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# Subtalar dislocation of the foot

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*SUMMARY.* Twenty patients with a subtalar dislocation of the foot are reported in this series. Thirteen cases had medial subtalar dislocation, 4 lateral, 2 posterior and 1 anterior. Open dislocation occurred in 2 cases. Manual reduction was successful in 16 cases and surgical reduction was necessary in 4. A short leg cast was applied for 3–6 weeks. There were no cases of aseptic necrosis of the talus. Excellent results, in terms of Hawkins' criteria (J Bone Joint Surg 1970; 52A: 991–1002), were achieved in 15 cases and good results in 5. Medial subtalar dislocation can be classified into two types: swing and shift. Most swing type cases showed features making their fractures irreducible, such as interposition of a tendon or retinaculum.

## INTRODUCTION

Subtalar dislocation is a simultaneous dislocation of both the talonavicular and the talocalcaneal joints without a major fracture of the talus. The first two cases of subtalar dislocation were reported by Judey[2] and Defourest[3] in 1811. In Japan, Nakano[4] reported the first case in 1947. This dislocation is so rare that only a few series include more than 10 cases. Leitner[5] reported the largest series, 42 cases in 1954. Therefore, it is important to recognize problems in diagnosis, treatment and prognosis, based on the data from numerous case reports.

## MATERIALS AND METHODS

From 1985 to 1993, 20 cases of subtalar dislocation were treated at Keio University Hospital and its affiliates (Table 1). The sex distribution was 16 males to 4 females. The mean patient age at the time of injury was 39 years (range 18–65 years). The affected side was the right in 7 cases and the left in 13. The cause of injury was a traffic accident in 9 cases, sports in 4, a fall from a height in 6 and other in 1. Classifying the dislocation according to the displacement of the distal part, 13 cases were classified as having a medial dislocation, 4 lateral, 1 anterior and 2 posterior. Open dislocation occurred in 2 cases. Avulsion fracture of the talus was a complication in 5 cases, avulsion fracture of the calcaneus in 3 cases, avulsion fracture of the cuboid in 1 and malleolar avulsion fracture in 4. Closed reduction under general or spinal anaesthesia was performed in all 20 cases and was successful in 16. The remaining 4 cases were manually irreducible because the talar head was buttonholed by the tendons of extensor digitorum communis, flexor hallucis longus or the extensor retinaculum. These cases underwent immediate open reduction. All 4 irreducible cases had medial dislocations and the calcaneus remained under the talus in 3 of the 4 cases. We immobilized the patients in short leg casts for 3–6 weeks. The mean follow-up period was 6.3 years (range 2–10 years).

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## RESULTS

None of the cases had any difficulty in activities of daily living and all were able to return to their original jobs. Range of motion, in both eversion and inversion, was severely limited in 5 cases. There were no cases of aseptic necrosis of the talus. Significant changes, including osteoarthrosis deformans of the subtalar joint were revealed in 2 cases. Excellent results, in terms of Hawkins'[1] criteria were achieved in 15 cases and good results in 5. None of the cases showed either fair or poor results.

