Fractures of the talus are uncommon. The relative infrequency of these injuries relates to limited guidelines to treat talus fracture. Talus fracture is always associated with high energy injury critical to the normal function of the ankle, sub-talar, and transverse tarsal joints. Outcomes vary widely and are related to the degree of initial fracture displacement. Nondisplaced fractures have a favorable outcome in most cases. Failure to recognize fracture displacement (even when minimal) can lead to undertreatment and poor outcomes. Current detailed diagnoses through Multidetector CT (MDCT) are preferred to avoid miss diagnosed in talar fracture. Although early treatment and delayed treatment did not significantly differ, multiple-choice to treat talus fracture should be known. Conservative and operative treatment can be done in accordance with clinical findings and fracture patterns. With a high risk of complication, appropriate therapy should be done. Many research and articles have been done to develop the treatment and reduce complications over talar fracture from an invasive procedure to a non-invasive procedure like arthroscopy. Therefore, we compile current treatment to give another perspective for surgeons to treat talar fracture patients.

Keywords: Talus, Ankle Fracture, Talar fracture


INTRODUCTION
Talus, a critical structure in the ankle and foot, supports normal ambulation and gait in humans. According to Haliburton and Sullivan, the word talus comes from the French “talo”, originating in ancient Greece and Rome. The heel bones of the horse, called taxillus, were thrown as dice by the Romans, whereas the Greeks used the vertebrae of sheep, called astragalus. The 2 terms were used interchangeably and became associated with the foot bone talus. First founded in the sixth century and firstly treated with taliceomy by Fabricius in 1608.

They are known to be challenging pathological conditions, and talar fracture treatment was evaluated and studied in many articles. In recent decades, surgical techniques, synthesis materials and level knowledge relating to the biology of bone repair and vascular supply of the talus have significantly evolved and changed the panorama of this type of fracture. The Incidence of talar fracture in early 2000 has been studied and most common have multiple injuries (86.0%). Until a study conducted by Sakaki MH et al found that the incidence of talus fracture usually associated with other injuries (47.8%) (ex: malleolar fracture, fracture of leg bones, fracture of the base of the fifth metatarsal, fracture of the lumbar spine, or acetabular fracture), 78.3% cases of talus fracture resulted from high energy trauma and 43.8% resulted from a traffic-related accident with highest incidence rate involving neck of the talus (73.9%).

Present study in an open talar fracture said falling from a height >1m are the most common causative (17.3%) with the highest incidence rate occur on the neck of the talus, highest prevalence rate on male patients compare to the female patients (6.29:1).

Based on those mentioned above, this literature study aims to evaluate further the current concept management of talus fracture from the anatomy, management, and complications due to the talus fracture.

ANATOMY OF TALUS
The current update in the literature is that the sinus tarsi artery provides the main blood supply of the talus (Figure 1). In order to determine a more specific blood supply of the talus, Prasarn ML et al., use Magnetic Resonance Imaging (MRI) for more detailed images. It shows that the talar body is provided by three main blood supplies, the anterior tibial, posterior tibial, and peroneal arteries. Each of these vessels has multiple branches contributing to the periosteal and intrasosseous vasculature of the talus. The medial talar neck branch was found to be sacrificed through the anteromedial approach inevitably. The anastomotic artery on the superomedial surface of the talus might be disrupted on aggressive dissection.
Figure 1. Anatomy and arterial supply of the talus from the (A) Lateral and (B) Medial view.

<p>| Table 1. Hawkins Classification of Talar Neck Fracture. |
|-------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Nondisplaced talar neck fracture</td>
</tr>
<tr>
<td>II</td>
<td>Talar neck fracture with mild displacement Subluxing of subtalar joint</td>
</tr>
<tr>
<td>III</td>
<td>Talar neck fracture with moderate displacement Subluxing of subtalar and ankle joint</td>
</tr>
<tr>
<td>IV</td>
<td>Talar neck fracture with severe displacement Subluxing of subtalar, ankle and talonavicular joint</td>
</tr>
</tbody>
</table>

