

TALOCALCANEAL NAVICULAR DISLOCATIONS: A REVIEW

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INTRODUCTION

Subtalar joint dislocations were first described in 1811 by Judey and Dufaurets and have also be referred to as peritalar or subastragalar (1, 2). A more accurate term for subtalar joint dislocations would be talocalcaneal navicular (TCN) dislocations because not only is the normal architecture of the subtalar joint affected, but the talonavicular joint is also disrupted. Subtalar joint dislocations are a relatively rare injury accounting for no more than 1% of traumatic dislocations or only 15% of all talar injuries (3, 4). The largest case series thus far included 25 patients by Bibbo et al in 2003, 23 patients by Jungbluth et al in 2010, and 17 patients by DeLee et al in 1982, with all others including small numbers of patients and case reports.

Broca developed a rudimentary classification in 1852 that sub-classified TCN dislocations into 3 directions: medial, lateral, and posterior based on the relationship of the foot to the talus. Malgaigne added a fourth dislocation, anterior, in 1855 (5). The most common of the TCN dislocations is medial displacement, followed by lateral, then anterior, and the least common is posterior displacement. Combined deformities have also been reported including anteromedial and anterolateral TCN dislocations, but these are very rare isolated incidents (6, 7). Concomitant injuries such as calcaneal fractures, fibular fractures, and midfoot fractures have been described but usually these are more common with open TCN dislocations (2, 8).

ANATOMY

Dislocation of the TCN joints of the foot in any plane and through any mechanism of injury involves a number of anatomical structures surrounding the joint. These various soft tissue structures and even bony facets play a vital role in determining proper anatomical reduction as well as landmarks for the possible need for surgical intervention. The subtalar joint itself consists of 3 facets, the anterior,

middle, and posterior originating from both the inferior talus and the superior calcaneus.

There are several muscular tendons that can have a significant effect on the mechanism of injury for a subtalar joint dislocation. Beginning with the posterior musculature, the flexor digitorum longus, flexor hallucis longus, and the posterior tibial tendons cross the subtalar joint posterior-medially. On the anterior aspect of the ankle/foot, there is the extensor digitorum longus tendon and from the medial anterior side, the tibialis anterior tendon. At the lateral aspect of the ankle found posteriorly to the lateral malleolus are the tendons of the peroneus longus and brevis muscles.

There are a number of ligaments that play a vital role in the stabilization of the subtalar joint. Several of these include: the deep deltoid ligaments, the calcaneofibular ligament laterally, the ligamentum cervicis, the interosseous talocalcaneal ligament, and the talonavicular ligament. It is also to be noted that the subtalar joint is reinforced itself with the joint capsule (9-14).

CLASSIFICATION

It is well known that Dufaurest and Judy are documented as the first to initially describe TCN joint dislocations in 1811. A classification system was not really developed until 1852 by Broca, which focused on the direction of the dislocation. He described them as medial, lateral, and posterior, starting with most frequent to least occurring (15). Malgaigne added the anterior direction to the classification system in 1856. While this is the rarest of the 4, there is still much debate as to whether both anterior and posterior dislocations are just secondary manifestations of the medial and lateral dislocations (Table 1).

MEDIAL TCN JOINT DISLOCATION

Medial TCN joint dislocation has been documented as having the highest frequency of occurrence among all four

Table 1

**BROCA AND MALGAIGNE'S
CLASSIFICATION OF TALOCAL-
CANEAL NAVICULAR JOINT
DISLOCATION WITH
FREQUENCY (16)**

Direction of Dislocation	Frequency of Dislocation
Medial	65-80%
Lateral	15-35%
Posterior	0.8-2.5%
Anterior	1%



Figure 1. Clinical photograph of a 33 year-old who sustained a medial closed TCN dislocation.

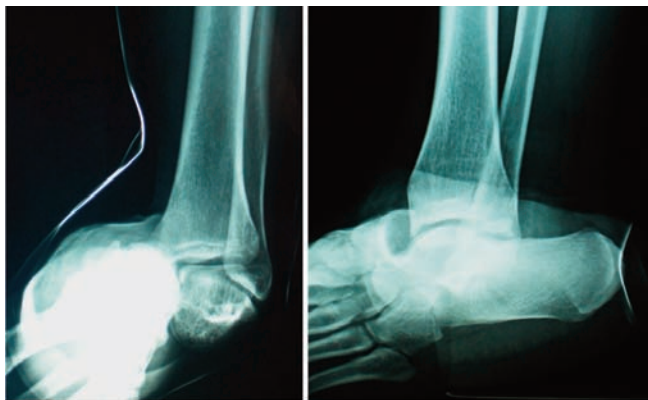


Figure 2. Anteriorposterior and Lateral radiographs showing medial TCN dislocations.