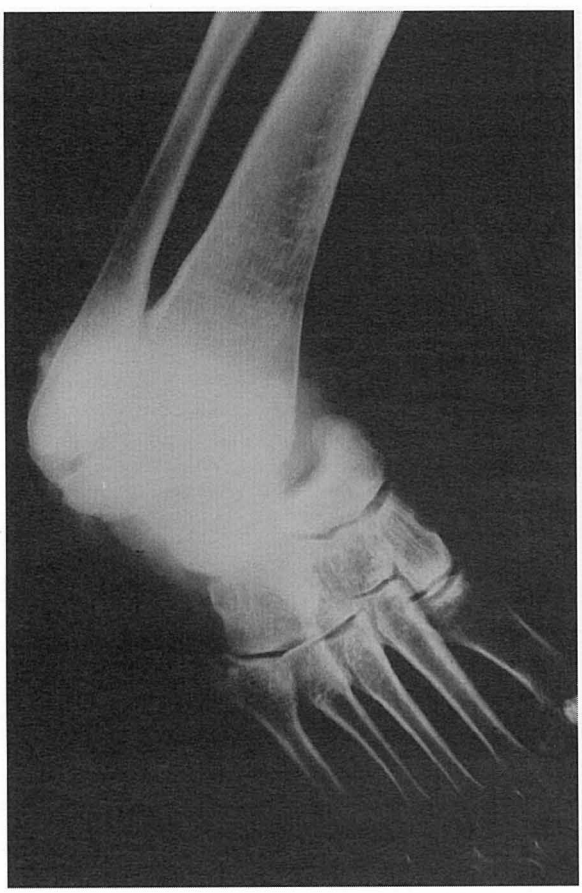
## CASE REPORTS

### Case 1

A 50-year-old female (No. 2 in Table 1) injured her right ankle in a fall from a bicycle. Radiography

**Table 1**—Twenty subtalar dislocation cases

| No. | Age (years) | Sex | Side | Cause | Type | Wound | Complication | Reduction |
|---|---|---|---|---|---|---|---|---|
| 1 | 35 | Female | Left | Falling from bicycle | Medial | Closed | – | Manual |
| 2 | 50 | Female | Right | Falling from bicycle | Medial | Closed | – | Manual |
| 3 | 27 | Male | Right | Falling from height | Medial | Closed | Avulsion of talar body | Operative |
| 4 | 18 | Male | Left | Traffic accident | Medial | Closed | – | Manual |
| 5 | 62 | Male | Left | Traffic accident | Medial | Closed | Avulsion of cuboid | Manual |
| 6 | 58 | Male | Left | Traffic accident | Medial | Closed | Fracture of tibia and fibula | Operative |
| 7 | 31 | Male | Right | Sports injury (sliding in baseball) | Medial | Closed | Avulsion of talar head | Operative |
| 8 | 22 | Male | Left | Falling from height | Medial | Closed | Avulsion of calcaneus | Operative |
| 9 | 18 | Male | Left | Traffic accident | Lateral | Closed | Avulsion of calcaneus | Manual |
| 10 | 33 | Male | Left | Sports injury (sliding in baseball) | Lateral | Closed | Avulsion of calcaneus | Manual |
| 11 | 24 | Male | Right | Traffic accident | Anterior | Closed | Avulsion of talar head | Manual |
| 12 | 48 | Male | Left | Traffic accident | Posterior | Open | – | Manual |
| 13 | 64 | Male | Left | Falling | Medial | Open | Avulsion of lateral malleolus | Manual |
| 14 | 41 | Male | Left | Falling | Medial | Closed | Avulsion of talar neck | Manual |
| 15 | 65 | Male | Right | Falling | Medial | Closed | – | Manual |
| 16 | 22 | Female | Left | Sports injury (volleyball) | Medial | Closed | – | Manual |
| 17 | 48 | Male | Left | Falling | Lateral | Closed | Avulsion of lateral malleolus | Manual |
| 18 | 34 | Male | Right | Sports injury (football) | Lateral | Closed | Avulsion of lateral malleolus | Manual |
| 19 | 22 | Male | Left | Traffic accident | Medial | Closed | – | Manual |
| 20 | 60 | Female | Right | Falling | Posterior | Closed | Avulsion of medial malleolus and talus | Manual |



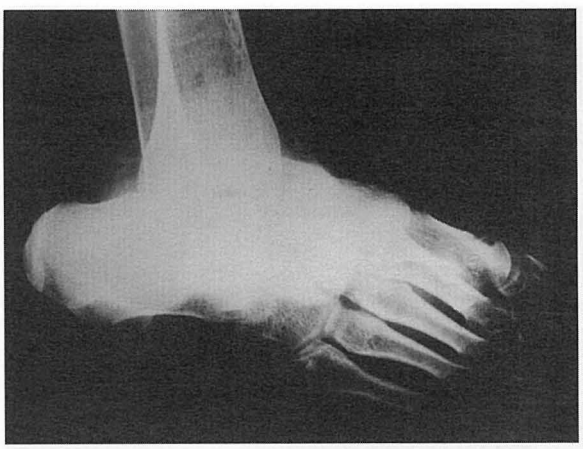


**Fig. 1**—50-year-old female (No. 2 in Table 1). Shift type of medial subtalar dislocation. Both the talonavicular and the talocalcaneal joints are dislocated. The calcaneus is displaced to the medial side of the talus.