Table 2. Sneppen classification of talar body fracture.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Compression or osteochondral dome fracture</td>
</tr>
<tr>
<td>B</td>
<td>Coronal shear fracture</td>
</tr>
<tr>
<td>C</td>
<td>Sagittal shear fracture</td>
</tr>
<tr>
<td>D</td>
<td>Posterior tubercle fracture</td>
</tr>
<tr>
<td>E</td>
<td>Lateral tubercle fracture</td>
</tr>
<tr>
<td>F</td>
<td>Crush comminuted fracture</td>
</tr>
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</table>

MECHANISM OF INJURY AND CLASSIFICATION

Talar head fractures can occur along the talonavicular joint proper and in the middle facet. They result from a compressive load delivered either through the sustentaculum of the calcaneus or the navicular with an axial load. Various investigators feel that dorsiflexion and inversion of the foot is the mechanism of injury-producing the fracture pattern. This loading can result in two distinct fracture patterns, a crush injury to the articular surface with significant comminution or a shear fracture. Another study called the talar fracture mechanism of injury as “aviator’s astragalus”. Referred to the rudder bar of a crashing airplane impacting the plantar aspect of the foot, resulting in a talar neck fracture.

Most use classification on talar neck fracture are Hawkins classification (Table 1). Classified as nondisplaced (type I), displaced with subtalar joint subluxation/dislocation (type II), displaced talar neck with talar body dislocation (type III). Canale ST and Kelly FB Jr add the fourth classification, which is displaced talar neck with talar body and head dislocation (type IV).

Talar body fracture is classified in multiple ways. The Sneppen classification includes 6 parts: type A, a compression or osteochondral dome fracture; type B,
a coronal shear fracture; type C, a sagittal shear fracture; type D, a posterior tubercle fracture; type E, a lateral tubercle fracture; and type F, a crush or comminuted fracture of the talus (Table 2). The Fortin classification is a simpler method of classification, described by Fortin PT and Balazsy JE, which includes 3 groups: type 1, a talar body fracture in any plane; type 2, a talar process or tubercle fracture; and type 3, a compression or impaction fracture of the talar body.

Watanabe H et al., recommended classification on posteromedial tubercle of the talus. Known as Cedell's fracture have never been classified before, thus fracture of the posteromedial tubercle is classified into 3 types based on mechanism of injury and fracture configuration: (1) Avulsion type; (2) Split type; and (3) Comminuted Type. Fracture that passes through the lateral border of the posterior subtalar joint should be diagnosed as body fractures. Classified accurately and clearly by noting the route of the fracture.

**RADIOLOGY IMAGING**

Appropriate radio-imaging need to be performed to identify the type of injury should include Anteroposterior (AP), oblique and lateral foot image, as well as ankle series, Canale and Kelly or mortise (Figure 2).

Radiologic criteria to confirm the reduction on the talar axis: Checked by measuring the talar-first metatarsal angle, typically looks parallel on the AP and lateral radiograph (±4°). Joint congruity including: A) subtalar joint should be congruent with head fragment and posterior facet congruent with body fragment; B) Ankle joint: Central position of the talus dome and congruous under tibial plafond; and C) Talonavicular joint: Talonavicular angle >78° indicates subluxation of the navicular on the talus.

Current technology to accurately diagnose talar fracture is Multi-Detector Computed Tomography (MDCT), also known as Multi-Slice Computed Tomography (MSCT), giving higher sensibility and specificity than ordinary CT. A volume rendering technique (VRT) reconstructions better visualize the displaced fragments. Ultrasound (US) and Magnetic Resonance Image (MRI) can be helpful to evaluate the oft-tissue injury. MRI is rarely obtained. When it is received, it is done incidentally in a patient who has pain, swelling, and inability to bear weight, but otherwise normal initial radiographic imaging to make a diagnosis. Some authors have used MRI to monitor Avascular Necrosis (AVN) in the postoperative period.

Talar head fractures involve the articular surface of the talus at the talonavicular articulation, often accompanied by dislocation or subluxation and adjacent bone fractures. After a talar head injury is identified or suspected, CT evaluation with MPR should be performed to evaluate better the degree of fragments displacement and the extension of the fracture line (Figure 4).

Shear fractures of the talar body often result from an axial load on a dorsiflexed foot in the setting of a high-level fall or motor vehicle accident. Crush comminuted talar body fractures have the worst prognosis of all talar body injuries. The incidence of bone loss and nonanatomic reduction is high and avascular necrosis commonly follows. While the initial diagnosis can be made with radiography, CT with coronal and sagittal (Figure 5), reformation to the ankle mortise is subsequently performed.
to assess comminution, intra-articular involvement, and surgical planning.  

