ORIGINAL ARTICLE

Nr 2023;13 (1):135-144

# Prospective Study of Clinical Outcome of Closed Subtalar Joint Dislocation, Two Years Follow-Up

P. R. Krishnaprasad[1], Kiran V. Acharya[1], Y. Lakshmisha Rao[2], B. V. Murlimanju[2], Sandesh Madi[1], Tatia Darshan Bajrang[1]

[1] *Department of Orthopaedics, Kasturba Medical College, Manipal, Manipal Academy of Higher Education, Karnataka, India*

[2] *Deparment of Anatomy, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India*

**CORRESPONDING AUTHOR:**
B.V. Murlimanju
Department of Anatomy
Kasturba Medical College
Manipal Academy of Higher Education
Mangalore 575004, India
E-mail: flutesnowmm@gmail.com;
murali.manju@manipal.edu

**DOI:**
10.32098/mltj.01.2023.15

**LEVEL OF EVIDENCE: 4**

## SUMMARY

**Background.** Acute traumatic subtalar dislocations often present to the emergency with a wide range of variety with respect to the mechanism of injury, clinical presentation and associated fractures around the foot and ankle. The nature of instability and irreducible primary subtalar dislocation, makes their management, challenging.

**Methods.** Here we present five consecutive male patients with the mean age of 24 years (18-35 years). Four patients presented with medial subtalar dislocation and one patient had lateral subtalar dislocation. All the patients except one, had fractures around the foot and ankle. The fracture dislocations in this study were closed type.

**Results.** Two patients underwent closed reduction under sedation in emergency and three had to undergo open reduction in operating room under the appropriate anesthesia as an emergency procedure. The mean follow-up period was two years. The mean American Orthopaedic Foot and Ankle Society (AOFAS) score was 82.4 out of 100 (ranging from 82 to 97). It was observed that the patients who undergone open reduction, had lower AOFAS score in comparison to the stable closed reduction. Two patients had radiological evidence of subtalar arthritis in the open reduction group, but they were clinically asymptomatic in the latest follow up.

**Conclusions.** Closed subtalar joint dislocation, managed with early closed reduction showed better prognosis in comparison to patients, who presented late and underwent open reduction. However, the overall functional outcome depends on the other associated fractures of the bones of the foot and its complexity. The limitations of our study include the small number of patients and a shorter follow-up time of two years.

## KEY WORDS

*Subtalar dislocation; acute traumatic dislocation; talonavicular joint; talocalcaneal joint; foot injuries.*

## BACKGROUND

Subtalar dislocations are rare traumatic injuries, which consists of dislocations of talocalcaneal and talonavicular joints, having an incidence rate of 1% (1). These can be resulted commonly from the high energy injuries such as motor vehicle accidents, as well as from a low energy sporting activity. They can present as pure dislocations or more commonly as fracture dislocations around the foot and ankle. The injuries can be classified, depending on the direction of foot with respect to the ankle as medial, lateral, posterior and anterior dislocations. Among them, medial direction is the commonest type. The lateral dislocation usually occurs due to high-energy trauma and is often associated with other injuries. These patients require open

reduction as the closed reduction can be usually unsuccessful (2). In all the types of dislocations, the talonavicular joint gets dislocated first, followed by the talocalcaneal joint.

The classification of the dislocation of subtalar joint is represented in **table I,** and **figure 1** shows the schematic representation of the traumatic lesions (3-7), which are associated with the subtalar joint dislocation. These rare and complex injuries demand the clinician, to have a high degree of suspicion to make the appropriate diagnosis. The local examination should include the assessment of neurovascular structures (8). They are usually managed as urgent procedures in the orthopaedic emergency department, under the sedation. The reduction of the subtalar joint will be achieved first followed by the assessment of reduction by radiographs and computed tomography (CT). This will confirm about both the reduction of dislocation as well as the occult fractures around the foot and ankle. However, if the closed reduction fails or the joint noticed to be unstable, open reduction with or without stabilization should be planned as an emergency procedure. In the literature review, there are several retrospective studies available, however the prospective studies were only two in number (9, 10). In this study, we present a prospective series of subtalar dislocations, which were presented to us with varying mechanisms of injuries and clinical features including the delayed presentation. The objective was to adapt a case specific management strategy, unlike a blanket treatment for subtalar dislocations.

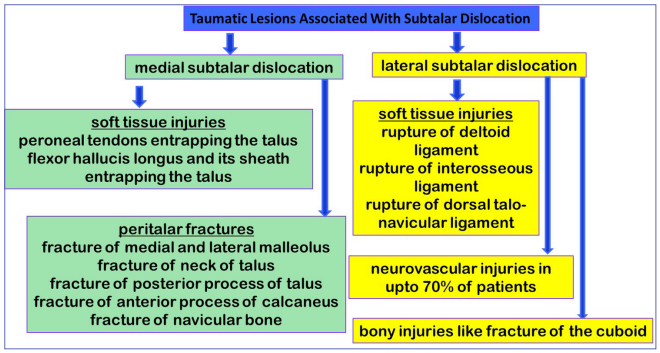



**Figure 1.** Schematic representation of the traumatic lesions, which are associated with the subtalar joint dislocation.

