ijlpr 2023; doi 10.22376/ijlpr.2023.13.2.L167-L174

International Journal of Life science and Pharma Research

ISSN 2250-0480

Research Article

Management of the Sustentaculum Tali Fracture

Fracture of The Sustentaculum Tali: Features and Surgical Management for Fracture Reduction

Pratik Mahapatra* and **Madhukar Chegu**

Department of Orthopaedics, Sree Balaji Medical College & Hospital, Chennai

Abstract: Sustentaculum tali is a horizontal shelf-like projection on the medial part of the calcaneum. The medial facet articulates to the talus and supports the medial column of the foot. The spring ligament originates at the plantar aspect of sustentaculum tali, and flexor hallucis longus passes below it and indirectly supports the longitudinal arch of the foot. Sustentaculum tali is a strong cortical bone, so its isolated fracture is unusual. Therefore, the fracture of the sustentaculum tali is easily misdiagnosed. The patients complain of pain below the medial malleolus and also on passive movement of the flexor hallucis longus tendon. The patient has a history of falls from height with the foot supinated or associated talus fracture. Sustentaculum tali fractures are sometimes considered to be extra-articular fractures. CT scan helps diagnose the intraarticular medial facet involvement in this fracture and is now regarded as intra-articular. Need of the study is to make the clinicians aware that these fractures, even if rare, do happen, if mismanaged, may lead to complications like impingement of flexor hallucis longus, post-traumatic arthritis etc. The study aimed to identify the clinical features and diagnosis of sustentaculum tali fracture and its management to prevent complications. Surgical reconstruction of the sustentaculum tali with a direct medial approach and fixation with cannulated cancellous screws. Ten patients were operated on in the last five years, and seven patients showed up for follow-up and had excellent results per the AOFAS scoring system. All of the fractures had signs of radiological union by the end of the third month. In Conclusion, Sustentaculum tali fracture, when suspected, should not be ignored, and the fracture must be fixed surgically. The current aspect of surgical fixation is befitting and should not be disregarded.

Keywords: sustentaculum tali fracture, medial approach, cannulated cancellous screws

***Corresponding Author**

Pratik Mahapatra , Department of Orthopaedics, Sree Balaji Medical College & Hospital, Chennai

Received On 20 August, 2022

Revised On 30 December, 2022

Accepted On 18 January, 2023

Published On 1 March, 2023

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation Pratik Mahapatra and Madhukar Chegu , Fracture of The Sustentaculum Tali: Features and Surgical Management for Fracture Reduction.(2023).Int. J. Life Sci. Pharma Res.13(2), L167-L174 http://dx.doi.org/10.22376/ijlpr.2023.13.2.L167-L174