directional dislocations. These types of TCN dislocations can occur from 65-80% of all TCN dislocations (10, 11). Often this type of STJ dislocation is related to some type of traumatic injury as a motor-vehicle accident or a fall from a height that causes a forced inversion of the foot while plantar flexed. It is with this positioning of the foot that the sustentaculum talus acts as a fulcrum for the posterior body of the talus to produce this type of dislocation. The talar head pierces the lateral capsule as the calcaneus rotates medially. This can then lead to associated fractures of the talar neck or sequential medial dislocation of the talonavicular joint. There have also been several documented cases that show other associated injuries such as: osteochondral fractures of the talonavicular and talocalcaneal joints, fractures of both malleoli, fractures of the base of the fifth metatarsal, the cuboid and the navicular bones (10).

Clinical manifestations of this injury often appear as a mere ankle injury until evaluation by radiographic imaging (Figure 1). Medial TCN dislocations are often referred to as “basketball foot,” a term coined by Graham in 1964, based on the fact that many of these injuries are often with associated sport injuries, particularly basketball (10). Medial TCN dislocations are even described as an “acquired clubfoot.” The talar head is often palpable on the dorsum of the foot lying in between the EDL and EDH tendons. The digits can sometimes appear dorsiflexed due to the relationship of the talar head with the EDL tendon. The significant tenting of the skin becomes a big concern especially if the deformity is not reducible. Forty percent of these injuries are open injuries (12).

Radiographic imaging with your standard AP, MO, and lateral views of the foot are essential in determining the joints involved (Figure 2). The direction of the dislocation with regard to the subtalar joint, but also the talonavicular joint is important in evaluation of the injury. The calcaneocuboid joint will remain congruous with an overlap of the tarsal bones with and unclear subtalar joint are evident on the lateral view (4, 12). The ankle joint/mortise will remain intact. Post reduction films are pivotal in determining other possible associated fractures.

LATERAL TCN JOINT DISLOCATIONS

Lateral TCN dislocations are often referred to as “acquired flatfoot” injuries and have the second highest occurrence among subtalar joint dislocations at about 15-35% (11). A lateral TCN dislocation requires a forced eversion of the foot in a plantar flexed position. The anterolateral talus acts as a fulcrum about which the anterior process pivots, resulting in possible talar neck fractures and the subsequent

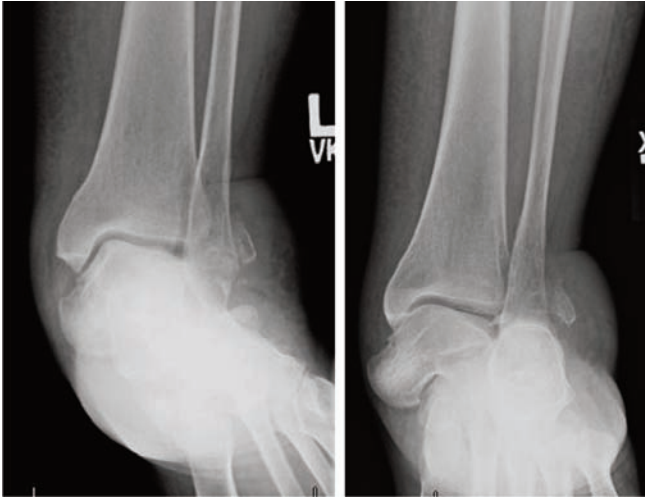


Figure 3. Anteriorposterior and mortise ankle views of 45y/o with lateral TCN dislocation.

lateral dislocation of the talonavicular joint and the subtalar joint. Because of the various anatomical structures involved, the lateral TCN dislocation requires more force to occur compared to the medial dislocation. Thus the injury increases the severity of soft tissue damage and the incident of open injuries and associated intraarticular fractures (4, 9, 12).

Clinically this also can manifest itself as a type of ankle dislocation until radiographic imaging is performed. The talar head is forced through the talonavicular joint capsule medially leading to the disruption of the STJ forcing the calcaneus laterally. The lateral border of the foot appears shortened in relation to the medial, which appears longer. The talar head is palpable medially and the digits may appear plantar flexed (12).