revealed both the talonavicular and the talocalcaneal joints to be completely dislocated. The calcaneus was displaced to the medial side of the talus. The axis of the calcaneus met the axis of the leg at a right angle. Applying traction and abduction on her foot under spinal anaesthesia, a closed reduction was achieved. A short leg cast was applied for 4 weeks. Active exercise was started immediately after removing the cast. Full weightbearing was prohibited for an additional

4 weeks. Aseptic necrosis did not occur. She had no pain while walking 4 years after the injury, the clinical result being excellent. There were no significant changes in the subtalar joint, such as osteoarthrosis deformans, on radiography.

### Case 2

A 22-year-old male (No. 8 in Table 1) injured his left ankle in fall from a height of 3 m. Radiography revealed both the talocalcaneal and the talonavicular joints to be dislocated. The calcaneus was medially rotated but remained under the talus. Closed reduction under spinal anaesthesia failed, necessitating immediate open reduction. Failure of manual repositioning was caused by interposition of the posterior tibial tendon. A short leg cast was applied for 4 weeks and weightbearing was prohibited for an additional 4 weeks. He had no pain while walking and showed excellent results 4 years after the injury.

### Case 3

A 33-year-old male (No. 10 in Table 1) injured his left ankle in a sliding injury incurred while playing baseball. Both the talonavicular and the talocalcaneal joints were dislocated and the foot was displaced to the lateral side of the talus without rotation in the anteroposterior view of the ankle. The lateral side of the talar head was in contact with the navicular tuberosity in the anteroposterior view of the foot. Closed reduction under spinal anaesthesia was achieved. A short leg cast was applied for 6 weeks. He had no pain while walking and was able to return to his original job. However, his result was good rather than excellent 7 years after the injury, because the range of motion in the subtalar joint was limited and osteoarthrosis deformans was present, as revealed by radiography.

### Case 4

A 24-year-old male (No. 11 in Table 1) injured his right ankle in a fall from a motorcycle. Both the talonavicular and the talocalcaneal joints were dislocated and the foot displaced forward. Lateral displacement of the foot was not seen on the radiographic anteroposterior view of the ankle joint. Complicated avulsion fractures affecting the neck of the talus and the cuboid were revealed in a lateral view of the foot. Closed reduction was achieved. A short leg cast was applied for 6 weeks. After removing the cast, active exercise was initiated, but weightbearing was prohibited for an