Posterior process fractures result from forced plantar flexion, leading to compression of the posterior process between the tibia and calcaneus (Figure 6).  

![Figure 4. Simple shear fracture of the head (sagittal CT MPR) Diagnose and Differential Diagnose.](image)

![Figure 5. Complex body fractures. Coronal (A) and sagittal (B).](image)

![Figure 6. Posterior process fractures have irregular edges and fit with a defect in the adjacent posterior part of the talus.](image)

direct trauma to the posterior ankle. Radiographs demonstrating a fracture fragment posterior and medial to the talus are diagnostic of a Cedell posterior medial tubercle fracture. The proposed mechanism is avulsion at the talar attachment of the posterior tibiotalar ligament with the ankle in dorsiflexion and pronation.  

**CURRENT MANAGEMENT**

Timing treatment of displaced talus fracture was recommended as an emergent procedure to reduce the risk of complications. However, recent studies show no significant difference between emergent Open Reduction Internal Fixation (ORIF) and delayed ORIF. They hypothesized that initial talar displacement affected the outcome rather than the timing of definitive fixation.  

In order to obtain excellent access allowing for anatomical reconstruction, an appropriate approach is necessary. Multiple surgical approaches are reported, including anteromedial approach, posteromedial approach, anterolateral approach, posterolateral approach. And the most commonly used is the anteromedial approach. While the posterior approach and posteromedial approach are not helpful for reduction and are necessary only for posterior to anterior fixation or placement of the screw.  

Treatment also determines through soft tissue coverage, whether it is an open or close fracture. Furthermore, a fracture can be treated using conservative or operative as mentioned below.

**CONSERVATIVE TREATMENT**

Non-operative treatment should only be taken for undisplaced fracture or minimally displaced. A study conducted by Cartwright-Terry M et al., used of plaster Paris back slab with the ankles in 90° of dorsiflexion and elevation of the injured limb provides good results in immature patients. It can also be treated in a cast in a neutral foot and ankle position for 6 weeks. The patients are restricted to partial weight-bearing of 15 kiloponds (kp) on the affected leg. Full weight-bearing is allowed at the time of complete radiographic union, usually after 8–10 weeks.  

If the open reduction is contraindicated in fracture-dislocations or severely displaced talar neck and body fractures, the closed reduction under complete patient relaxation may be attempted. For displaced talar neck fractures, the forefoot is brought first into hyper dorsiflexion followed by forced plantar flexion under axial and downward pull on the heel. The latter may be facilitated with a Schanz screw introduced perpendicular to the calcaneal tuberosity. Displaced talar body fractures are reduced with direct manipulation of the displaced body fragment under a maximum axial pull on the hindfoot. It has to be borne in mind that every unsuccessful attempt at closed reduction increases the damage to the already compromised soft tissues, thus further increasing the risk of severe soft tissue complications. Therefore, open reduction should be considered even in high-risk patients.
OPEN REDUCTION TREATMENT

For operative treatment on talar fracture, the various approaches have been determined. Dissection using any approaches, especially dual approaches (medial and lateral), has to be careful and avoid dissection dorsally and plantarly to avoid injury to branches from the dorsalis pedis artery and the anastomosis network the tarsal canal (Figure 7). Despite its risk, dual approach routes were recommended to better preserve soft tissue and provide more precise reduction, as long as the technique has been learned beforehand.

TALAR HEAD FRACTURE

Multiple approaches have been recommended for the treatment of talar head fracture. From the dorsal approach, ensuring appropriate visualization of the articular reduction without extensive soft tissue dissection, weakness from the dorsal approach is the risk of damaging the blood supply of the talar head. Rammelt S and Zwipp H provided the only other description of a two-incision approach to fix talar head fractures. The medial incision allows visualization and immobilization, whereas lateral incision use for reduction and temporary fixation.