1. INTRODUCTION

The incidence of sustentaculum tali is estimated to be less than 1% of all calcaneus fractures all around the world. [1] The surrounding structures around it make it more stable and makes the fracture less common to happen.[2] The sustentaculum tali is a rack-like projection on the medial side of the calcaneus. It can be easily palpated on one finger below the medial malleolus.[3] The tendon of Flexor hallucis longus passes below the groove below the sustentaculum tali and is sometimes trapped between the fractured fragment, which then leads to non-union if left as it is.[4] The spring ligament, tibial-calcaneal ligament, and medial talocalcaneal ligament are attached to it. Above it articulates with the middle calcaneal talar surface. The anterior margin attaches to the spring ligament, and the medial part attaches to the deltoid ligament.[5] Wrong management causes long-term complications leading to permanent disability which affects the patient's quality of life. [6] The spring ligament is attached to the inferior aspect of the sustentaculum tali, which supports the longitudinal arch.[7] Isolated fractures of sustentaculum tali are usually uncommon.[8] Conventionally they have always been regarded as an extra-articular fracture.[9] Sustentaculum tali sometimes includes the middle facet of the subtalar joint and adjoin with the anterior facet of the subtalar joint.[10] Displaced fracture of the sustentaculum can lead to subtalar joint incongruency and subtalar arthritis, and hindfoot stiffness along with Tarsal tunnel syndrome is also sometimes seen.[11] There has been very limited research regarding these articles, mostly limited to case reports.[4,8]Aim of our study is to study clinical features and diagnosis of sustentaculum tali fracture as well its management to prevent complications like non-union, arthritis, tarsal tunnel syndrome, etc. Our objective is surgical reconstruction of the sustentaculum tali with a direct medial approach, which helps view the fracture directly and stay safe from the neurovascular bundle, then fixed with cannulated cancellous screws. Only an axial view of an X-ray or CT Scan helps diagnose the fracture. In addition to it, CT Scan has the added benefit of diagnosing any intra-articular involvement or subtalar dislocation. The surgical fixation is highly essential because conservative management is noted to cause varus of the hindfoot, impingement of the FHL tendon, pain and swelling of the hindfoot, and tarsal tunnel syndrome.[12] Classical lateral approach by Benirschke can be difficult. [13] Only the medial approach helps us directly see the fracture line and the posterior tibia neurovascular bundle.[14] The fracture is rare; the best treatment method has yet to be concluded. In our study, we had ten patients with this fracture in the last five years, out of which five patients had subtalar dislocations, and three had intra-articular middle facet involvement. Here we will discuss the mechanism of injury and management of this fracture by open reduction and internal fixation by direct medial approach and fixation by cannulated cancellous screws with the screws directed plantarly and posteriorly. All the fixations done for the patients had radiological union by the end of 3rd month without any complications, which would have likely happened if the fracture had been managed conservatively.

2. MATERIALS AND METHODS

From January 2017 to January 2022, 10 patients with sustentaculum tali fractures came to Sree Balaji medical college and hospital, Chennai, and were treated with open reduction and internal fixation. The AO classification was used to describe the fracture. All partial articular, as well as complete intra-articular fractures, were included. Follow-up x-rays were taken, and the American Orthopedic Foot-and-Ankle Society score was used to evaluate the patients (Table 1). All the demographic details were properly recorded. Seven patients had the right side, and three had left-side fractures. The average age was 28yrs. Of the total patients, eight were male, and two were female. Other related injuries were also noted. X-ray, CT scan, and patient records were evaluated. (Figure. 1 & 2) showing the pre-op X-ray and CT scan of a patient). For the surgical approach, i.e. direct medial approach, an incision is made below the medial malleolus parallel to the posterior tibial tendon. The neurovascular bundle and the tendons are carefully handled to prevent errors or complications. All the patients were fixed with cannulated cancellous screws plantarly and posteriorly. Depending upon the requirement, 1 or 2 screws were used. The postoperative protocol was followed as discussed below, and the patient was made to have partial weight-bearing walking for 6-8 weeks till radiological union was achieved.

Table 1: The table below is the American Orthopaedic foot and ankle society score(AOFAS). The total score is a hundred. The score is interpreted as excellent (95-100), good (75-94), fair(51-74), and poor(0-50).

Category	Parameter	Points
Pain	None	40
	Mild	30
	Moderate	20
	Severe	0
Activity limitation	None	10
	Limitation on recreational activities	7
	Some limitations on recreational and daily activities	4
	Severe limitations on recreational and daily activities	0
Maximum continuous walking distance	>600 meter	5
	>400 meter & <600 meter	4
	>100 meter & <400 meter	2
	<100 meter	0
Walking surfaces	No difficulty on any surface	5
	Some difficulty on terrain, stairs, inclines	3
	Severe difficulty or inability to walk on uneven terrain, stairs, inclines	0
Sagittal motion	Normal or mild restriction (30 degrees or more)	8
	Moderate restriction (15 degrees to 29 degrees)	4

	Severe restriction (<15 degrees)	0
Gait abnormality	None or slight	8
	Obvious	4
	Marked	0
Hindfoot motion	normal or mild restriction (75% to 100%)	6
	Moderate restriction (25%-74%)	3
	Severe restriction (<25%)	0
Ankle Hindfoot Stability	Stable	8
	Unstable	0
Alignment	Good, plantigrade foot, well aligned	10
	Fair, plantigrade foot, mild to moderate degree of malalignment	5
	poor, nonplantigrade foot, severe malalignment	0