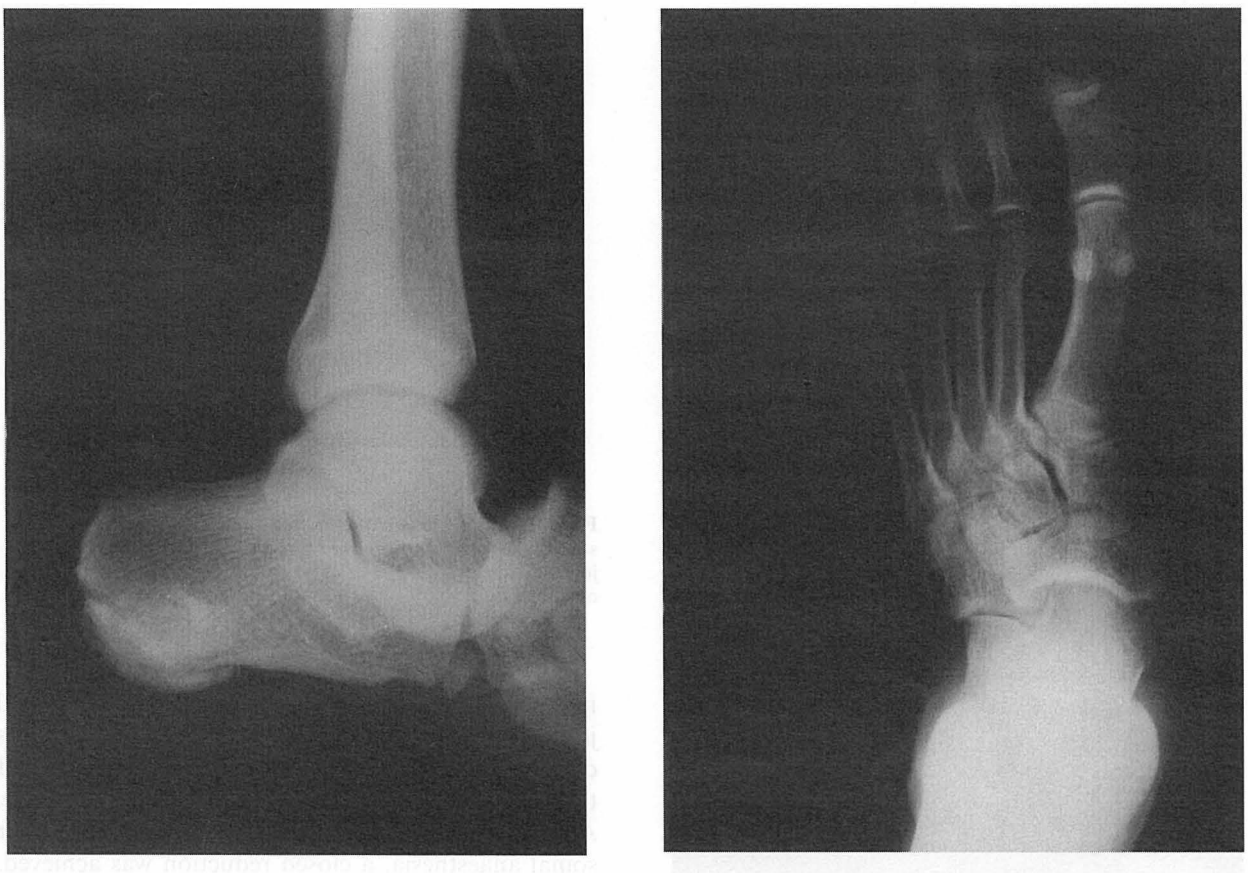
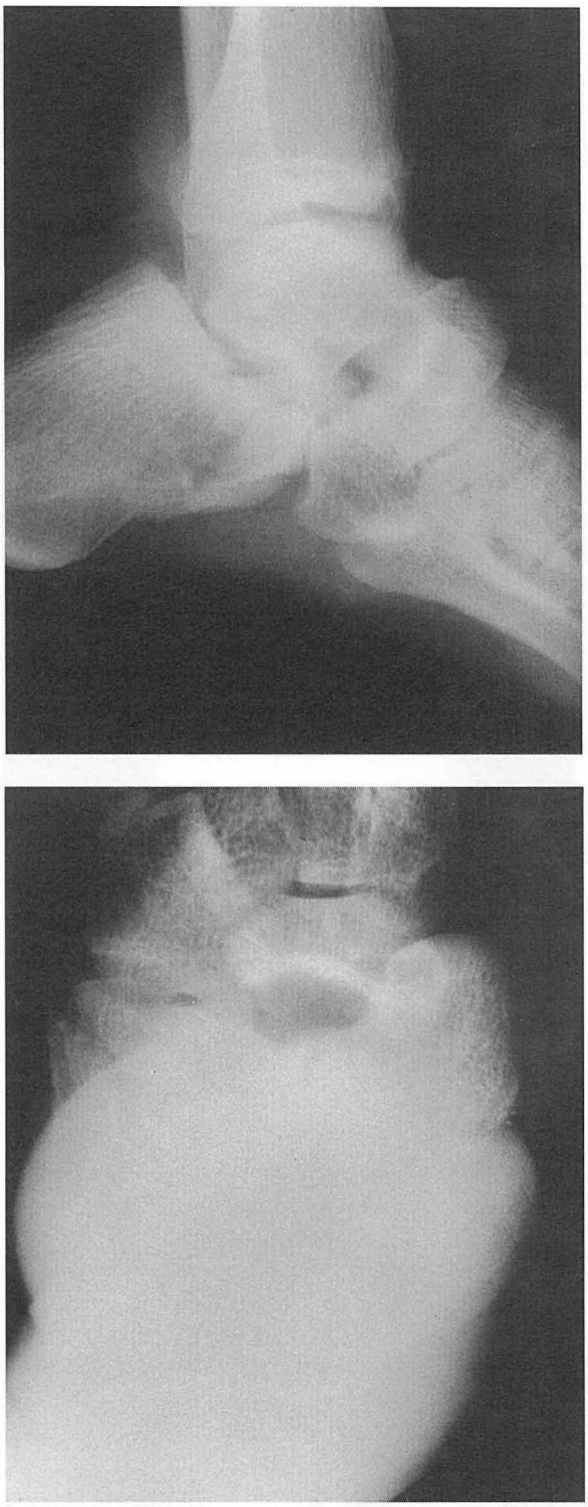