## MATERIALS AND METHODS

The present prospective study included five young male patients (n = 5) of closed subtalar dislocation, who were managed in the orthopedic and traumatology department of our institution. The right foot was involved in three patients and left foot in the remaining two of them. The mean age of the patients was 24 years. Among them, two were university students, who presented with pain and deformity following the twisting injury during the sport activity (basketball and badminton games). Specifically, the ankles were buckled, while jumping and landing, which resulted in subtalar dislocation. Both of these patients were presented to us with in an hour of the injury. The other three patients, had high velocity injury due to two wheeler motor vehicle accidents. One among them, presented with a delay of 24 hours following the accident. All these cases were closed dislocations and none of them had any neurovascular involvement. There was no history of any previous trauma, systemic illness or congenital anomalies in the involved limb. In the present study, all the five patients were assessed regularly at the 6, 9, 12, 18 and 24 months follow up. The present study has the approval of institutional Ethics Committee of Kasturba Medical College and Kasturba Hospital, Manipal on August 08, 2020 (protocol number IEC 379/2020) and it is in accordance with the international ethical standards as per the guidelines of declaration of Helsinki (11).

**Table I.** Classification and mechanism of injury of subtalar joint dislocation.

| Position of the dislocated foot with respect to talus | Mechanism of injury | |
|---|---|---|
| 1. Medial (75%) | **Low energy injury** | **High energy injury** |
| 2. Lateral (17-25%) | 1. Sports related injury around ankle | 1. Motor vehicle accidents |
| 3. Posterior (0-2.5%) | 2. Twisting/tripping of ankle | 2. Fall from height |
| 4. Anterior (0-1%) | 3. Jumping and landing on the supinated foot | |
| | **Clinical features** | |
| | Obvious deformity | Deformity may be masked due to multiple injury mechanism |
| | Closed fracture dislocation | Open/closed fracture dislocation |

## RESULTS

### Patient 1

A 25-years-old student presented to the orthopedic emergency unit, following a twisting injury of the right ankle while playing the basketball game. He was carried by his mates as he was unable to bear the weight on his right lower limb. On clinical examination, there was a presence of deformity at the ankle and foot, which was identical to the deformity (**figure 2A**), typically described in the literature as "acquired club foot" (12-14). The distal pulsations were palpable and the sensations in the toes were intact and comparable with the contralateral limb. The plain radiographs of foot and ankle, confirmed the medial subtalar dislocation and the 5th metatarsal tuberosity fracture (**figure 2B,C**). As an urgent procedure, closed reduction was performed under the sedation with muscle relaxant, by flexing the knee to relax the gastrocnemius. The traction was given manually at the foot, which was held in plantar flexed position, by using the flexed knee as a counter traction. Firm, pointed, digital pressure was applied at the head of talus for few seconds, which resulted in reduction with an audible clunk. Clinically, there was sudden relief of the pain along with the passive painless free movements at the ankle and subtalar joints. This confirmed the reduction of the subtalar joint.

The CT scan of the foot and ankle was performed to know more details about the existing fifth metatarsal fracture and also to rule out other coexisting occult fractures. Once the isolated undisplaced fracture of fifth metatarsal tuberosity was confirmed, it was decided to proceed with the conservative management. This included below knee plaster slab immobilization with ankle and foot in plantigrade position as first stage, followed by absolute non-weight-bearing for a period of 2 weeks. At 2 weeks follow up, a check radiograph was taken to reconfirm the reduced position of the fracture. The immobilization was continued in a CAM (continuous ankle movement) boot for 2 more weeks. By the end of total 4 weeks of immobilization, the ankle movement was allowed, however the inversion and eversion at the subtalar joint were restricted. The patient was reviewed again at six weeks, at this point, partial weight-bearing was advised. Full weight bearing over the next 6 weeks was allowed in a progressive manner. At 12 weeks, the patient was sent for sport rehabilitation and by the 16 weeks, he was allowed to take part actively in sports.

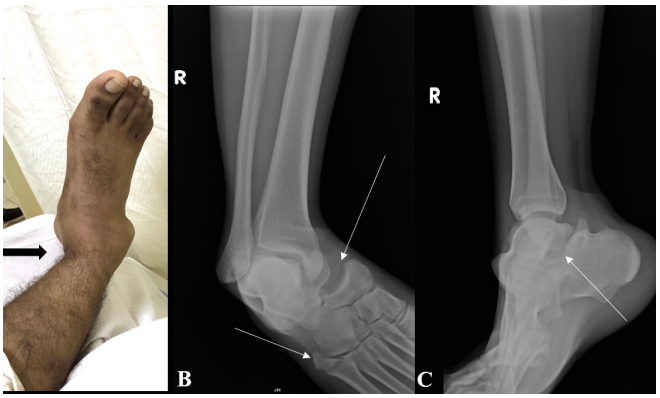



**Figure 2. (A)** Showing the clinical deformity of acute subtalar dislocation in early presentation, **(B)** AP view, **(C)** Lateral view, plane radiographs showing the subtalar medial dislocation with the fifth metatarsal tuberosity fracture (patient 1).

