

# Correction of Severe Flatfoot Deformity by 3-Portal Arthroscopic Triple Arthrodesis



Ho Ming Li, M.B.Ch.B., and  
Tun Hing Lui, M.B.B.S., F.R.C.S. (Edin), R.H.K.A.M., F.H.K.C.O.S.

**Abstract:** Severe flatfoot deformity with lack of coverage of the talonavicular joint is frequently treated by triple arthrodesis. Various arthroscopic triple arthroscopic techniques have been described to reduce the extent of soft-tissue dissection. The purpose of this Technical Note is to describe the details of 3-portal arthroscopic triple arthrodesis for correction of severe flatfoot deformity. This approach allows thorough preparation of all fusion surfaces, and the bone removal by decortications facilitates reduction of the talonavicular joint and correction of the forefoot supination.

Severe flatfoot deformity usually requires open corrective surgery (e.g., triple arthrodesis). Frequently, this involves extensive soft-tissue dissection. This may result in potential devitalization, greater postoperative swelling, and increased risk of wound complications especially in patients afflicted by poor soft-tissue envelopes.<sup>1</sup> The technique of arthroscopic triple arthrodesis with the advantage of minimally invasive surgery was first described in 2006.<sup>2</sup> The arthroscopic approach to the triple joints would appear to provide good visualization and preparation of the fusion surfaces while preserving the soft-tissue envelope.<sup>1</sup> Initial descriptions included a 6-portal approach with preparation of fusion surfaces by microfracture of the subchondral bone.<sup>2-5</sup> Modified techniques had been described with a 2-portal approach and preparation of the fusion surfaces by decortication<sup>1,6</sup>; however, it is difficult to approach the

calcaneocuboid joint and the medial half of the talonavicular joint. This incomplete preparation of the talonavicular joint will affect reduction and fusion of the joint in case of severe flatfoot deformity. In this Technical Note, we report the technique of 3-portal arthroscopic triple arthrodesis in correction of severe flatfoot deformity. It is indicated for correction of severe chronic flatfoot deformity, especially if the 3 joint surfaces are degenerated and the skin quality is poor.<sup>1</sup> It is contraindicated if there is active infection of the soft-tissue envelope, deformity with extensive bone loss requiring bone block grafting, and rigid deformity (Table 1).

## Technique

### Preoperative Planning and Patient Positioning

The degree of deformity is assessed clinically and radiologically. The flexibility of the deformity and the degree of possible passive correction of the hindfoot,

From the Department of Orthopaedics and Traumatology (H.M.L.), Kwong Wah Hospital, Hong Kong SAR, China, and Department of Orthopaedics and Traumatology (T.H.L.), North District Hospital, Hong Kong SAR, China.

The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Received July 31, 2019; accepted September 3, 2019.

Address correspondence to: Proofs and reprint requests should be addressed to Tun Hing Lui, M.B.B.S., F.R.C.S. (Edin), R.H.K.A.M., F.H.K.C.O.S., Department of Orthopaedics and Traumatology, North District Hospital, 9 Po Kin Rd, Sheung Shui, NT, Hong Kong SAR, China. E-mail: [luithderek@yahoo.co.uk](mailto:luithderek@yahoo.co.uk)

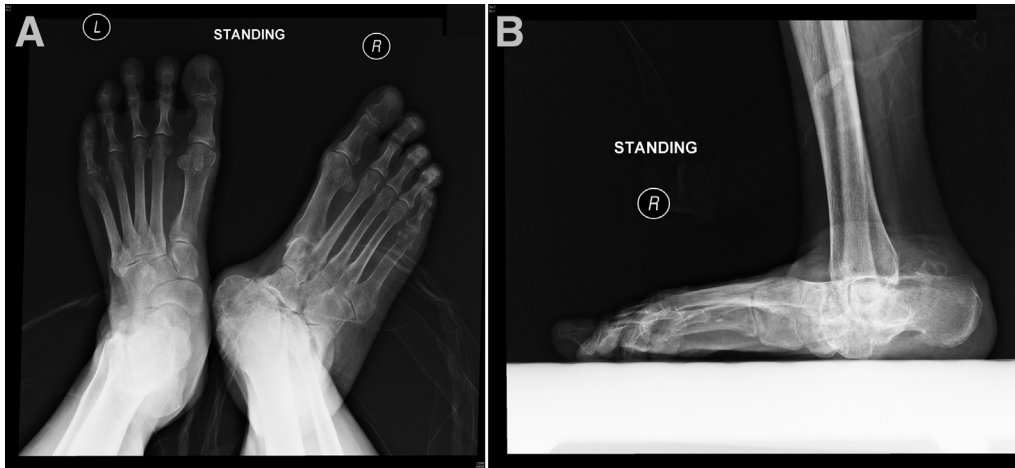
© 2019 by the Arthroscopy Association of North America. Published by Elsevier. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

2212-6287/19953

<https://doi.org/10.1016/j.eats.2019.09.017>

**Table 1.** Indications and Contraindications of Correction of Severe Flatfoot Deformity by 3-Portal Arthroscopic Triple Arthrodesis