TALAR NECK FRACTURE

Treatment for talus neck fracture evolved from closed reduction and immobilization to limited fixation and currently, open reduction and internal fixation are being performed on most talar neck fractures. Grade I Hawkins injury without displacement and no varus malalignment of the subtalar joint are still controversial whether it is best non-operative treatment or operative. Rush SM et al., recommended for these injuries should take open reduction and internal fixation. Fracture rehabilitation allows early rehabilitation, which minimizes the stiffness in the hindfoot. Higher grades were recommended operative treatment even in cases with a closed reduction to reduce the fracture. The dislocated talar body is usually locked posterior from the subtalar facet and even posterior to the malleolus. Immediate closed reduction should be performed.

Abdelgaid SM et al. said that percutaneous reduction and fixation are promising treatment modalities of a talar neck fracture. Although close reduction was tried first by plantar flexion of the foot on Hawkins type II fracture, continue with two Schanz screws with T handle were inserted into the body and the head fragment and used as “joystick” to adjust talar rotation and angulation. Combined with the calcanean Steinmann pin and traction bow with counter traction, ankle joint distraction significantly reduced the reduction. The fracture was then fixed using two cannulated screws.

A minimally invasive method with easier rehabilitation and avoiding secondary operative procedures are beneficial from this procedure. Comparison to plate fixation provides a biomechanical advantage over anatomical alignment. No reports on early complications make this procedure best with a high risk of tissue complication.

Xue Y et al., through their operative procedure using dual approach (medial-lateral) and stabilization using Kirschner wires, shows the modified distal radius plate placed on the lateral column combined with medial column neutralization screw fixation through dual approaches can obtain anatomical reduction, rigid fixation and early rehabilitation, allowing optimal clinical outcomes with a low rate of complications.

A previous study by Abdelkafy A et al. used a lag screw in treating talar neck fractures with oblique fracture line with posterior-to-anterior direction and others with anterior-to-posterior direction, shows satisfactory fixation and functional outcomes. The vertical fracture of the talar neck and dislocation of the posterior subtalar facet are depicted in Figure 8 based on the previous study.

Maceroli MA et al., used a medial position screw fixation augmented with lateral mini fragment plates to provide stable construction, less complication, and no patients required removal implants due to symptomatic medial ankle impingement. The related study said safe angle for screw insertion is centered on the sinus tarsi and tilted approximately 61° in the direction of toes, based on a standard ankle lateral view.

Particular case in Talar fracture Hawkins grade IIb and grade III classification, in which the talar dome is extruded posteromedially. Where a true emergency due to a compromised tissue envelope, the patient should be taken to the operating room to get a close reduction. Anterior lateral approach, anterior medial approach, combined with a central threaded pin through calcaneal...
tuberosity and Schanz pin to control talar dome, were techniques to reduce talar dome.\textsuperscript{33}

Gonzales A reported that deltoid blood supply to the medial talar body is still intact even with the talus extruded.\textsuperscript{23} Careful attention on surgery procedures around deltoid blood supply may be the only remaining blood supply. Some studies said medial malleolar osteotomy could help successful operative especially for the irreducibility of the talar body. The medial malleolar osteotomy approach (Chevron osteotomy) is used to crack the medial malleolar piece (intact with its soft tissue and blood supply) and reflect it distally. This additional method can achieve excellent access and deal with irreducible dislocation of the body. wedge-shaped chevron osteotomy achieves more stability than oblique osteotomy also minimizes the risk of a damaging artery as to lead to AVN.\textsuperscript{34}

**TALAR BODY FRACTURE**

Treatment over talar body fracture has a similar principle for the talar neck fracture. The surgical approaches used on talar neck fracture may be used for talar body fracture. Medical malleolar osteotomy can also be performed for access to the talar dome. It is important not to violate the deltoid ligament, an important source of blood supply to the talar body.\textsuperscript{25}

Walter et al. stated that the talar body with severely comminuted fracture provides excellent outcomes after being treated with anatomic open reduction and internal fixation with multiple Kirschner wires and absorbable screws and pins.\textsuperscript{36} Treatment over talar body non displaced fracture with screw fixation through a minimal posterolateral and anteromedial incision, for talar body displaced fracture fixation using screw-in combination with absorbable pins or fibrin glue for osteochondral fracture treating displaced fracture through the dual approach.\textsuperscript{25} Complex body fractures in coronal and sagittal views were depicted in Figure 9 based on a previous study.\textsuperscript{18}