2.1 INCLUSION & EXCLUSION CRITERIA

- ***Inclusion criteria***

a. Age >18yrs and less than 40 years
b. Willing patients to be included in the study
c. All patients with or without subtalar dislocation or middle facet involvement
d. All partial articular and complete articular fractures are based on the AO Classification. [15]

- ***Exclusion criteria***

a. Patients not willing to be included in the study
b. Age >40 years
c. Severe injury with soft tissue defect
d. Skeletal immaturity
e. Difficult mobility of patient before the surgery
f. Degeneration of hindfoot joints
g. Severe osteoporosis

2.2 Surgical Principle & Objective

Reconstruction of displaced sustentaculum tali fracture by direct medial approach with cannulated cancellous screw fixation, thereby repairing medial facet and medial arch.

2.3 Advantages and Disadvantages

- ***Advantages***

a. Easy procedure
b. Reduced chances of post-traumatic arthritis
c. Reduced chances of non-union and tarsal tunnel syndrome

- ***Disadvantages***

a. Tibialis posterior tendon and FHL Tendon nearby
b. Proximity to the neurovascular structure
c. Case being rare needs expert surgical knowledge

2.4 Indication and contraindication

- ***Indication***

a. Intra Articular step >2mm
b. Medial facet involvement
c. FHL, Tibialis Posterior entrapment
d. Fracture reaching out to the posterior facet

- ***Contraindication***

a. Infection
b. Affected blood supply
c. High blood sugar
d. Other comorbidities

2.5 Patient Information

a. Infection, wound dehiscence, swelling, non-union
b. Screw loosening or irritation over the skin
c. Subtalar joint, restricted ROM
d. Adhesion of FHL or Tibialis Posterior tendon
e. Injury to neurovascular structures

2.6 Preoperative workup

a. X-ray of Foot and calcaneal axial view X-ray
b. CT Scan of the foot with ankle
c. Proper splinting to reduce swelling
d. Analgesics and anti-inflammatories to reduce the soft tissue swelling

2.7 Instruments and Implants

a. Cannulated cancellous screws (4mm to 7.3mm)
b. K wire and drill set
c. Foot instrument set
d. C-arm machine
e. Tourniquet to apply

2.8 Anaesthesia and positioning

General anaesthesia/spinal anaesthesia/femoral block
Position: - supine with the index knee flexed

2.9 Special surgical consideration

Fractures without intra-articular involvement can be managed by percutaneous fixation. C-arm should be used to visualize the fracture, and for screw fixation, the surgeon has to be careful as the fracture is near important tendons and neurovascular structures.

2.10 Postoperative management

a. POP Slab or cast for 1-2 weeks
b. ROM exercise after removing POP to keep joint supple and prevent stiffness
c. Partial weight bearing for 6-8 weeks till union is achieved

2.11 Error, hazards, and complications

a. Irritation of screw if present implant exit was done.
b. Wound dehiscence (rare in medial approach) {was not seen in any of the cases included}
c. Tendon adhesion if seen physiotherapy was done or tenolysis was done.
d. Injury to the neurovascular structure was managed with exploration and repair.
e. Infection was managed with antibiotics and VAC dressing.