For the lateral TCN dislocation, both standard foot and ankle views are ordered for full assessment of the foot and ankle (Figures 3, 4) As with the medial TCN dislocation, the lateral radiographs of the foot demonstrate an overlapping of the tarsal bones with a non-distinguishable subtalar joint. The calcaneocuboid joint will remain congruous with a lateral dislocation of the navicular in relation to the talus on an anteroposterior view of the foot (9, 10, 12).

TREATMENT

A prompt closed reduction of the dislocation is recommended as soon as possible to avoid any neurovascular compromise or potential skin necrosis (12). It is recommended that local and intravenous sedation either in the emergency room or operating room be utilized for the patient. Reduction is accomplished by traction on the foot and heel in the line of the deformity and with the knee bent at a ninety-degree angle with counter traction (Figure 5). Firm longitudinal traction



Figure 4. Lateral ankle and anteriorposterior foot view of lateral TCN dislocation.

applied to the foot with counter traction of the leg is held while re-creation of the deformity is performed, an eversion of the foot for lateral dislocation and inversion for medial dislocation (8). Reversal of the deformity is performed by applying direct pressure to the talar head for both types of dislocation (8). Confirmation of the reduction should be followed with post-reduction radiographs and even consideration of a computed tomography (CT) for overall alignment and associated fractures (16) (Figures 6, 7). The usefulness of CT cannot be over emphasized with these types of injuries.

In 2001, Bibbo et al presented that 44% of their cases of TCN dislocation revealed further information about the injury that altered their course of treatment (16). Utilization of CT can even alter the course of conservative measures if there is associated pathology in the sense that one might adjust the length of immobilization or the rehabilitation protocol (6). Magnetic resonance imaging may be utilized in these cases for the concern of soft tissue damage, bony edema, and depending on the nature of the trauma to the talus, avascular necrosis of the talus.

There are many theories and arguments concerning the length of immobilization or techniques. Immobilization in either a short- or long-leg cast for 4-6 weeks with strict non-weight bearing to the involved extremity is recommended. Outcomes of isolated TCN joint dislocation closed reduction have shown to be significantly favorable with 80% having restriction in motion after healing and 50-80% having radiographic evidence of post traumatic arthritis (12). However it must be noted that it is reported within the literature that failed closed reduction occurs in 10-20% of medial and lateral TCN dislocations (12, 17). Many of these failures can be attributed to “button holing” of the talar head through the EDL tendon or impingement of other soft

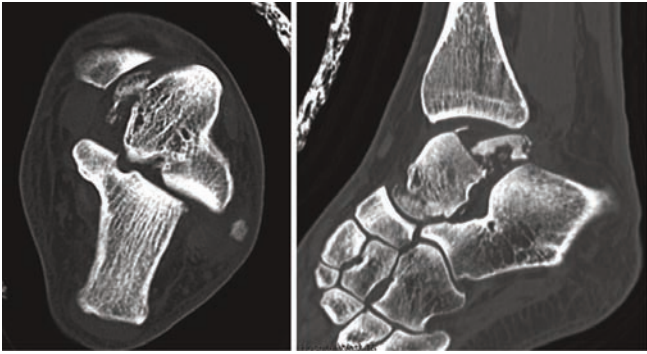


Figure 5. Pre-reduction of a medial TCN dislocation CT scan (A) Coronal and (B) Sagittal views of 43 year-old with an associated talar body fracture with incongruence of the talo-navicular joint.

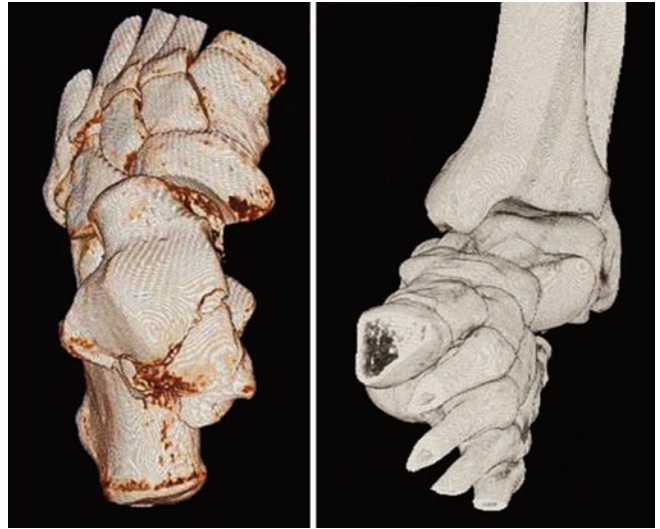


Figure 6. Pre-reduction CT 3D reconstructions of 43 year-old with medial TCN dislocation.