**LATERAL PROCESS FRACTURE**

Late or delayed diagnosis of lateral process fracture leads to a significantly poorer outcome, like non-union, bonny overgrowth or osteoarthritic changes.\textsuperscript{37} A recent study shows that a delayed fracture management (>14 days) did not lead to poorer outcomes, but early treatment is recommended.\textsuperscript{38} Known as snowboarding injury, fractures of the lateral process of talus are often misdiagnosed with ankle sprain injury.\textsuperscript{39} And missed on initial plain radiographs as they may be subtle and difficult to visualize. It's best seen on ankle mortise and internal oblique views, but CT scan preferred to visualize fracture and determine necessary operative intervention.\textsuperscript{35}

Hawkins described three patterns of fracture, such as: 1) Simple, extends from the talofibular articular surface to the posterior talocalcaneal articular surface of the subtalar joint; 2) Comminuted, involves both articular surfaces and the entire lateral process; 3) Chip, from the anterior and inferior portion of the posterior articular process involving only the subtalar joint.\textsuperscript{40} Approach on lateral process fracture through an incision the tip of the distal fibula extended distally along the axis of the fourth metacarpal.

**POSTERIOR PROCESS FRACTURE**

Posterior Process Fracture. Plain lateral radiography on the ankle shows a similar projection with the Os Trigonum. On posteromedial tubercle fractures, a 30-degree external rotation view is likely to show a clear image on the posteromedial tubercle.\textsuperscript{41} Advance imaging with either CT or MRI is recommended to differentiate Os Trigonum and posterior process fractures.\textsuperscript{35}

Posteromedial fracture is described as a fracture of the medial tubercle of the posterior process. However, it is often misdiagnosed as an ankle sprain and its obscuring on the anteroposterior and lateral radiograph. Watanabe H et al., propose...
protocol treatment on posteromedial fracture such as 1) Conservative treatment by cast immobilization for split-type or nondisplaced and fresh avulsion-type fracture; 2) Bone excision recommended for displaced or nondisplaced; and 3) Open reduction and internal fixation is recommended for comminuted-type fractures.\(^{30}\)

Immobilization with a period of non-weight-bearing to treat small and nondisplaced fractures could be used as a combination with open reduction internal fixation for bigger fragments and those displaced more than 2 mm. The patients also need to remain non-weight bearing for 2 months after surgery. Mehrpour SR et al., recommended the use of one or two headless compression screws for ORIF.\(^{42}\) Romeo NM et al., in their study said that plate and screw stabilization provide more reliable means of maintaining the reduction until time to union.\(^{15}\)

MINIMALLY INVASIVE PROCEDURE

Nowadays, minimally invasive treatment using arthroscopy, known as Arthroscopic Reduction and Internal Fixation (ARIF), is being held worldwide. Although treatment through the ARIF method is still limited and studied, some publications already describe this method. Indications that have been reported for ARIF include transchondral talar dome fracture, talar fracture, low-grade fracture of the distal tibia, syndesmotic disruption, malleolar fracture, and chronic pain following definitive management of fracture about the ankle.\(^{44}\) An arthroscopic approach can provide better visualization of the articular surface while preserving the soft tissue envelope and help prevent complications associated with an open approach such as wound infections and dehiscence.\(^{45}\)

Several discussions about tourniquet application for arthroscopy, known to improve operative field visibility.\(^{46}\) Although it does not improve operation time, the use of a tourniquet help the operator minimize false procedure intraoperatively and describe lesion or fracture clearly.\(^{47}\)

Talar fracture management through ARIF can be done in several cases like osteochondral lesion, lateral processes of talus fracture or ligament injury around the ankle. A study from Vega J et al., showed several indications for ankle arthroscopy were Impingement Syndrome, Osseous Impingement, Soft-Tissue Impingement, osteochondral lesions, tissue transplantation, acute trauma and sequelae.\(^{48}\)

An osteochondral lesion is defined as a lesion involving articular cartilage and/or subchondral bone. In order to treat the subchondral lesion, the basic principle is to create the optimal biological environment to restore the subchondral bone to allow the generation of a chondral surface.