2.12 *OPERATIVE PROCEDURE*

The patient was in a supine position with parts painted and draped and under spinal/epidural anaesthesia. The affected limb was externally rotated with a tourniquet applied high in the thigh by medial approach beginning over 2 cm distal to the tip of the medial malleolus and extending to the navicular tuberosity. The tibialis posterior and Flexor digitorum longus retracted anteriorly, and the posterior tibial artery, vein, and posterior tibial nerve retracted posteriorly. The fracture was then fixed with 1-2 cannulated cancellous screws directed plantarly and posteriorly, proper wound wash was given, and the skin was sutured. (Fig.3 & 4) representing fixation with cannulated cancellous screws). After evaluation of all radiographic reports of all patients, it was seen that seven patients had subluxation of the subtalar joint and 3 had intra-articular middle facet involvement. Of the seven dislocated subtalar joints. Three had depression, and the rest 4 had comminution. All patients were operated on in an average of 7 days with a medial approach only and fixed with a cannulated cancellous screw. Three patients were lost to follow-up. The mean follow-up time was 15.8 months. All patients had radiological union by the end of 3rd month. The outcome was excellent in 6 and good in 1. 1 patient had a wound gaping after suture removal, necrosed edges were trimmed, and the wound was approximated and then healed appropriately. (Fig. 6 showing union in the 10th week)

Fig 1: Preoperative X-ray lateral and axial view showing sustentaculum tali fracture.

Here in Figure 1 above is a preoperative X-ray in lateral(left) and axial view(right) where we can see on the right axial view X-ray fracture of Sustentaculum tali. The fracture line (red arrow) is visible. The Sustentaculum tali being separated from the calcaneum when interpositioned with soft tissue or tendon of FHL causes non-unionnon-union or other complications, as discussed here.

Fig 2: Preoperative CT scan

The Ct scan was taken on the patient's arrival in an emergency, showing the axial section of the ankle showing distal fibula, tibia, talus and calcaneum. The axial cut shows a fracture of sustentaculum tali with a clear visible gap present and away from the calcaneum.

Fig 3: Intraoperative c-arm picture of the calcaneum

The calcaneum in the axial view shows the sustentaculum tali being fixed with two cannulated cancellous screws. The fracture gap is now completely obliterated reducing the risk of any soft tissue interposition thereby reducing the chances of non-union and promoting the rapid union of the bone.

Fig 4: Intraoperative c-arm picture of the ankle joint in lateral view

Here in the lateral view, we can see the sustentaculum tali being fixed with two cannulated cancellous screws.

Fig 5: Immediate postoperative X-ray

Here in the immediate postoperative X-ray, we can see the cannulated cancellous screws in place fixed by direct medial approach and the patient is on below knee POP.

Fig 6: Post OP X-ray in the 10th week

X-ray here is taken when a patient comes to the OPD for follow-up. Here we can see signs of the union in the fracture. The above images (Figures 1 to 6) are of a 28-year-old man who had a history of road traffic accidents and was treated with a cc screw with a direct medial approach.

3. RESULTS

A total of ten patients were included in this study. Out of them, seven had a fracture of the right side, and three had left sustentaculum tali fractures. A total of eight patients were male and two were female. Three patients did not show up after discharge and were lost to follow-up. All fractures were fixed by direct medial approach and with cannulated cancellous screws. All the patients who came to casualty were advised for an X-ray followed by a CT scan. Seven patients had a history of falls from height, and three with a history of road traffic accidents. Radiological evaluation revealed five isolated sustentaculum tali fractures. In addition, five patients had subtalar dislocation along with sustentaculum tali fracture, and three had intra-articular middle facet involvement. There was no fracture noted in any other limbs or extremities.Closed reduction of the subtalar dislocation was reduced under anaesthesia, and POP was put in for the swelling to subside. The average waiting period was ten days (five to fifteen days). The waiting period was for the swelling to subside. All fractures were fixed by direct medial approach, and one to two canulated cancellous screws were fixed depending on the fracture. Sutures were removed on postoperative day fourteen. All the wounds healed properly. Only one patient had edges necrosed whose edges were trimmed and sutured which healed properly later. The average follow-up period was 15.8 months (15-16 months). Postoperatively the patient was advised for complete non-weight bearing for up to 6-8 weeks or till radiological union was seen, generally by the end of 3rd month. The American orthopaedic foot and ankle scoring system was used to evaluate the patient outcome. All seven patients who had come for follow-up had excellent outcomes as evaluated using the scoring system.