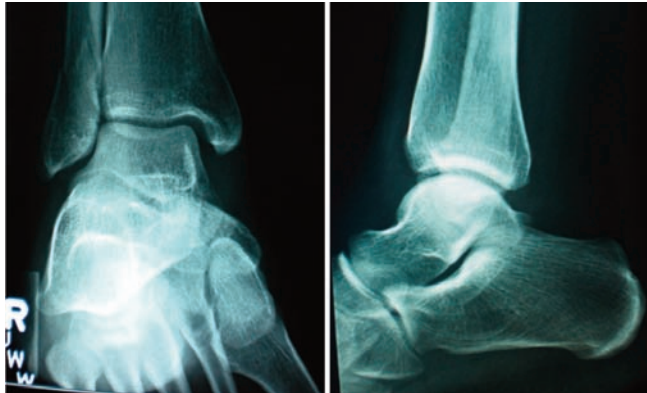


Figure 7A. Anteriorposterior and lateral radiographs post reduction.



Figure 7B. CT 3D reconstruction of post reduction of lateral TCN dislocation.

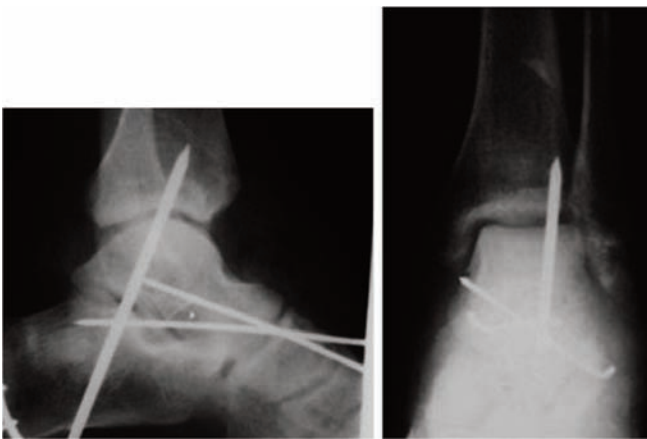


Figure 8. A 33 year-old with unstable isolated medial TCN dislocation who underwent percutaneous pinning with steiman pins.



Figure 9. Lateral radiograph of closed posterior TCN dislocation.

tissue structures previously mentioned in the anatomy section. The concern may also revolve around the fact that the reduction may be successful, but the overall stability is poor. This is when one may consider the use of some type of external fixation or the utilization of percutaneous pinning with cast immobilization (Figure 8). These are two options that can offer a rigid stable construct for healing. There are the options of ring fixators, delta frames, monorale system, Kirschner wire (K-wire) fixation, Steinmann pins, etc. Milenkovic et al theorized the use of mild distraction with and external fixation for TCN dislocations as a method to prevent infection and avascular necrosis of the talus (18). Both percutaneous pinning and external fixation can also play an important role for open injuries secondary to TCN dislocations. According to a series by Merchan et al, 40% of TCN joint dislocations may be open injuries and 64% with associated fractures being present (18). Both of these types of TCN dislocations may be significant with prolonged treatment courses including extensive physical therapy.

POSTERIOR DISLOCATIONS

Few reports of posterior TCN dislocations have been described to date. It is a rare injury, accounting for only 2-6% of all TCN dislocations (3). These dislocations are easily converted to either medial or lateral dislocations, which is in part why an isolated dislocation in the posterior direction is a rare entity. The mechanism of injury is important when describing a posterior TCN joint dislocation. Excessive plantar flexion is described as the main cause and it is hypothesized that pure hyperplantar flexion could lead to a progressive subtalar ligament weakening that may result in a complete ligament rupture if the plantar flexion force is prolonged (3). This excessive hyperplantar flexion is normally the result of either a fall from a height or direct blunt force and trauma. This could be observed in the presence of good bone quality and if the force is applied distally at the navicular bone. The interosseous ligament and medial and lateral ligaments of the ankle joint are torn. Generally there is no rotational component to posterior displacements of the TCN joint. The instances of posterior dislocations with rotational components were open injuries (13).