**Fig. 2**—22-year-old male (No. 8 in Table 1). Swing type of medial subtalar dislocation. Both the talonavicular and the talocalcaneal joints are dislocated. The calcaneus is medially rotated but remains under the talus.



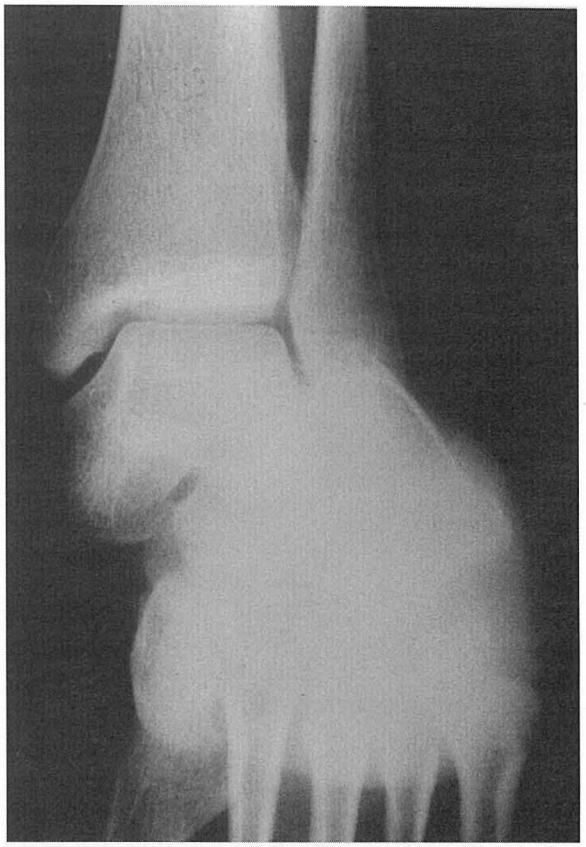


**Fig. 3**—33-year-old male (No. 10 in Table 1). Lateral subtalar dislocation. Both the talonavicular and the talocalcaneal joints are dislocated. The calcaneus displaced to the lateral side of the talar head.

additional 6 weeks. He had no pain while walking and the result was evaluated as excellent 4 years after the injury.

### Case 5

A 48-year-old male lorry driver (No. 12 in Table 1) injured his left ankle in a vehicular collision. Radiography revealed both the talonavicular and the talocalcaneal joints to be dislocated and the foot displaced backward. The head of the talus was located on the navicular bone. No significant lateral displacement of the foot was seen on the radiographic anteroposterior view of the ankle joint. Closed reduction was achieved under spinal anaesthesia. Active exercise was started after immobilization with a short leg cast for 3 weeks. However, full weightbearing was prohibited for an additional 6 weeks. The patient returned to his original job and the result was evaluated as excellent 3 years after the injury.