4. DISCUSSION

Fracture of sustentaculum tali is rare and the literature regarding it is scarce.[16] Despite this it still happens, and its

clinical picture and surgical management are important. The patient comes to the hospital with a history of RTA or fall, is usually not weight-bearing, and complains of pain around the medial malleolus.[6] Some patients can walk with an antalgic gait and appear in an emergency.[17]Historically, this fracture is mostly conservatively managed with plaster because it was thought to be an extra-articular fracture and minimal displacement-mandated nonsurgical management.[18,19] Nonsurgical management of these fractures was not correct in displaced fractures or fractures which were intra-articular in nature. The interposition of the FHL tendon can cause non-unionnon-union. [20-22] Tarsal tunnel syndrome, along with non-union, is also sometimes seen.[4,20,23] In this study, out of ten patients, three patients were lost to follow-up. Five of the seven patients had dislocation of the subtalar joint, and two had Intra-articular middle facet involvement. The study by Wagner et al. indicated that the middle facet shares more load despite having a smaller contact area. The average contact pressure for the anteromedial facet was 1.44MPa, while it was 0.93MPa for the posterior facet.[24] Knowing the middle facet, despite having a smaller area, shares a big load of the subtalar joint, so the sustentaculum tali fracture mandates surgical management because it is vital in load sharing. The classical L Shaped lateral incision does not help in proper visualization because of the intact calcaneal tuberosity. The sustentaculum tali are on the medial side, so the medial incision helps properly reduce the fracture. In addition, it helps the surgeon to be more cautious about the neurovascular structures as well. Mcreynolds described the medial approach initially and was expanded by Burdeaux [25,26]. Some of the patients operated by Burdeaux also were operated by an additional lateral approach. The outcomes from only the medial approach were still satisfactory. The study by Zwipp et al., in which he. Used a medial approach to fixation calcaneal fractures and mentioned sustentaculum as an important key factor for reduction. [27] In his study, he operated on around two third of the patients with displaced intra-articular fractures with a medial approach. Burdeaux also published an article on 61 calcaneal fractures operated with a direct medial approach with 4.4 years of follow-up and reviewed using AOFAS scoring had 46 patients with good to excellent results.[28] Proper reduction of the fracture helps the fracture unite, and the articular subtalar joint is reconstructed appropriately, which is essential as the anteromedial facet bears more load, as discussed above. This study has drawbacks mainly due to a smaller number of cases. This is because the fracture itself happens very rarely. Gatha et al. reported four cases in their fifteen years of practice.[14] The study by Della Rocca GJ et al.[1] in which fifteen patients were operated on by direct medial approach. Nine of the patients were operated on with plate and screw fixation, and rest six with only screw fixation. All patients had signs of the radiological union by the end of the third month. Only one patient had shown subtalar arthrosis radiologically. Two patients requested implant removal, given soft tissue irritation.[14] Another study by MU H et al. in which all seven patients had radiological union by the end of 3rd month. Out of the seven, five were excellent, and two had good results according to the AOFAS scoring system.[10] All patients had signs of the radiological union by the end of the third month. Restoring the fracture anatomically helps indirectly reduces the subtalar joint anatomy, thereby helping prevent complications like arthritis and non-union and tarsal tunnel syndrome. [4,29]

5. CONCLUSION

Fractures of sustentaculum tali are rare injuries as well as easily missed out. When suspected, necessary radiological investigation should be done due to its anatomical importance and should be treated surgically to prevent complications like non-union, tarsal tunnel syndrome, etc. Fractures treated with a direct medial approach help protect the neurovascular structure and help visualization of the sustentaculum tali directly. Anatomical reduction with cannulated screws had excellent and good results. Surgical fixation of sustentaculum tali fracture is necessary to prevent the associated complications. The previous literature supports the same as discussed above. This study also gives a similar outcome to the previous research. The study is done only in a single hospital is a drawback. A multi-hospital study of this fracture will help us to understand this fracture better and determine other treatment methods as well as find patient outcomes.

6. ACKNOWLEDGEMENT

The author is thankful to Sree Balaji Medical College and Hospital for providing the related support to compile this work.