The diagnosis of posterior TCN dislocation can be confirmed with lateral and anteroposterior radiographs (Figure 9). On lateral radiographs, the head of the talus is atop the navicular, and the posterior portion of the talus will be in contact with the posterior subtalar facet of the calcaneus (19). According to Inokuchi et al, the frontal view should show no significant medial-lateral displacement or rotation of the foot (3). Importantly, the ankle joint mortise will remain intact, however a CT scan is war-

ranted especially in cases where other fractures along with the dislocation are suspected. Clinically the posterior TCN joint dislocation will typically have a wound due to skin necrosis at the anterior aspect of the ankle joint. This is due to the talar head protruding dorsal and anteriorly causing increased traction on the skin. Also, clinically the entire foot will appear shortened in the lateral view.

Immediate reduction under general or spinal anesthesia is recommended to avoid soft tissue complications and reduce the chances of avascular necrosis of the talus. Posterior dislocations are also very unstable due to the fact that the talus is balancing on two points, the navicular and the facets of the calcaneus, respectively. With posterior TCN dislocation, reduction can be achieved with no fixation by manual traction. This is done with the left knee kept slightly flexed and a countertraction performed by the leg. At this point, ankle traction is applied, and a firm digital pressure over the head of the talus is performed from anterior to posterior, passing through plantar flexion to dorsiflexion. The reduction should be associated with an audible clunk. A radiograph should be performed to ensure the reduction of the dislocation and to exclude any iatrogenic fracture. Again CT or magnetic resonance imaging scans of the ankle and foot should be done post-reduction to evaluate the talus and sub-talus articular surface if suspected.

Associated fractures as cited in the literature include, talar neck and body fractures, anterior process of the calcaneus, posterior process of the talus, posterior malleolus chip fractures of the navicular, cuboid fractures, and associated osteochondral fractures (3, 13, 14, 20). However, TCN joint dislocation with a fractured talar neck or cuboid should be diagnosed as a fracture of the talus due to the fact that the talarnavicular joint normally remains intact. A recent case report by Budd et al, showed that a posterior displacement was irreducible due to an anterior process fragment (14). In this case manual reduction with the use of a delta frame external fixation would be advised.

In general posterior dislocations do not require internal or external fixation. Fixation of associated fractures is required depending on the type of fracture, displacement, and timing of the injury. Good functional outcomes for closed posterior TCN dislocation have been uniformly reported in the literature (3). Post-reduction immobilization in a nonweight-bearing cast is required for TCN dislocation. The period of immobilization is controversial. In general we follow the protocol set forth by Jungbluth et al in 2010, consisting of six weeks in a short-leg cast with aggressive rehabilitation and full weight bearing thereafter (14). Radiographs at 6-8 weeks are a usual protocol to ensure no vascular necrosis of the talus. This can also be done with the use of CT and MRI.

ANTERIOR DISLOCATIONS

Isolated anterior dislocations of the TCN joint are exceedingly rare accounting for less than 1% of all TCN joint dislocations (14). Like that of posterior dislocations, anterior dislocations are easily converted to either medial or lateral dislocations, which is in part why an isolated dislocation in the anterior direction is rare. Only scant case studies are found in the literature with only 12 cases reported (21). The mechanism of injury in purely anterior dislocations is a result of traction force acting on the foot in an anterior direction. The interosseous ligament along with the medial and lateral ligaments of the ankle joint cause sliding of the posterior subtalar facet beyond the calcaneal apophysis, this is a result of the foot being in a dorsiflexed position during the injury. Typically this injury results from the foot being in a dorsiflexed position while falling from a height (16).

The diagnosis of anterior TCN dislocation can be confirmed with lateral and anteroposterior radiographs. As previously mentioned anterior dislocations are highly associated with medial and lateral dislocations, therefore anteroposterior radiographs of both the foot and ankle need to be obtained to distinguish. Inokuchi et al, proposed that TCN dislocations in which the foot was mainly displaced forward and the posterior subtalar facet of the talus is stranded on the calcaneal tuber can be diagnosed as anterior TCN dislocation, even if slight lateral displacement was observed on anteroposterior view radiographs. Importantly, the ankle joint mortise will remain intact, however a CT scan is warranted especially in cases where other fractures along with the dislocation are suspected. Associated fractures as cited in the literature include, talar neck and body fractures, and associated osteochondral fractures (21). Clinically, the foot will appear elongated in the lateral view of the foot. An indentation at the anterior aspect of the ankle joint may appear where the head and neck of the talus should be along with tension on the Achilles tendon at the insertion.