Chondral substitution can be achieved by 3 general means: osteochondral fixation, subchondral bone microfracture, or tissue transplantation.\(^{49}\)

Arthroscopic microfracture has been widely accepted as the primary treatment strategy with good to excellent functional outcomes for small to mid-sized OLT (Osteochondral Lesions of the Talus) because of quick recovery, cost-effectiveness, technical feasibility, high success rate, and low morbidity associated with this procedure.\(^{50}\) Arthroscopic microfracture is considered the primary treatment strategy for osteochondral lesions of the talus and has been shown to provide successful outcomes.\(^{51}\)

Arthroscopic microfracture was performed with the patient under general anesthesia and with the use of a tourniquet. The non-invasive distraction was performed by use of a foot strap, and a 2.5-mm, 30 arthroscopes (Linvatec) was used through 3 portals (anteromedial, anterolateral, and posterolateral), all unstable cartilaginous and fibrous tissues were debrided, and sharp perpendicular articular margins were created to attach suitable marrow clots. The lesion edges were resected using a ring-shaped or curved curette to develop sharp and perpendicular articular margins that were suitable for marrow clot attachment. Microfracture awls (Arthrex) were used at different angles to place the subchondral bone penetrations approximately 3 to 4 mm deep, 3 to 4 mm apart, and peripheral to the center of the lesion.\(^{50}\) Subchondral bone bleeding and the presence of fat droplets were confirmed after the release of the tourniquet. A bulky compressive dressing was then applied with the ankle in a neutral position with a posterior splint.\(^{51}\) Appropriate position of ankle arthroscopy portals was shown in Figure 10.

The anteromedial portal is usually created first because of the absence of any significant neurovascular structures near the portal. It is located medially to the anterior tibialis tendon at the level of the ankle joint line. This portal can be used as a working portal for medical pathology.

The anterolateral portal has a variable location. The different branches of the superficial peroneal nerve will place the portal, either medial or lateral, to its lateral

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**Figure 10.** Appropriate position of ankle arthroscopy portals as seen from the (a) medial (PM and AM portals visible), (b) anterior (AM and AL portals visible), and (c) lateral (AL and PL portals visible) perspectives.\(^{52}\)
branch (intermediate dorsal cutaneous nerve). The identification of this nerve before portal placement is mandatory. The safest anterolateral portal placement is just lateral to the peroneus tertius tendon. This portal can be used as a working portal for lateral pathology, including the treatment of anterolateral soft-tissue impingement or ankle instability.48

The reported rate of complications due to distraction is higher than that from using a dorsiflexion approach. This method is performed by anterior ankle capsule attachment inserts at 6 to 8 mm from the articular surface. When the tibiotalar joint is dorsiflexed, an enlarged anterior working area is created, and thus, the arthroscope and instruments can be safely placed within the joint.48

The stabilization and pinning of osteochondral fragments are suitable for lesions that present acutely or semi-acutely and have not been completely detached from the underlying bone. Detached osteochondral lesions with a large (>15 mm) viable osseous component are also amenable to arthroscopic fixation. Fixation should always be considered for adolescents, irrespective of the lesion size.

Subchondral bone microfracture can be achieved by creating perforations in the subchondral bone. The purpose of microfracture is to allow mesenchymal stem cells and growth factors from the microfracture to allow mesenchymal stem cells and growth factors from the microfracture to facilitate the migration of chondrocytes to the articular surface. When the overlying cartilage is damaged, the first step is debridement to a stable rim. Conversely, drilling is performed retrograde to avoid violating its integrity if the cartilage is intact.48,52

The results of subchondral bone microfracture have been demonstrated to be satisfactory at short-term to mid-term follow-up, with an overall success rate of 85% reported. The technique's success is progressively reduced over long-term follow-up, although good results have been reported up to 20 years following surgery.48,52

For larger lesions (>15mm in diameter), tissue transplantation is preferred. Transplantation techniques replace lesions with hyaline tissue that is more biomechanically favorable than fibrocartilage. Techniques include osteochondral autograft transplantation, allograft transplantation, osteochondrocyte implantation, and the use of particulated juvenile allograft cartilage. In all cases, hyaline-like cartilage has been histologically confirmed at the site of the lesion in treated patients.48,52

Arthroscopic reduction and internal fixation for a type I fracture of the LPT can be easily accomplished, and precise anatomic reduction can be obtained. With an early diagnosis and prompt treatment, the best possible results and early return to pre-injury daily as well as sporting activities may be achieved.53 The surgical step and technique tips were depicted in Table 3.