7. DECLARATION OF PATIENT CONSENT

The patient consent form was obtained for this study

8. DATA AND MATERIALS AVAILABILITY

All data associated with this study are present in the paper

9. AUTHORS CONTRIBUTION STATEMENT

Dr Pratik Mahapatra conceptualized, gathered, and curated the data and prepared a draft regarding the study. Then, Dr Madhukar Chegu analyzed the data and draft and gave the necessary inputs for changes. Both authors contributed to the design of the manuscript. Both the authors discussed the methodology, result and discussion and finalized the manuscript.

10. CONFLICT OF INTEREST

Conflict of interest declared none.

11. REFERENCES

1. Daftary A, Haims AH, Baumgaertner MR. Fractures of the calcaneus: a review with emphasis on CT. RadioGraphics. 2005 Sep;25(5):1215-26. doi: 10.1148/rg.255045713, PMID 16160107.
2. Razik A, Harris M, Trompeter A. Calcaneal fractures: where are we now? Strategies Trauma Limb Reconstr. 2018 Apr;13(1):1-. doi: 10.1007/s11751-017-0297-3, PMID 29052080.
3. Warrick CK, Bremner AE. Fractures of the calcaneum, with an atlas illustrating the various types of fracture. J Bone Joint Surg Br. 1953 Feb;35-B(1):33-45. doi: 10.1302/0301-620X.35B1.33, PMID 13034868.
4. Myerson MS, Berger BI. Nonunion of a fracture of the sustentaculum tali causing a tarsal tunnel syndrome: a case report. Foot Ankle Int. 1995 Nov;16(11):740-2. doi: 10.1177/107110079501601113, PMID 8589816.