## DISCUSSION

### Name and definition

Subtalar dislocation can be defined as simultaneous dislocation of both the talonavicular and the talocalcaneal joints without a major fracture of the talus. Total dislocation of the talus which includes talocrural dislocation in addition to those of both the talonavicular and the talocalcaneal joints was excluded. Talar neck fractures of Hawkins'[1] type 2, 3 or 4 were also excluded. Some authors[6–9] have used the term 'peritalar dislocation' to distinguish subtalar dislocation from dislocation of the posterior subtalar

**Fig. 4**—24-year-old male (No. 11 in Table 1). Anterior subtalar dislocation. Both the talonavicular and the talocalcaneal joints are dislocated. The middle of the foot is displaced forward. Lateral displacement of the foot was not seen on the radiographic anteroposterior view.

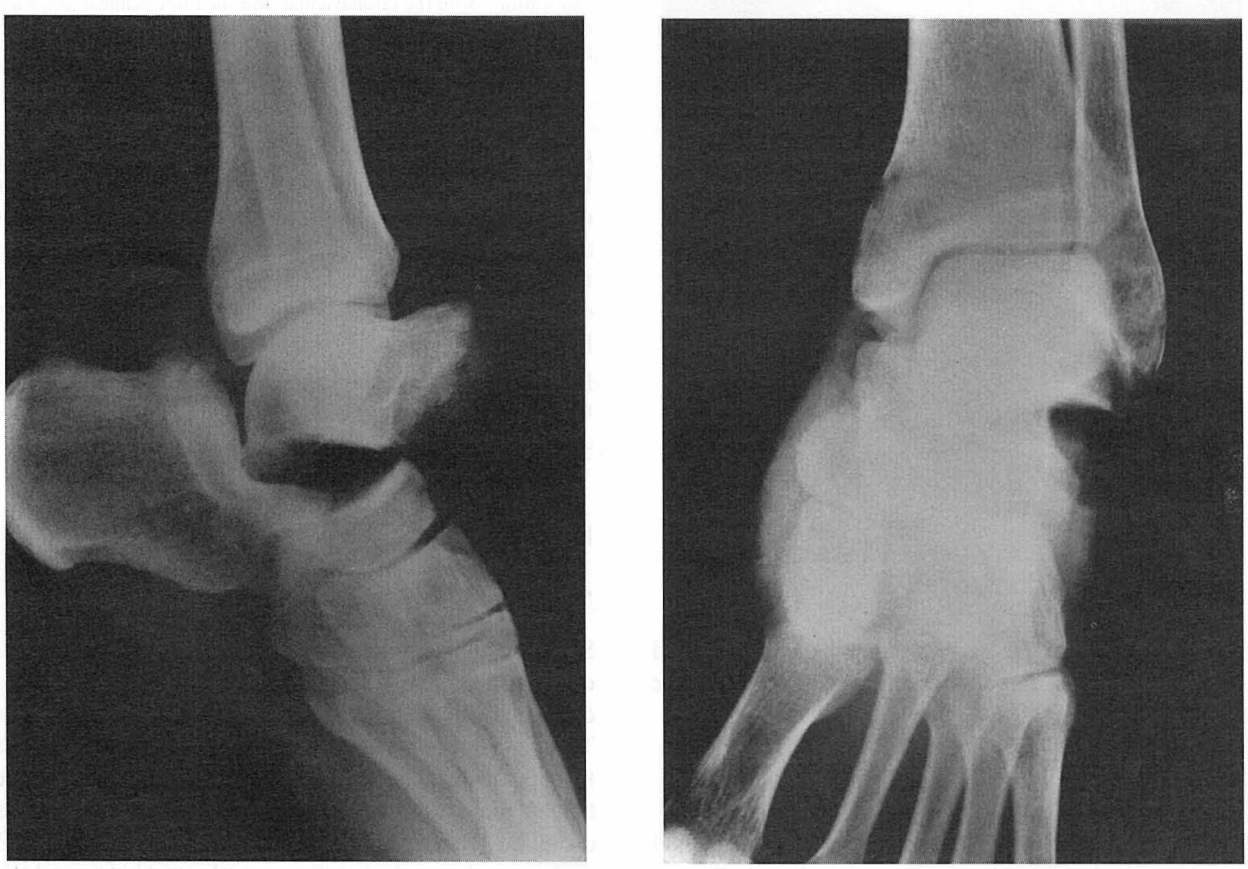


**Fig. 5**—48-year-old male (No. 12 in Table 1). Posterior subtalar dislocation. Both the talonavicular and the talocalcaneal joints are dislocated. The middle of the foot is displaced backward. The head of the talus appears to be stranded on the navicular bone. Lateral displacement of the foot was not seen on the radiographic anteroposterior view.