Internal fixation to shorten the duration of joint immobilization has been recommended for undisplaced talar neck fractures by others.54 In talar fractures, Fracture fixation is commonly performed with K-wires or lag screws, with the latter being preferred if the fragments are large enough to permit screw fixation, and traditional implants should be countersunk so that they do not protrude on the articular surface or headless compression screws should be used.55 The placement of screws for talar body shear fractures can be performed with additional accuracy. The fracture reduction can be visually controlled, diminishing postoperative complications with auxiliary subtalar and hindfoot arthroscopy.54 Usage of ARIF procedure alone might be challenging to achieve arthroscopic reduction and fixation in comminuted fragments.56

A Herbert screw is a special purpose screw used to compress small fracture fragments. One end of the screw (upper ends in x-ray and photograph above) has cancellous threads, while the other end has larger diameter cortical screw threads. The cancellous screw is inserted first and crosses the proximal fracture, screwing into the bone of the distal fragment. As it is screwed in, the proximal cortical portion engages the proximal bone fragment. Each turn of the screw causes the distal end to travel farther into bone than the proximal end, compressing the fracture.57

The surgical technique of using K-wire

### Table 3. Surgical steps and technique tips.53

<table>
<thead>
<tr>
<th>Surgical Step</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>A 2.7-mm-diameter 30° arthroscope and a fluoroscope are used. Saline solution is injected into the sinus tarsi to facilitate insertion of the arthroscope into the lateral talar space.</td>
</tr>
<tr>
<td>Arthroscopic LPT Examination</td>
<td>• An anterolateral portal is used as the viewing portal and a medial portal as the working portal.</td>
</tr>
<tr>
<td></td>
<td>• Hematoma, soft tissues around the talus, cartilaginous flakes, and small osteochondral fragments are removed.</td>
</tr>
<tr>
<td>Reduction of Fragment</td>
<td>• The lateral fragment of the LPT is pushed medially with a tiny mosquito clamp from the medial portal.</td>
</tr>
<tr>
<td></td>
<td>• Correct reduction alignment is confirmed under both arthroscopy and fluoroscopy.</td>
</tr>
<tr>
<td></td>
<td>• If the displacement of the superior aspect and/or posterior aspect is large, an additional superior portal (an anterolateral portal in the ankle joint) and/or a posterolateral subtalar portal may be needed.</td>
</tr>
<tr>
<td>Insertion of guidewire and</td>
<td>• A 1.1-mm guidewire is used for temporal fixation from the lateral side of the lateral process into the body directed 45° superior and parallel to the fibula with the ankle in a neutral position.</td>
</tr>
<tr>
<td>screw</td>
<td>• When it is difficult to determine whether the guidewire is correctly inserted, the position and direction of the guidewire should be confirmed under both arthroscopy and fluoroscopy.</td>
</tr>
<tr>
<td></td>
<td>• A headless compression screw is inserted through the guidewire to the measured depth.</td>
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</table>

fixation was associated with excellent clinical. However, some limitations of the surgical technique should be considered. First, there is a need to remove the K-wire at 6 weeks after the primary procedure; however, this is a nonarticular day surgery procedure associated with low morbidity. Second is the high incidence of kneeling pain.  

POSTOPERATIVE MANAGEMENT

Successful surgical fixation can be seen by the integrity and alignment of the sustentacular tali. Alignment was measured by performing anteroposterior, lateral, and mortise radiographs with considered: 1) Normal between 4° and 8° of valgus; 2) A varus malunion if the angle was inferior to 4° of valgus; and 3) A valgus malunion if the angle was superior to 8° of valgus. After surgery, Compressive dressing and splint fixation in a neutral position for the first 48 hours, continue with soft cast and boot. To prevent planter flexion and an eventual equinus deformity. Patient kept non-weight bearing for 6 weeks after treatment. Another study said in conservatively treated ankle fracture, greater dorsiflexion Range of Motion (ROM) at the time of immobilization removal correlated with better long-term outcomes. Physical treatment is given once or twice a week for 6 to 8 visits of 30 to 45 minutes in duration. Early supervised physical therapy weight-bearing believed to improve long-term outcomes in talar fracture patients, but over and underloading may lead to prolonged and complicated recovery. Partial weight-bearing (10-15 kg) during the first 8 weeks or 6 to 8 weeks are recommended. In this period, revascularization of the talor body known as the Hawkins sign exposes through radiology examination.