### Patient 2

A 19-year old boy presented with pain and deformity in his right ankle following the buckling of ankle, while landing after a jump during a badminton game. He was carried immediately to the emergency department, as he was not able to walk. The standard plain radiographs of foot and ankle revealed "medial subtalar dislocation". The CT scan was performed to rule out the fractures around the foot and ankle. Closed reduction under the sedation was carried out as an urgent procedure in emergency, with the same reduction technique as described in the case 1. The subtalar joint was reduced clinically with a "clunk", which was confirmed with the post reduction radiographs, which ruled out the fractures around the foot and ankle. The right lower limb immobilization was done with below-knee plaster slab and non-weight bearing was advised with a walking aid. However, the patient returned to us in about a week's time with the complaint of pain in the foot. The plaster slab was opened and examined to find the tenderness around the talo-navicular joint. Repeat plain x ray, magnetic resonance imaging (MRI) and relevant CT cuts of ankle and foot were taken. The MRI revealed an undisplaced fracture of the head of talus, which was extending into the talo-navicular joint (**figure 3**). After a detailed discussion with the patient, the conservative management was considered unanimously in view of the undisplaced nature of the head of the talus fracture. But it was decided to have a close watch in the subsequent follow ups, because of the talo-navicular joint involvement. The limb was immobilized in a plaster slab for 2 more weeks and at the end of the 3 weeks, the patient was reviewed with check radiographs, which confirmed the healing of fracture without the displacement.

At this third week review, the CAM boot immobilization was opted, in view of promoting the active mobilization of the ankle. When the case was again reviewed at the end of 6 weeks from the day of trauma, the patient was symptomless, and the radiographs showed healing of fracture. Hence it was decided to start partial weight bearing within

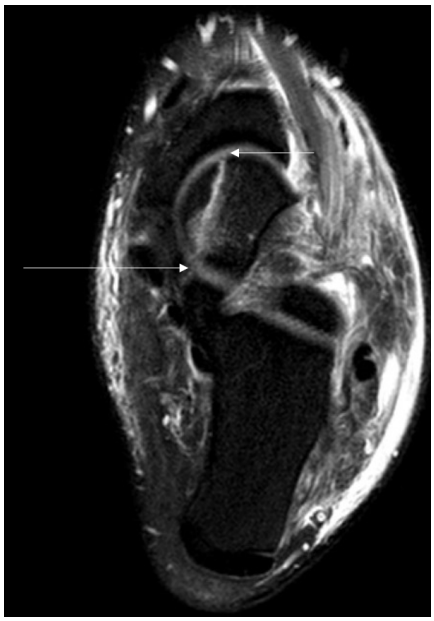


**Figure 3.** MRI (axial section) fat suppression sequence showing an un-displaced fracture of the talar head (patient 2).

the CAM boot, with a walking aid for 6 more weeks. On subsequent reviews, it was decided to gradually progress to full weight bearing. At 3 months follow up, the patient was made to walk without support in the normal shoes, since the check plain radiographs showed the healing of fracture. Later, this patient was sent for the sports rehabilitation for 4 weeks' duration, before allowing him to indulge in the active sports.

## Patient 3

A 30-year-old business representative was presented to the orthopedic emergency after one day (24 hours delayed), following a motor vehicle accident, while riding a two-wheeler. Soon following the accident, he was taken to the local hospital where he received first aid and was put on a below knee plaster of Paris slab. When he was not relieved with the pain in the left ankle and foot, he visited our hospital. The patient was not able to bear the weight and walk in his injured left foot, when he visited our department. On clinical examination, the left ankle and foot were swollen diffusely (**figure 4A**), which was masking the deformity. However, there was a subtle inversion at this foot in comparison to the contralateral foot. The distal neurovascular status of the limb remained intact, which was confirmed by the arterial Doppler. The radiographs of foot and ankle with relevant views and CT scan revealed medial subtalar dislocation, without the associated fractures around the foot and ankle. As an urgent procedure, a single attempt of closed reduction was performed in the emergency department under sedation, which was unsuccessful. Under tourniquet control, the open reduction under spinal anesthesia was carried out. The talus was surgically exposed through a sub-fibular approach extending on to a dorsolateral side. The talus head was observed to be held entrapped by extensor retinaculum and peroneal sheath with its tendons (**figure 4B**). The peroneal tendon sheath and the extensor retinaculum were incised to release the talus. The reduction attempted at this point could not be achieved. Hence the talus was approached from the medial side with a medial malleolar osteotomy. At this time by manipulation on the lateral and medial side, the subtalar joint reduction was achieved. But the reduction achieved was found to be unstable at the subtalar joint, hence the subtalar joint was held in stable reduction with a trans-articular 4 mm Steinmann pin. The wounds were closed in layers. Special care was taken to suture the peroneal sheath and extensor retinaculum. The limb was immobilized in a below-knee plaster slab by incorporating the Steinmann pin. The vascular sufficiency was confirmed after deflating the tourniquet. The suture removal of the surgical wounds was performed at 14$^{th}$ postoperative day and trans-articular pin was removed after 3 weeks postoperatively. Absolute non-weight bearing on the affected limb was continued for 16 weeks in an ankle foot orthosis. However, active range of movement (ROM) was initiated by 12 weeks. At 16 weeks, partial weight bearing was allowed with a waking aid, and at 20 weeks, full weight bearing was allowed with the normal footwear. Patient was advised to perform eccentric Achilles stretching with global ankle strengthening exercises with the physiotherapist's supervision. This patient returned to his day to day activity by 5 months.