joint in neck fracture of Hawkins'[1] type 2, 3 or 4. However, peritalar dislocation should be included in talocrural dislocation as well as talonavicular and talocalcaneal dislocation, because 'peri' means 'around' in Greek. The dislocation of the calcaneus in which both the talocalcaneal and the calcaneocuboid joints are dislocated without major calcaneus fracture is similar to subtalar dislocation. However, the relationship between the talus and the middle of the foot remains intact in calcaneus dislocation, while there is displacement in subtalar dislocation. Calcaneus dislocation is even rarer than subtalar dislocation.

### Classification and frequency

Subtalar dislocation occurs only rarely. Shands,[10] in 1928, attributed the first report of subtalar dislocation to Judey[2] and Defourest[3] in 1811. Smith,[11] in 1937, mentioned that only 155 cases had been reported in the 125 years since the first report. Leitner,[5] in 1954, reported 42 cases of subtalar dislocation in his institution from 1925 to 1950, and estimated that this injury accounted for only 1% of all traumatic dislocations (4125 cases). Grantham,[12] in 1964, reviewed 225 cases of subtalar dislocation in the literature incorporating Smith's[11] report as a baseline. Nakano,[4] in 1947, reported the first case of subtalar dislocation in Japan. Including our series, a total of 59 cases of subtalar dislocation have been reported in the Japanese literature since 1947.

Broca,[13] in 1852, classified subtalar dislocations into four types according to the displacement of the distal part as follows: lateral (outward), medial (inward), anterior (forward) and posterior (backward). In 1937, Smith[11] reported that 87 cases (56%) among a total of 155 cases were medial, 52 (34%) lateral, 6 (4%) anterior and 10 (6%) posterior. Leitner,[5] in 1954, reported that medial dislocation occurred in 36 cases (86%), lateral in 5 (12%), posterior in 1 (2%) and anterior in none. Grantham,[12] in 1964, reported medial dislocation in 145 cases (64%) among 225 subtalar dislocations, lateral in 61 (27%), anterior in 6 (3%) and posterior in 13 (6%). Freund,[14] in 1989, reviewed the literature on subtalar dislocation and stated that medial subtalar dislocation was the most frequent type, accounting for 60–80% of all subtalar dislocations, followed by lateral dislocation at an incidence of 20–40%, with the anterior and posterior dislocations being seen only in very small percentages. As for open dislocation, Goldner[15] in 1995 reported that 5 (33%) of 15 open subtalar dislocations were medial and 10 (66%) were lateral. In 1993, Hashimoto[16] reviewed 33 cases in the Japanese literature and reported that 16 (48%) had medial subtalar dislocation, 14 (42%) lateral and 3 (9%) anterior. In our series, 13 cases (65%) showed medial dislocation, 4 (20%) lateral, 2 (10%) posterior and 1 (5%) anterior. Medial dislocation is also the predominant type in Japan.

Anterior subtalar dislocation is very rare. Case 4 (no. 11 in Table 1) is the fourth case of anterior subtalar dislocation reported in the Japanese literature. The first case in Japan was reported by Nakano[4] in 1947 as an old anterior dislocation without radiographic confirmation. The other 2 cases were reported with only lateral radiographic views of the foot. Leitner[5] described not having observed any anterior dislocations in his 1955 series. Bonnin,[17] in 1950, stated that all anterior dislocations were doubtful because all were reported in the 'pre-radiological era'. Ofner & Poigenfrust[18] reported a case in 1990 from the same institution as Leitner,[5] described as a 'dorsal subtalar dislocation of the foot'. This case is apparently the equivalent of anterior subtalar dislocation in Broca's[13] classification, because the middle of the foot was displaced forward in relation to the talus.