5. Olexa TA, Ebraheim NA, Haman SP. The sustentaculum tali: anatomic, radiographic, and surgical considerations. Foot Ankle Int. 2000 May;21(5):400-3. doi: 10.1177/107110070002100507, PMID 10830658.
6. Pranata AS, Kawiyana KS, Aryana GNW, Febyan. Cannulated cancellous screw fixation for the management of sustentaculum tali fracture: A case report. Int J Surg Case Rep. 2022 Jan 1;90:106661. doi: 10.1016/j.ijscr.2021.106661, PMID 34923229.
7. Davis WH, Sobel M, DiCarlo EF, Torzilli PA, Deng X, Geppert MJ et al. Gross, histological, and microvascular anatomy and biomechanical testing of the spring ligament complex. Foot Ankle Int. 1996 Feb;17(2):95-102. doi: 10.1177/107110079601700207, PMID 8919408.
8. Romash MM. Fracture of the calcaneus: an unusual fracture pattern with subtalar joint interposition of the flexor hallucis longus. A report of two cases. Foot Ankle. 1992 Jan;13(1):32-41. doi: 10.1177/107110079201300106, PMID 1577339.
9. Al-Ashhab ME, Elgazzar AS. Treatment for displaced sustentaculum tali fractures. Foot (Edinb). 2018 Jun 1;35:70-4. doi: 10.1016/j.foot.2017.12.002, PMID 29852385.
10. Mu H, xiangyang x, gang B. Isolated fractures of the sustentaculum tali: injury characteristics and surgical technique for reduction management. J Foot Ankle Surg. 2014 Dec 1;1(2):48-51. doi: 10.5005/jp-journals-10040-1011.
11. Drayer-Verhagen F. Arthritis of the subtalar joint associated with sustentaculum tali facet configuration. J Anat. 1993 Dec;183(3):631-4. PMID 8300440.
12. Dürr C, Zwipp H, Rammelt S. Fractures of the sustentaculum tali. Oper Orthop Traumatol. 2013 Dec;25(6):569-78. doi: 10.1007/s00064-013-0247-2, PMID 24306047.
13. Benirschke SK, Sangeorzan BJ. Extensive intraarticular fractures of the foot. Surgical management of calcaneal fractures. Clin Orthop Relat Res. 1993 Jul 1;292(292):128-34. doi: 10.1097/00003086-199307000-00015, PMID 8519099.
14. Della Rocca GJ, Nork SE, Barei DP, Taitsman LA, Benirschke SK. Fractures of the sustentaculum tali: injury characteristics and surgical technique for reduction. Foot Ankle Int. 2009 Nov;30(11):1037-41. doi: 10.3113/FAI.2009.1037, PMID 19912711.
15. Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA et al. Fracture and dislocation classification compendium – 2007: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma. 2007 Nov 1;21(10);Suppl:S1-133. doi: 10.1097/00005131-200711101-00001, PMID 18277234.
16. Allen JD, Githens MF. Fractures of the sustentaculum tali. InFractures and dislocations of the talus and calcaneus 2020 (pp. 281-90). Berlin: Springer.
17. Gatha M, Pedersen B, Buckley R. Fractures of the sustentaculum tali of the calcaneus: a case report. Foot Ankle Int. 2008 Feb;29(2):237-40. doi: 10.3113/FAI.2008.0237, PMID 18315982.
18. Rowe CR. Fractures of the os calcis: a long-term follow-up study of 146 patients. JAMA. 1963 Jun 22;184(12):920-3. doi: 10.1001/jama.1963.03700250056007.
19. Moonot P, Sharma G, Kadakia AR. Mal-union of sustentaculum tali fracture with talo-calcaneal coalition leading to tarsal tunnel syndrome: A case report. Foot (Edinb). 2021 Jun 1;47:101797. doi: 10.1016/j.foot.2021.101797, PMID 33964532.
20. Garchar DJ, Lewis JE, DiDomenico LA. Hypertrophic sustentaculum tali causing a tarsal tunnel syndrome: a case report. J Foot Ankle Surg. 2001 Mar 1;40(2):110-2. doi: 10.1016/s1067-2516(01)80053-3, PMID 11324667.
21. Benirschke SK, Sangeorzan BJ. Extensive intraarticular fractures of the foot. Surgical management of calcaneal fractures. Clin Orthop Relat Res. 1993 Jul 1;292(292):128-34. doi: 10.1097/00003086-199307000-00015, PMID 8519099.
22. Komiya K, Terada N. Entrapment of the flexor hallucis longus tendon by direct impalement in the osseofibrous tunnel under the sustentaculum tali: an extremely rare complication of a calcaneal fracture: a case report. JBJS Case Connect. 2014 Oct 8;4(4):e100. doi: 10.2106/JBJS.CC.N.00047, PMID 29252768.
23. Rodríguez-Merchán EC, Moracia-Ochagavía I. Tarsal tunnel syndrome: current rationale, indications and results. EFORT Open Rev. 2021 Dec 10;6(12):1140-7. doi: 10.1302/2058-5241.6.210031, PMID 35839088.
24. Wagner UA, Sangeorzan BJ, Harrington RM, Tencer AF. Contact characteristics of the subtalar joint: load distribution between the anterior and posterior facets. J Orthop Res. 1992 Jul;10(4):535-43. doi: 10.1002/jor.1100100408, PMID 1613627.
25. McReynolds IS. The case for operative treatment of fractures of the os calcis. Controversies Orthop Surg. 1982:232-54.
26. Burdeaux Jr BD. The medical approach for calcaneal fractures. Clin Orthop Relat Res. 1993 May 1;290(290):96-107. PMID 8472476.
27. Zwipp H, Tscherne H, Thermann H, Weber T. Osteosynthesis of displaced intraarticular fractures of the calcaneus. Results in 123 cases. Clin Orthop Relat Res. 1993 May 1;290(290):76-86. PMID 8472474.
28. Burdeaux Jr BD. Fractures of the calcaneus: open reduction and internal fixation from the medial side a 21-year prospective study. Foot Ankle Int. 1997 Nov;18(11):685-92. doi: 10.1177/107110079701801102, PMID 9391812.
29. Krähenbühl N, Horn-Lang T, Hintermann B, Knupp M. The subtalar joint: a complex mechanism. EFORT Open Rev. 2017 Jul 6;2(7):309-16. doi: 10.1302/2058-5241.2.160050, PMID 28828179.