Indications	Contraindications
1. Correction of severe chronic flatfoot deformity, especially if the 3 joint surfaces are degenerated and the skin quality is poor	1. Active infection of the soft-tissue envelope 2. Deformity with extensive bone loss requiring bone block grafting 3. Rigid deformity



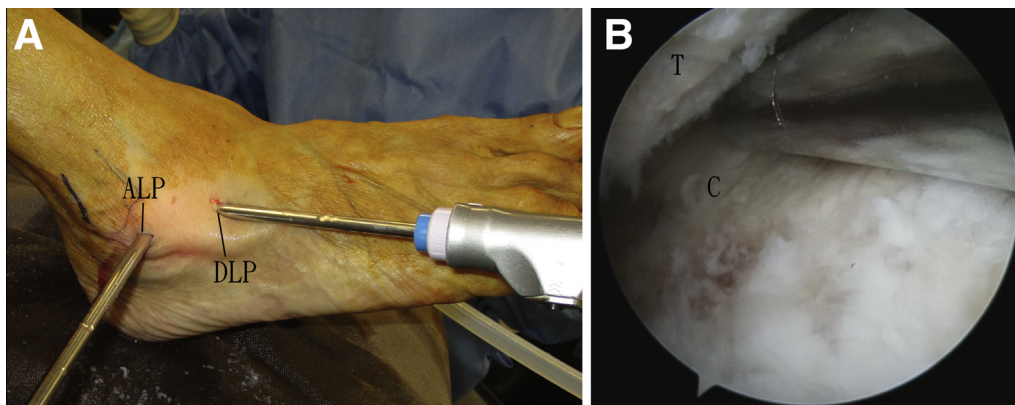
**Fig 1.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in the supine position with the legs spread. Radiographs of the illustrated foot showed severe flatfoot deformity with no coverage of the talar head. (A) Dorsoplantar view. (B) Lateral view.

midfoot, and forefoot deformity is assessed clinically. Any significant soft-tissue imbalance is determined. Standing radiographs of the foot and ankle are important for studying the different components of the deformity and the presence of arthritic joints (Fig 1).

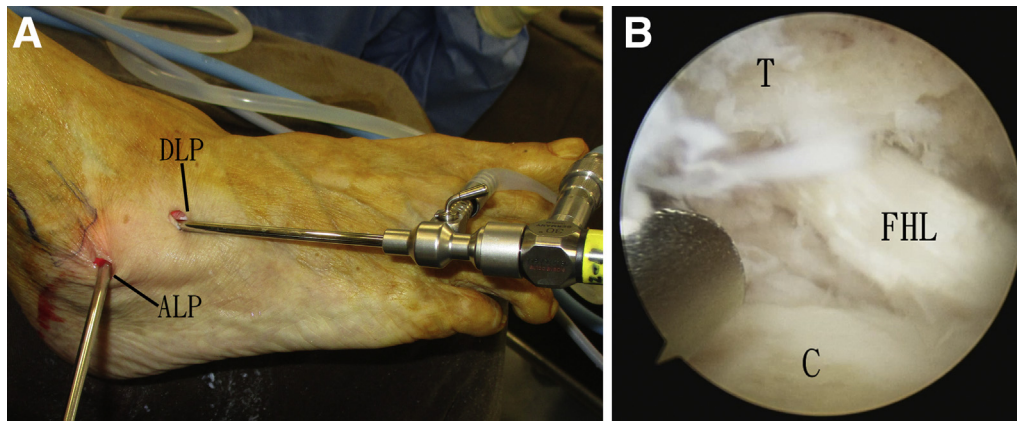
The patient is in the supine position with the legs spread. A thigh tourniquet is applied to provide a bloodless operative field. A 4.0-mm 30° arthroscope (Dyonics, Smith and Nephew, Andover, MA) is used for this procedure. Fluid inflow is by gravity and no arthropump is used.

### Portal Placement

Anterolateral subtalar, dorsolateral midtarsal, and medial midtarsal portals are used for this procedure. The anterolateral subtalar portal is just dorsal to the angle of Gissane. The dorsolateral midtarsal portal is at the junction between talonavicular and calcaneocuboid joints. The medial midtarsal portal is at the medial edge of the talonavicular joint, just dorsal to the navicular insertion of the posterior tibial tendon. Five-millimeter incisions are made at the portal sites.<sup>2-5</sup>



**Fig 2.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. (A) The anterolateral subtalar portal is the viewing portal and the dorsolateral midtarsal portal is the working portal. (B) The cartilage and the subchondral bone of the anterior and lateral parts of the joint are removed by an arthroscopic shaver and arthroscopic acromionizer. (ALP, anterolateral subtalar portal; C, calcaneus; DLP, dorsolateral midtarsal portal; T, talus.)



**Fig 3.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. (A) The dorsolateral midtarsal portal is the viewing portal and the anterolateral subtalar portal is the working portal. (B) The cartilage and the subchondral bone of the posterior and medial parts of the joint are removed by the shaver and acromionizer. (ALP, anterolateral subtalar portal; C, calcaneus; DLP, dorsolateral midtarsal portal; FHL, flexor hallucis longus tendon; T, talus.)