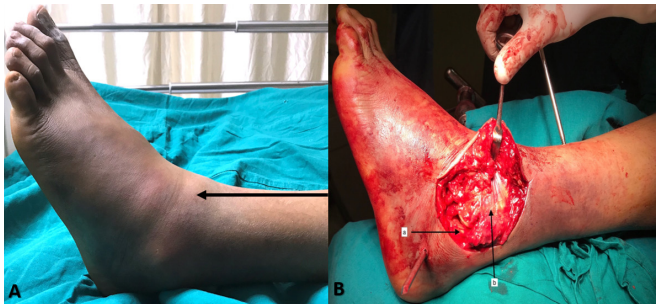



**Figure 4. (A)** Diffuse swelling masking the deformity in delayed presentation (patient 3), **(B)** Showing the entrapment of the talar head by peroneal sheath with tendons (a) and inferior extensor retinaculum (b).

## Patient 4

A 35-year-old professional was presented to the orthopedic emergency, after 6 hours following a two-wheeler motor accident, with chief complaints of intolerable pain in the right ankle and foot with inability to move the ankle and walk. On clinical examination, there was fullness around the ankle and foot, without any obvious deformity. There was no distal neurovascular deficit, and the patient was subjected to routine investigations in the form of plain radiographs with relevant views and a CT scan of the foot and ankle. They showed medial subtalar dislocation, accompanied by the fracture of sustentaculum tali of calcaneum (**figure 5A**) and navicular bone fracture (**figure 5B**). A single attempt of closed reduction was performed under sedation as an urgent basis. However, this was failed, hence an open reduction and internal fixation of fracture dislocation was planned as an emergency procedure. Under tourniquet control, a medial incision was made (**figure 6A**), extending 4 cm both proximally and distally from the medial malleolus, exposing the talus bone. A 2 mm Schanz pin was used as a joystick, to aid the achievement of the reduction. Thus reduced joint was stable at the subtalar joint (**figure 6B**), but it was found to be unstable at the talonavicular joint with dorsal subluxation. Hence, a "bridge plate" (**figure 6C**) was planned across the medial column of the foot to maintain the length of the column in view of the crushed and comminuted fracture of the navicular bone. A 1/3$^{rd}$ tubular plate was used as a bridge plate, extending across the talo-navicular and naviculo-cuneiform joint. Once the talonavicular joint was stable, the fractured sustentaculum tali was approached through the same incision, by developing a plane between the tibialis posterior tendon and neurovascular bundle. The fracture was identified and held reduced temporarily with a 2 mm diameter Kirshner wire (K-wire), with the guidance of image intensifier. Thus reduced fracture was fixed with the two headless cannulated screws of 3 mm size. The wound was closed in layers. The skin suture was removed on 14$^{th}$ post-operative day. The limb was kept immobilized in a below knee plaster slab.

Post operatively, non-weight bearing immobilization in CAM boot was continued till 12 weeks. However, the active range of motion (ROM) exercises were started after 6 weeks following a check radiograph confirming the stability and healing of fractures. By 16 weeks, partial weight bearing was advised within the CAM boot to progress to full weight bearing by 20 weeks. Later, global ankle strengthening exercises were started under supervision (**figure 7**). After confirming the fracture healing at 20 weeks, by radiographs and CT scans, the medial bridge plate was removed. Then the patient was allowed full weight bearing, immediately. The surgical stab wounds of plate removal were healed uneventfully.

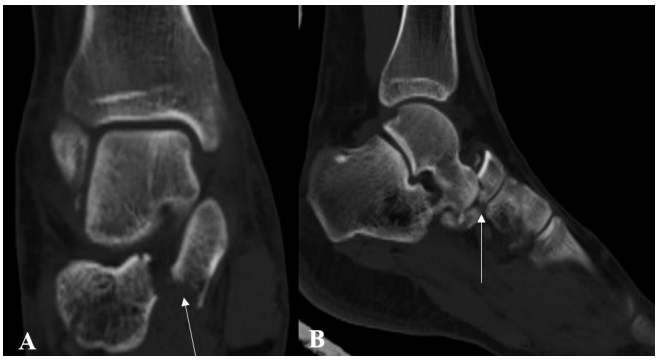



**Figure 5. (A)** Coronal section showing the sustentaculum tali fracture, **(B)** CT scan sagittal section showing subtalar dislocation and navicular fracture with plantar comminution (patient 4).

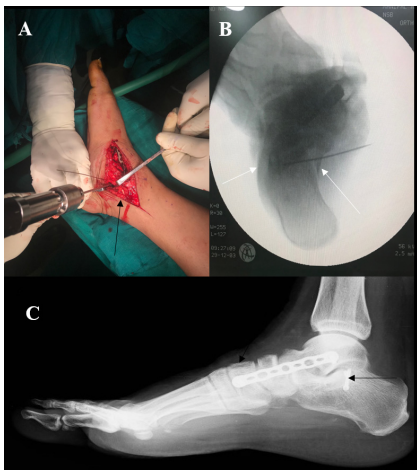



**Figure 6.** Fixation of subtalar dislocation with accompanying sustentaculum tali fracture by using headless screws.

**(A)** Surgical plane developed between the tibialis posterior tendon and neurovascular bundle through a posterior medial approach before inserting the implant, **(B)** Intraoperative imaging confirming the reduction, **(C)** Post-operative lateral view ankle and foot radiograph showing the bridge plate for the medial column, stabilizing the unstable subtalar joint and implant, which stabilized the sustentaculum tali fracture (patient 4).



**Figure 7.** Follow up of patient 4 at 24 months.

**(A)** Active dorsiflexion 0-30 degrees comparable to the contralateral ankle, **(B)** Active plantar flexion 0-20 degrees, 20 degrees less than the contralateral limb.