The keystone of treatment for anterior dislocations is prompt and gentle reduction under general anesthesia. With anterior TCN dislocation, reduction can be achieved with no fixation by manual traction. This is done with the left knee kept slightly flexed and a countertraction performed by the leg. At this point, ankle traction is applied; force is then applied at the calcaneus posterior inferior direction, passing through dorsiflexion flexion to plantarflexion. The reduction should be associated with an audible clunk. A radiograph should be performed to ensure the reduction of the dislocation and to exclude any iatrogenic fracture. Again CT or MRI scans of the ankle and foot should be done post-reduction to evaluate the talus and sub-talus articular surface.

Reduction of these injuries is generally achieved without problem and is not associated with irreducible fractures or having to pin or externally fixate the dislocation. Fixation of associated fractures is required depending on the type of fracture, displacement, and timing of the injury. Good functional outcomes for closed posterior TCN dislocation have been uniformly reported in the literature (21). Post-reduction immobilization in a nonweight-bearing cast is required for TCN dislocation. The period of immobilization is controversial. In general we follow the protocol set forth by Jungbluth et al in 2010, consisting of 6 weeks in a short-leg cast with aggressive rehabilitation and full weight bearing thereafter (14). Radiographs at 6-8 weeks are a usual protocol to ensure no avascular necrosis of the talus. This can also be done with the use of CT and MRI.

COMPLICATIONS

The literature is divided on the long-term outcomes of TCN joint dislocations. This is motivated by several factors including type of dislocation, severity of the injury, presence of associated fractures and postoperative course. An overall complication rate of 20% is cited in the literature for any TCN joint dislocation (16) (Figure 10). Complications for lateral TCN joint dislocations are higher because of associated injuries, higher incidences of open fractures and osteochondral lesions. Literature cites that osteochondral lesions are as high as 88% and could be as high as 100% if CT scans were done in all injuries regardless of type (4) (Figure 11). Again Bibbo et al found that patients who had post-reduction CT scans had better outcomes due to the fact that treatment plans changed if associated injuries were identified earlier (16).

Complications can be divided into early and late complications (Table 2). No recurrent TCN dislocation has been described in the literature to date, suggesting that

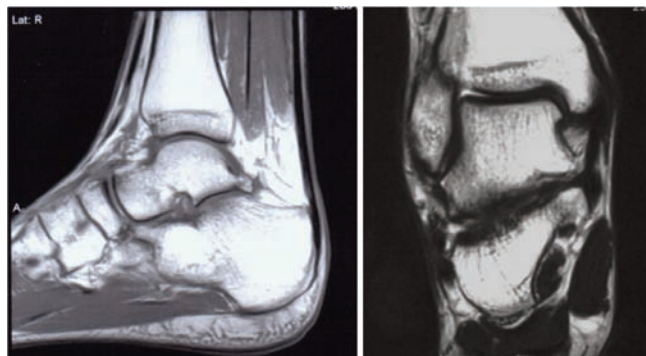


Figure 10. Status post isolated medial TCN dislocation with reduction MRI (A) sagittal and (B) frontal views of 17 year-old. Patient had casting non-weight bearing for 4 weeks followed with CAM boot for two weeks with aggressive physical therapy. No post treatment problems with normal congruous STJ facets and joints at 1 year.



Figure 11. Lateral radiograph showing severe STJ arthrosis 4 year status post lateral TCN dislocation.

medial displaced on the talus and the least common being posterior displacement of the foot. Most closed dislocations are amendable to closed reduction and a period of nonweight bearing in either a short leg cast or a boot, which have resulted in good clinical outcomes compared to open TCN dislocations which require more invasive and aggressive initial treatment.

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Table 2

COMPLICATIONS OF TALOCALCANEAL NAVICULAR JOINT DISLOCATIONS

TERM	COMPLICATION	%
Early	Fracture Blisters	Unknown
	Skin Necrosis	Unknown
	Osteocondral Lesions	88% to 100%
Late	Post-traumatic Arthritis	
	STJ	63%
	Ankle	31%
	AVN Talus	10% to 23%
	Subtalar joint Arthrosis	89%
	Postural deformations	Unknown
	Ankle Instability	22%
	Subtalar joint Instability	0%
	Chronic Pain	50% to 100%
TMTJ Arthrosis	15%	

residual subtalar joint laxity does not represent a risk for future recurrent TCN dislocation. It does seem that patients overall do well with just isolated dislocations having had a period of nonweight bearing for 3-6 weeks followed by aggressive physical therapy.

CONCLUSION

TCN joint dislocations still remain a relatively rare type of injury, in total about 1% of all dislocation injuries. The most common TCN dislocation are those with the foot being