COMPLICATION

Early and late complications are common in talar neck and body fractures. Nerve injury accounted for 49% of all complications and was the most common complication due to portal or distractor pin placement. Soft tissue complications like wound infection and healing problems could occur as early complications. Early complications such as skin necrosis, wound dehiscence, and infection have emerged in as many as 77% of cases. And late complications consist of malunion (59%), AVN (20% cases), and DJD (94%) makes talart fracture a challenging case to prevent complications. In correlation with talus fracture, avascular necrosis, known as AVN, was first studied by Hawkins by correlating Hawkins injury type with AVN incidence. A large sample was used (848 talus), with the overall rate of AVN is 33.3%. Vallier HA et al., reported on their study that the extent of subtalar displacement at the time of injury is responsible for AVN incidence. Therefore, the Hawkins modified classification is reliable and straightforward and can be used to develop post-traumatic AVN. We can evaluate Hawkins sign through a plain radiograph, with a dependable indicator of talar perfusion and a favorable prognostic sign.

Secondary salvage procedures on AVN, including takedown, bone grafting, and tibiocalcaneal fusion, also could be performed. Azeez A et al., recommended a stainless steel talar body prosthesis in treating avascular necrosis or severe crush injuries of the talus. The latest study in 2018 found out that the timing of surgical reduction and stabilization is not necessarily for AVN prevention. Malunion significance is influenced by the fracture type (neck or body). Varus malunion was found in 67% of cases of the talar neck fracture and valgus malunion was found in 25% of cases of the talar body fracture. It is correlated with the initial reduction of the fracture. Due to its primary reason for the poor clinical result, the initial recognition of the talar neck fracture pattern is very important. Attempted reduction without the appreciation for this hyper dorsiflexion impact injury may lead to a dorsal or varus mal union.

A previous study by Friberger Pajalic K et al., said that there was a substantial variation in the reported absolute risks for complications – pyogenic arthritis between 0.08% and 0.42%, deep vein thrombosis between 0.12% and 0.41%, and pulmonary embolism between 0.03% and 0.11%. The similar complications also observed by Hagino T et al., such as haemarthrosis (60.1%), infection (12.1%), thromboembolic disease (6.9%), anaesthetic complications (6.4%), instrument failure (2.9%), Complex Regional Pain Syndrome (CRPS) 1 (2.3%), ligament injury (1.2%) and fracture or neurological injury (0.6%). The complication rate was higher in more complex procedures; 2.4 % in meniscal repair and 1.8 % in the reconstruction of the ACL.

The arthroscopy procedure relates to several complications. Early complications related to the port entry of the arthroscopy device led to infection post-ARIF can be suppressed by the “nick and spread technique” used by making a small incision in the skin and using a hemostat to spread the subcutaneous tissues. Incorrect portal placement might also give neurovascular injury complications.

The use of pneumatic tourniquets, which subject the limb root to pressures that are two to three times higher than the systolic pressure, thereby making it easier to view and carry out the procedure, either through the absence of bleeding or through greatly diminished bleeding but the use of tourniquets is not free from risks, since the compression cause tissue trauma. Clear surgical advantages achievable from using a tourniquet in procedures concern blood loss control, arthroscopic visibility and better surgical field management. But there is also no evidence of dramatic systemic or local complication with the use of a tourniquet, except for some early complications and some cases of DVT.

The combined use of a tourniquet for additional open procedures requires special care since it can cause skin and soft tissue injury of the patient’s posterior thigh due to prolonged high pressure. The dorsiflexion technique to perform the arthroscopic procedure is the main reason for the low percentage of complications compared to other series using a continuous distraction system. In this dorsiflexed position, the nerves and vessels are relaxed and can thus move away when a blunt instrument is introduced. Compared to the distracted and slightly plantarflexed position, nerves and vessels are stretched and cannot move, making them more vulnerable to iatrogenic damage.
CONCLUSION
In conclusion, there are several choices to treat talar fracture according to the pathologic pattern of talar fracture. The use between conservative, open reduction and arthroscopic reduction is well described in this article. Appropriate diagnostic and perioperative treatment is the key to success in talar fracture management.

CONFLICT OF INTEREST
There is no competing interest regarding the manuscript.

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