### Patient 5

An 18-year-old electrician, met with a two wheeler motor vehicle accident and rushed to the orthopedic emergency within an hour with a deformity at the left ankle (**figure 8A**). There were multiple abrasions around the medial and dorso-medial aspect of the ankle with tenting of skin over the talonavicular joint. On examination, neurovascular status was found to be normal. Further investigation with plain radiographs (**figure 8B**) revealed lateral subtalar dislocation. There was lateral malleolar avulsion fracture, which was clearly seen in the post reduction CT scan (**figure 8C**). This was associated with the fracture of the posterior process of talus (**figure 8D**). A single attempt of closed reduction of the subtalar dislocation under sedation was performed and it was failed. Hence open reduction with a medial incision was planned and it was performed under the spinal anesthesia. But the achieved reduction was unstable both at the ankle and subtalar joints. Hence, to maintain the reduction and also in view of offering rest to the soft tissues, an external fixator, spanning the ankle joint was applied intraoperatively. The CT was performed postoperatively to rule out the occult fractures and plan the further management. Later, the patient was mobilized with non-weight bearing at the left lower limb. The surgical wounds were healed by 3 weeks and a check radiographs were taken to confirm the stability once again. The reduction was maintained in the subtalar and ankle with the fracture's fragments in place. Hence it was decided to continue the ankle spanning fixator for 3 more weeks, to achieve total immobilization of 6 weeks. At the 6$^{th}$ week review, CT was done to plan the further management, which showed healing of the fracture of talus and the lateral malleolus, and were observed to be in position. The ankle spanning fixator was removed and the limb immobilization was continued with an ankle foot orthosis. The active ROM at the ankle (**figure 9**) was encouraged at this time and non-weight bearing on the left lower limb was continued for one more month. At the 4 months' review, after confirming the healing of fracture by the plain radiographs, the global strengthening of ankle muscles with eccentric Achilles' stretching exercises were advised. The patient was instructed and trained to walk with partial weight bearing with the support of walking aid and an ankle foot orthosis. Eventually, the patient was made to bear the full weight and walk by 20 weeks.

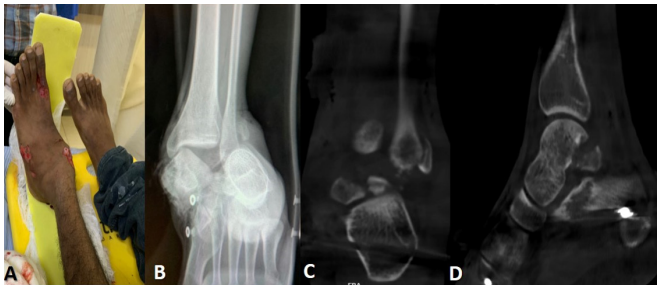



**Figure 8. (A)** Clinical valgus deformity at the left ankle and foot indicating the lateral subtalar dislocation, **(B)** Plain radiograph showing the lateral dislocation of subtalar joint with ankle subluxation, **(C)** Post reduction CT demonstrating the lateral malleolar avulsion fracture, **(D)** Post reduction CT showing the posteromedial comminution of talus fracture (patient 5).




**Figure 9. (A)** Supination at the subtalar joint on affected left side limited by 5 degrees, **(B)** Pronation at left subtalar joint is comparable with the contralateral subtalar joint (patient 5).

## DISCUSSION

The acute subtalar dislocation can occur with both the spectrum of velocity of injury. The "low velocity sporting injury" makes one end of spectrum and a complex "high velocity" motor vehicle accident or fall from height forms the other end. In a review of literature, out of total 359 subtalar dislocations, motor vehicle accidents resulted in 44%, fall from height in 33% and sports injuries accounted for 14% of total cases (15). In our study, two (40%) patients had "low velocity" sporting injury, where the ankle was buckled while playing badminton and basketball games, which were typically correlating with the description of "basketball foot" by Grantham *et al.* (16). In these injuries, the feet were forcefully inverted around the sustentaculum tali, which acts as a fulcrum to the posterior part of the body of talus, resulting in medial subtalar dislocation (17). However, one patient presented with irreducible medial subtalar dislocation, which was associated with the sustentaculum tali and navicular bone fractures. This is not a common combination, however there is a mention in the literature about the rare fracture of sustentaculum tali, accompanying the lateral irreducible subtalar dislocation (18). The lateral subtalar dislocation occurs, when the foot is forcefully driven to eversion, around the anterior calcaneal process, which acts

as a fulcrum to the anterolateral corner of the talus. In the present study, one patient had the lateral subtalar dislocation, which was due to a motor vehicle accident. Clinically, subtalar dislocations can be presented either with a striking deformity, making the diagnosis obvious or in cases of delayed presentations, the deformity may be masked due to the presence of swelling (19). Unbearable pain, with a typical inversion or eversion deformity at the foot is a classical clinical presentation of acute traumatic subtalar dislocation. But circumstances with regards to mechanism of injury, delayed presentation, delay in the diagnosis in a multiple injury patient can mask this typical presentation. In the present study, three patients presented early to us (within an hour) irrespective of high or low energy of injury and the deformity were prominent. This was making it easy for the clinician to suspect the subtalar dislocation. In contrast, patients reaching late to the emergency department following the injury, (6 hours in one patient and 24 hours in another), the deformity was masked with diffuse swelling, and it was giving an appearance of less urgent situation. In a polytrauma situation, or in a busy emergency department, these patients may get down triaged, delaying the reduction of dislocation. This may have its repercussion in the overall prognosis of the condition. Prada-Cañizares *et al*. (19). states that, masking of deformity depends on the elapsed time since injury. Hence there should be high index of suspicion, especially in subtalar dislocations.

