52(1):36–48.
12. Sneppen O, Christensen SB, Krogsoe O, Lorentzen J. Fracture of the body of the talus. Acta Orthop Scand. 1977; 48(3):317–24.
13. Vallier HA, Nork SE, Barei DP, Benirschke SK, Sangeorzan BJ. Talar neck fractures: results and outcomes. J Bone Joint Surg Am. 2004; 86-A(8):1616–24.
14. Williams T, Barba N, Noailles T et al. Total talar fracture—inter- and intra-observer reproducibility of two classification systems (Hawkins and AO) for central talar fractures. Orthop Traumatol Surg Res. 2012; 98(4): 56–

65.

15. Chan G, Sanders D, Yuan X et al. Clinical accuracy of imaging techniques for talar neck malunion. J Orthop Trauma. 2008; 22(6):415–418.

16. Lindvall E, Haidukewych G, DiPasquale T et al. Open reduction and stable fixation of isolated, displaced talar neck and body fractures. J Bone Joint Surg Am. 2004; 86–A(10): 2229–2234.

17. Sanders D, Busam M, Hattwick E et al. Functional outcomes following displaced talar neck fractures. J Orthop Trauma. 2004; 18(5):265–270.

18. Bellamy J, Keeling J, Wenke J et al. Does a longer delay in fixation of talus fractures cause osteonecrosis? J Surg Orthop Adv. 2011; 20(1):34–37.

19. Babu N, Schuberth J. Partial avascular necrosis after talar neck fracture. Foot Ankle Int. 2010; 31(9):777–780.

20. Patel R, Van Bergeyk A, Pinney S. Are displaced talar neck fractures surgical emergencies? A survey of orthopaedic trauma experts. Foot Ankle Int. 2005; 26(5):378–381.

21. Xue Y, Zhang H, Pei F, Tu C, Song Y, Fang Y, Liu L. Treatment of displaced talar neck fractures using delayed procedures of plate fixation through dual approaches. Int Orthop. 2014; 38(1):149–154.

22. Fleuriau Chateau P, Brokaw D, Jelen B et al. Plate fixation of talar neck fractures: preliminary review of a new technique in twenty-three patients. J Orthop Trauma. 2002; 16(4):213–219.

23. Maceroli M, Wong C, Sanders R et al. Treatment of comminuted talar neck fractures with use of minifragment plating. J Orthop Trauma. 2016; 30(10):572–578.

24. Ziran B, Abidi N, Scheel M. Medial malleolar osteotomy for exposure of complex talar body fractures. J Orthop Trauma. 2001; 15(7):513–518.

25. Ohl X, Harisboure A, Hemery X et al. Long-term follow-up after surgical treatment of talar fractures: twenty cases with an average follow-up of 7.5 years. Int Orthop. 2011; 35(1):93–99.

26. Gonzalez A, Stern R, Assal M. Reduction of irreducible Hawkins III talar neck fracture by means of a medial malleolar osteotomy: a report of three cases with a 4-year mean follow-up. J Orthop Trauma. 2011; 25(5): 47–50.

27. van Bergen C, Tuijthof G, Sierevelt I et al. Direction of the oblique medial malleolar osteotomy for exposure of the talus. Arch Orthop Trauma Surg. 2011; 131(7):893–901.

28. Prewitt E, Alexander I, Perrine D et al. Bimalleolar osteotomy for the surgical approach to a talar body fracture: case report. Foot Ankle Int. 2012; 33(5):436–440.

29. Muir D, Saltzman C, Tochigi Y et al. Talar dome access for osteochondral lesions. Am J Sports Med. 2006; 34(9):1457–1463.

30. Simpson R, Auston D. Open reduction for AO/OTA 81-B3 (Hawkins 3) talar neck fractures: the natural delivery method. J Orthop Trauma. 2016; 30(3): 106–109.

31. Miller A, Prasarn M, Dyke J et al. Quantitative assessment of the vascularity of the talus with gadolinium-enhanced magnetic resonance imaging. J Bone Joint Surg. 2011; 93(12):1116–1121.

32. Liu H, Chen Z, Zeng W et al. Surgical management of Hawkins type III talar neck fracture through the approach of medial malleolar osteotomy and mini-plate for fixation. J Orthop Surg Res. 2017; 12(1):1–9.

33. Fortin P, Balazsy J. Talus fractures: evaluation and treatment. J Am Acad

Orthop Surg. 2001; 9(2):114–127.

34. Draper SD, Fallat LM. Autogenous bone grafting for the treatment of talar dome lesions. J Foot Ankle Surg. 2000; 39(1):15–23.

35. Wu K, Zhou Z, Huang J et al. Talar neck fractures treated using a highly selective incision: a case-control study and review of the literature. J Foot Ankle Surg. 2016; 55(3):450–455.

36. Mayo K. Fractures of the talus: principles of management and techniques of treatment. Tech Orthop. 1987; 2(3):42–54.

37. Paulos LE, Johnson CL, Noyes FR. Posterior compartment fractures of the ankle. A commonly missed athletic injury. Am J Sports Med. 1983; 11(6):439-43.

38. Summers NJ, Murdoch MM. Fractures of the talus: a comprehensive review. Clin Podiatr Med Surg. 2012; 29(2):187-203.

39. Heckman JD, McLean MR. Fractures of the lateral process of the talus. Clin Orthop Relat Res. 1985; 199: 108-13.

40. Perera A, Baker JF, Lui DF, Stephens MM. The management and outcome of lateral process fracture of the talus. Foot Ankle Surg. 2010; 16(1):15-20.