Posterior subtalar dislocation is also very rare. In 1954, Leitner[5] reported a case of posterior dislocation and in 1957, Larson[19] reported 2 cases of posterior dislocation. We experienced 2 cases of posterior dislocation including our case 5. Essentially, lateral dislocation includes some anterior displacement of the calcaneus and navicular bone while medial dislocation includes an element of posterior displacement because of the skeletal structure of the subtalar joint. Therefore, anterior and posterior subtalar dislocation should not be diagnosed if any lateral displacement of the foot was revealed on the radiographic anteroposterior view of the ankle joint.

### Mechanism of injury

It was reported that subtalar dislocation is the result of violent inversion in medial type and eversion in lateral type, with the sustentaculum tali acting as a fulcrum during the application of this sudden excessive force. Ogiuchi[20] in 1974 reported that release of both the interosseous and calcaneofibular ligaments and the capsule of the talonavicular joint was necessary to experimentally create medial subtalar dislocation in amputated limbs. They reported also that releasing both the interosseous and deltoid ligaments and the capsule of the talonavicular joint was necessary to produce lateral dislocation of the subtalar joint. Medial subtalar dislocation occurs more frequently than the lateral form because the lateral talocalcaneal and calcaneofibular ligaments are weaker than deltoid and medial talocalcaneal ligaments. We were also unable to produce subtalar dislocation of any type without releasing the interosseous ligament in our experiments with amputated limbs. Therefore, rupture of the interosseous ligament may be the key to achieving experimental subtalar dislocation. It is necessary to release both the calcaneofibular and the deltoid ligament, as well as the interosseous ligament, in order to experimentally induce either anterior or posterior subtalar dislocation. Furthermore, anterior and posterior subtalar dislocations are very unstable and lateral displacement of the calcaneus occurs readily. This is another reason for the rarity of anterior and posterior subtalar dislocations.

**Swing type and shift type medial subtalar dislocations**

We can divide medial subtalar dislocations into two types: swing and shift. The calcaneus rotates medially but remains under the talus in swing type, while the calcaneus is directly shifted medially beside the talus in shift type. Four cases among 13 medial subtalar dislocations showed the swing type, 9 the shift type. Among medial subtalar dislocations in our series, 3 (75%) of 4 swing type cases were irreducible manually, while only one of the shift type cases could not be reduced manually.

Calcaneus rotation under the talus is limited by the interosseous ligament which is extensively stretched in the talar sinus. In forcing inversion on the ankle, an internal rotation force as well as an adduction force act on the subtalar joint. The interosseous ligament is twisted and torn, while the calcaneus is forced to rotate internally around the middle portion of the interosseous ligament. Initially, the inversion force causes partial rupture of the interosseous ligament from both the medial and the lateral edge. The narrower the interosseous ligament becomes, the more easily the calcaneus rotates. If the lateral talocalcaneal and the talonavicular ligaments are ruptured while the interosseous ligament remains partially intact, such that the calcaneus does not directly shift medially beside the talus, the calcaneus swings around the remaining interosseous ligament and the swing type subtalar dislocation occurs. With continued application of violent force, the interosseous ligament finally ruptures completely and the shift type subtalar dislocation occurs. Swing type subtalar dislocations without irreducible features, such as interposition of the tendon, may undergo spontaneous reduction. Many swing type subtalar dislocations reducing spontaneously, without manual intervention, are probably inappropriately managed as severe sprains and may cause prolonged pain in the subtalar joint as in the sinus tarsi syndrome. Furthermore, any irreducible features encountered in the swing type subtalar dislocation, in clinical practice, should be examined radiographically.

The swing type of lateral subtalar dislocation was not recognized in any of our patients. Interosseous ligament and medial components are of similar strength, and they rupture at the same time. This accounts for the swing type being rare in lateral subtalar dislocation. However, Bonnin[17] in 1950 referred to Malgaigne's[21] two varieties of lateral subtalar dislocation. In the first type, 'the posterior subtaloid joint is intact and the rest of the tarsus swings laterally around this, thus externally rotating the foot'. In the second type, 'the whole tarsus is shifted directly laterally under the talus'. If there is an irreducible feature, such as interposition of the posterior tibial tendon, the first type should exist in the same configuration as the swing type medial subtalar dislocation.

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