Classifying the subtalar dislocation has significance in understanding the mechanism, which helps in reducing the dislocation and also communicating to the fellow surgeons. Subtalar joint dislocation was first classified by Broca (20) in 1,852, based on the direction of the dislocation, which was further modified and expanded by Malgaigne and Buerger (21) in 1,856. Accordingly, the dislocation can be classified into medial, lateral, and posterior. Later, "anterior dislocation" was added. Clinically, the medial dislocation is characterized by the foot in plantar flexion and inversion, which is as a result of foot and calcaneus dislocating medially and the talar head was felt as a prominence dorsolaterally. The lateral dislocation on the contrary, the foot is in pronation and the calcaneus is displaced lateral to the talus. In the present study, four patients had medial dislocation and one patient had lateral. This is in accordance with the literature that, medial dislocation accounts for about 80%-85% (16, 22) of all types of dislocation. We had associated fractures both in low-velocity sporting injuries as well in high-velocity injuries. The CT scan becomes an important investigatory tool to detect these occult fractures, which have a prognostic value. Many studies are in agreement of performing the CT scan, because of identifying the associated injuries which have an incidence range from 38.8% to 88%. (12, 23-24). One patient in our study had an MRI imaging during the first follow up (10 days) due to the persisting pain and swelling around the ankle. This showed an undisplaced talar head fracture in a fat suppression series, even though both the pre and post reduction radiographs did not reveal anything. The pre reduction computed tomography also did not show any fracture during the trauma and post reduction in emergency. Hence, even though MRI has a doubtful role in the acute setting in comparison to the CT, it has a value in the detection of hairline fractures, osteo-chondral fractures, which may go unnoticed in an acute setting. Detection of these pathologies can make a difference in the overall reduction of the morbidity and disability.

Urgent closed reduction in the emergency room setting under sedation is the recommended treatment for the acute traumatic subtalar dislocations. This can prevent the acute complications, which are related to the neurovascular compromise and tenting of the skin due to the prominent talus leading to ischemia and soft tissue complications. There are certain precautions which needs to be kept in mind, while attempting the closed reduction, as they are aimed at preventing the prolonged morbidity. We need to avoid excessive traction, multiple abrupt reduction maneuver, which in turn can cause damage to the articular cartilage, bones, and soft tissues resulting in the long term morbidity (22, 25). In our study, two patients who arrived within 30 minutes of low-velocity sporting injury responded well to the closed reduction under the sedation in a single attempt, which was performed by the gentle maneuver. The other three patients with high-velocity motor vehicle injury had failure of single attempt of closed reduction in emergency, which mandated us to take them up for the open reduction on an emergency basis under the spinal anesthesia. The common reason for the open reduction noted was the talar head entrapment in the soft tissues. In the first two cases, which were medial subtalar dislocation, the talar head was entrapped in the extensor retinaculum and within the extensor tendons, in addition there was involvement of the peroneal tendons as well, leading to the buttonholing of the talar head. The surgeon should be cautious regarding the involvement of deep peroneal neurovascular bundle (19) in such situations. In the patient with lateral dislocation, the talar head was entrapped within the deltoid ligament and anteromedial capsule. The literature mentions that the entrapment of talar head by the posterior tibial tendon or flexor hallucis longus can necessitate the open reduction due to the failure of closed reduction (26).

The surgical incision was placed over the prominent head of talus, on the dorsolateral aspect of foot (27) in two patients with medial subtalar dislocation and on the medial aspect of foot just distal to the medial malleolus at the prominence

of talar head, in lateral subtalar dislocation. After reducing the joint, by releasing the talar head from its entrapment, in medial dislocations, there was presence of instability found at the subtalar joint in one patient and the instability at talonavicular joint in another, which were temporarily stabilized. In the patient with "lateral subtalar dislocation", who went for an open reduction, in contrast to the other two unstable cases of medial dislocation, the ankle as well as the subtalar joints were still unstable. This may be due to the presence of "fracture at the talus" with "posterior comminution" and the presence of an avulsion fracture at the lateral malleolus. Hence it was decided to temporarily stabilize the joints with an ankle spanning external fixator (delta frame), where the joints remained stable and also aimed at resting the soft tissues with "ligamentotaxis". These were confirmed intraoperatively with the image intensifier. It is a well-documented fact in the literature that, presence of instability dictates the type of temporary stabilizer required in the acute traumatic subtalar dislocations following the open reduction and this has better prognosis (19).

In this study, all the patients were men and the mean age at the time of trauma was 24 years (range, 18-35 years). Among the five patients, four patients had medial dislocation and one had lateral dislocation of the sub talar joint. All the patients except one (case 3), diagnosed to have associated fractures around the ankle, tarsal and metatarsal bones. The patient 1 had 5$^{th}$ metatarsal tuberosity avulsion fracture, patient 2 had talar head fracture with the intraarticular extension into the talonavicular joint. The patient 4 had sustentaculum tali fracture along with the fracture of navicular bone, while the patient 5 had fracture of posterior process of talus and lateral malleolar avulsion fracture. In managing these traumatic emergencies, two patients underwent closed reduction under sedation in emergency and three patients had to undergo open reduction in the operating room under appropriate anesthesia. The mean follow-up period, which was the mean period between the date of trauma to the date of last review was two years (range 12 to 24 months). The average ankle hind foot scale score (AOFAS) was 83.3 out of 100 (range 72 to 94) at six months post-reduction. This was improved to 89.8 (range 82 to 97) by the two years' review, in all the patients irrespective of closed or open reduction. In the fifth patient who had the latest follow up, the AOFAS score was 75. Out of five patients, two patients were students, who were actively involved in the university level sports, had stable fracture dislocation and undergone, closed reduction. They had excellent clinical and functional outcomes (AOFAS 95 out of 100). They were managed non-operatively and were able to return to their respective sporting activities. The other three patients were able to perform routine day to day activities and returned to their respective jobs by 20 weeks. There were radiological signs of arthritis (Altman grade 1) at the subtalar joint in two patients. This was observed at 10 months follow up in one patient and 24 months follow up in another, but both were clinically asymptomatic. However, they had swelling and occasional pain, while walking and standing for long

**Table II.** Comparison of the prospective and retrospective studies of subtalar joint dislocation.

| Authors | Milenkovic *et al.* (2) | Lasanianos *et al.* (3) | Bibbo *et al.* (23) | Camarda *et al.* (29) | Our study |
|---|---|---|---|---|---|
| Type of study | Prospective | Prospective | Retrospective | Retrospective | Prospective |
| N of cases | 11 | 8 | 25 | 21 | 5 |
| Mechanism of injury | | | | | |
| Motor vehicle accident | 2 | 5 | 11 | 13 | 3 |
| Fall from height | 9 | 2 | 5 | 8 | nil |
| Inversion | nil | 1 | 9 | nil | 2 |
| Type of injury | | | | | |
| Closed | 11 | 7 | 18 | 14 | 5 |
| Open | nil | 1 | 7 | 7 | nil |
| Time from injury to reduction | | | | | |
| Less than 2 hours | / | 8 | 0 | nil | 2 |
| Between 2 to 6 hours | 11 | nil | | 21 | 2 |
| More than 6 hours | / | nil | | nil | 1 |
| Total AOFAS score | / | 90.75 | 71 | 82.3 | 82.4 |
| Mean follow up | 28 months | 36 months | 61.6 months | 76 months | 24 months |

hours. In our study, no cases developed avascular necrosis of talus and none of them had recurrence of dislocation. The average AOFAS ankle hind foot scale score was 83.3 out of 100 (range 72 to 94) at six months' post-reduction, which was improved to 92.5 and 95.5 in open reduction and closed reduction group of patients respectively. By the end of 24 months follow up, the score was 89.8 (range 82 to 97) in all the four patients irrespective of closed or open reduction. In the fifth patient who had lateral subtalar dislocation and undergone open reduction, the ankle and subtalar joints were still unstable. This patient had the latest 24 months follow up and the AOFAS score was 75 (out of 100). All the above findings were comparable (**table II**) to the prospective and retrospective studies of previous authors (9, 10, 23, 24, 28, 29). Hoexum and Heetveld (15) opined that the lateral subtalar dislocation carries a poor prognosis in comparison to the medial dislocation.

## CONCLUSIONS

The acute traumatic subtalar joint dislocation can present with wide variety of mechanisms of injury, clinical presentation, presence of associated fracture with dislocations around the foot and ankle and post reduction instability. We believe that this study will enlighten about the various atypical presentations of subtalar dislocation and its accompanying occult and definitive fractures. Closed subtalar joint dislocation, managed with early closed reduction showed better prognosis in comparison to patients, who presented late and underwent open reduction. Hence, a custom-made approach and management on case to case basis, is mandatory for the successful outcome with lesser morbidity. However, the overall functional outcome depends on the other associated fractures of the bones of the foot and its complexity. The limitations of our study include the small number of patients and a shorter follow-up time of two years. A prospective study with a longer follow up and higher sample size is necessary to arrive at a definitive conclusion.

## FUNDINGS

None.

## DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

## CONTRIBUTIONS

PRK: Study conception and design. PRK, TDB: data collection. PRK, YLR, BVM: results analysis and interpretation. PRK, KVA, YLR, BVM, SM: draft, critical revision. PRK, KVA, SM: Other (study supervision, materials, *etc...*). All authors reviewed the results and approved the final version of the manuscript.

## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

## REFERENCES

1. Arain AR, Adams CT, Haddad SF, et al. Diagnosis and treatment of peritalar injuries in the acute trauma setting: a review of the literature. Adv Orthop. 2020;2020:1852025. doi: 10.1155/2020/1852025.
2. Lugani G, Rigoni M, Puddu L. et al. Subtalar dislocation: a narrative review. Musculoskelet Surg. 2022;106(4):337-44. doi: 10.1007/s12306-022-00746-x.
3. Sharma S, Patel S, Dhillon MS. Subtalar Dislocations. J Am Acad Orthop Surg Glob Res Rev. 2021;5(12):e21.00295. doi: 10.5435/JAAOSGlobal-D-21-00295.
4. Sangeorzan A, Sangeorzan B. Subtalar joint biomechanics: from normal to pathologic. Foot Ankle Clin. 2018;23(3):341-52. doi: 10.1016/j.fcl.2018.04.002.
5. Kou JX, Fortin PT. Commonly missed peritalar injuries. J Am Acad Orthop Surg. 2009;17(12):775-86. doi: 10.5435/00124635-200912000-00006.
6. Naranja Jr RJ, Monaghan BA, Okereke E, Williams Jr GR. Open medial subtalar dislocation associated with fracture of the posterior process of the talus. J Orthop Trauma. 1996;10(2):142-4. doi: 10.1097/00005131-199602000-00014.
7. Lianou I, Tatarakis D, Ntourantonis D. Lateral subtalar dislocation associated with cuboid fracture. Prompt diagnosis and initial management of this rare orthopaedic manifestation at the emergency department. J Orthop Case Rep. 2021;11(12):65-8. doi: 10.13107/jocr.2021.v11.i12.2570.
8. Wang HY, Wang BB, Huang M, Wu XT. Treatment of closed subtalar joint dislocation: A case report and literature review. Chin J Traumatol. 2020;23(6):367-71. doi: 10.1016/j.cjtee.2020.08.008.
9. Milenkovic S, Mitkovic M, Bumbasirevic M. External fixation of open subtalar dislocation. Injury. 2006;37(9):909-13. doi: 10.1016/j.injury.2006.02.051.
10. Lasanianos NG, Lyras DN, Mouzopoulos G, Tsutseos N, Garnavos C. Early mobilization after uncomplicated medial subtalar dislocation provides successful functional results. J Orthop Traumatol. 2011;12(1):37-43. doi: 10.1007/s10195-011-0126-2.

11. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191-4. doi: 10.1001/jama.2013.281053.
12. Garofalo R, Moretti B, Ortolano V, et al. Peritalar dislocations: a retrospective study of 18 cases. J Foot Ankle Surg. 2004;43(3):166-72. doi: 10.1053/j.jfas.2004.03.008.
13. Straus DC. Subtalar dislocation of the foot. Am J Surg. 1935;30(3):427-34. doi: 10.1016/S0002-9610(35)91206-5.
14. Bohay DR, Manoli A. Subtalar dislocations. Foot Ankle Int. 1995;16(12):803-8. doi: 10.1177/107110079501601212.
15. Hoexum F, Heetveld MJ. Subtalar dislocation: two cases requiring surgery and a literature review of the last 25 years. Arch Orthop Trauma Surg. 2014;134(9):1237-49. doi: 10.1007/s00402-014-2040-6.
16. Grantham SA. Medial subtalar dislocation: five cases with a common etiology. J Trauma. 1964;4:845-849. Available at: https://pubmed.ncbi.nlm.nih.gov/14225332/.
17. Heck BE, Ebraheim NA, Jackson WT. Anatomical considerations of irreducible medial subtalar dislocation. Foot Ankle Int. 1996;17(2):103-6. doi: 10.1177/107110079601700208.
18. Zaraa M, Jerbi I, Mahjoub S, Sehli H, Mbarek M. Irreducible Subtalar Dislocation Caused by Sustentaculum Tali Incarceration. J Orthop Case Rep. 2017;7(1):58-60. doi: 10.13107/jocr.2250-0685.688.
19. Prada-Cañizares A, Auñón-Martín I, Vilá Y Rico J, Pretell-Mazzini J. Subtalar dislocation: management and prognosis for an uncommon orthopaedic condition. Int Orthop. 2016;40(5):999-1007. doi: 10.1007/s00264-015-2910-8.
20. Broca P. Mémoire sur les luxations sous-astragaliennes. Mem Soc Chir. 1853;3:566-656. Available at: https://cir.nii.ac.jp/crid/1571135650068683776.
21. Malgaigne JF, Buerger CG. Die Knochenbrüche und Verrekungen. Stuttgart; Rieger 1856;820.
22. Saltzman C, Marsh JL. Hindfoot dislocations: when are they not benign? J Am Acad Orthop Surg. 1997;5(4):192-8. doi: 10.5435/00124635-199707000-00002.
23. Bibbo C, Anderson RB, Davis WH. Injury characteristics and the clinical outcome of subtalar dislocations: a clinical and radiographic analysis of 25 cases. Foot Ankle Int. 2003;24(2):158-63. doi: 10.1177/107110070302400210.
24. Jungbluth P, Wild M, Hakimi M, et al. Isolated subtalar dislocation. J Bone Joint Surg Am. 2010;92(4):890-4. doi: 10.2106/JBJS.I.00490.
25. Horning J, DiPreta J. Subtalar dislocation. Orthopedics. 2009;32(12):904. doi: 10.3928/01477447-20091020-17.
26. Conesa X, Barro V, Barastegui D, Batalla L, Tomás J, Molero V. Lateral subtalar dislocation associated with bimalleolar fracture: case report and literature review. J Foot Ankle Surg. 2011;50(5):612-5. doi: 10.1053/j.jfas.2011.04.034.
27. Pehlivan O, Akmaz I, Solakoglu C, Rodop O. Medial peritalar dislocation. Arch Orthop Trauma Surg. 2002;122(9-10):541-3. doi: 10.1007/s00402-002-0448-x.
28. de Palma L, Santucci A, Marinelli M, Borgogno E, Catalani A. Clinical outcome of closed isolated subtalar dislocations. Arch Orthop Trauma Surg. 2008;128(6):593-8. doi: 10.1007/s00402-007-0459-8.
29. Camarda L, Abruzzese A, La Gattuta A, Lentini R, D'Arienzo M. Results of closed subtalar dislocations. Musculoskelet Surg. 2016;100(1):63-9. doi: 10.1007/s12306-015-0380-1.