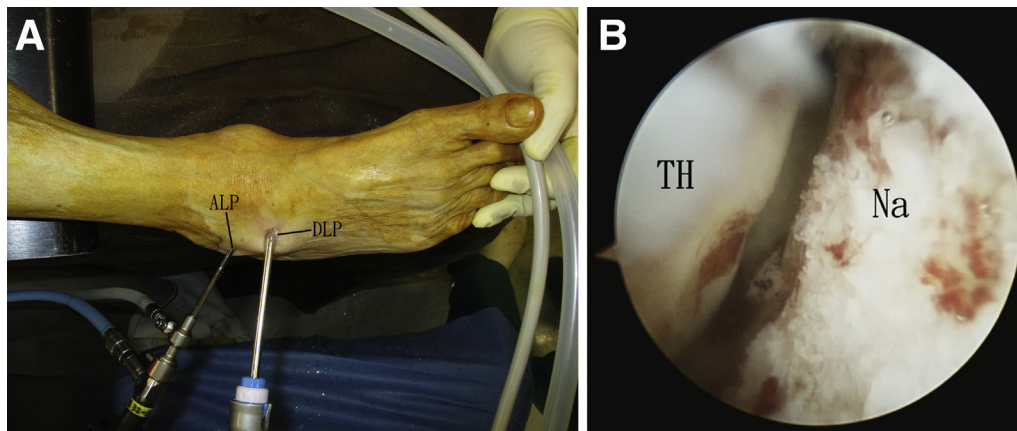
### Posterior Subtalar Arthroscopy

Posterior subtalar arthroscopy is performed via the anterolateral subtalar and dorsolateral midtarsal portals. The portals are interchangeable as the viewing and working portals.

The anterolateral subtalar portal is the viewing portal and the dorsolateral midtarsal portal is the working portal. The cartilage and the subchondral bone of the anterior and lateral parts of the joint are removed by an

arthroscopic shaver (Smith and Nephew) and arthroscopic acromionizer (Dyonics) (Fig 2).

The dorsolateral midtarsal portal is the viewing portal and the anterolateral subtalar portal is the working portal. The cartilage and the subchondral bone of the posterior and medial parts of the joint are removed by the shaver and acromionizer. The surgeon should be careful not to damage the flexor hallucis longus tendon at the medial side of the joint (Fig 3).



**Fig 4.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. (A) The anterolateral subtalar portal is the viewing portal and the dorsolateral midtarsal portal is the working portal. The foot is inverted to facilitate access to the lateral part of the talonavicular articulation. (B) The cartilage and the subchondral bone are removed by means of the shaver and acromionizer. (ALP, anterolateral subtalar portal; DLP, dorsolateral midtarsal portal; Na, navicular bone; TH, talar head.)

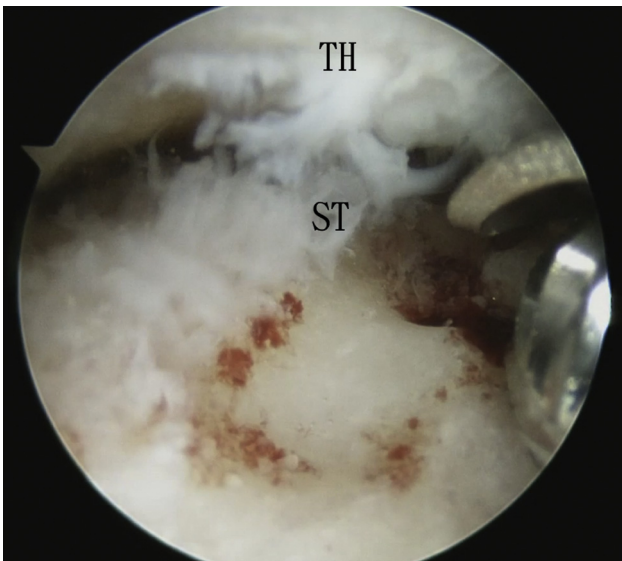




**Fig 5.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. The medial midtarsal portal is established by inside out technique. The arthroscopic trocar-cannula is inserted via the dorsolateral midtarsal portal, through the plantar part of the articulation to the medial midtarsal portal. (A) Dorsoplantar view. (B) Lateral view. (C) Anteroposterior view. (DLP, dorsolateral midtarsal portal; MP, medial midtarsal portal.)

### Talocalcaneonavicular Arthroscopy

Talocalcaneonavicular arthroscopy is performed via all 3 portals. The lateral part of the anterior talocalcaneal and talonavicular articulation can be accessed via the anterolateral subtalar and dorsolateral midtarsal portals. Foot inversion can facilitate access to the lateral part of the talonavicular



**Fig 6.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. With the dorsolateral midtarsal portal as the viewing portal and the medial midtarsal portal as the working portal, the cartilage and subchondral bone of the medial part of the anterior talocalcaneal articulation are removed. (ST, sustentaculum tali; TH, talar head.)

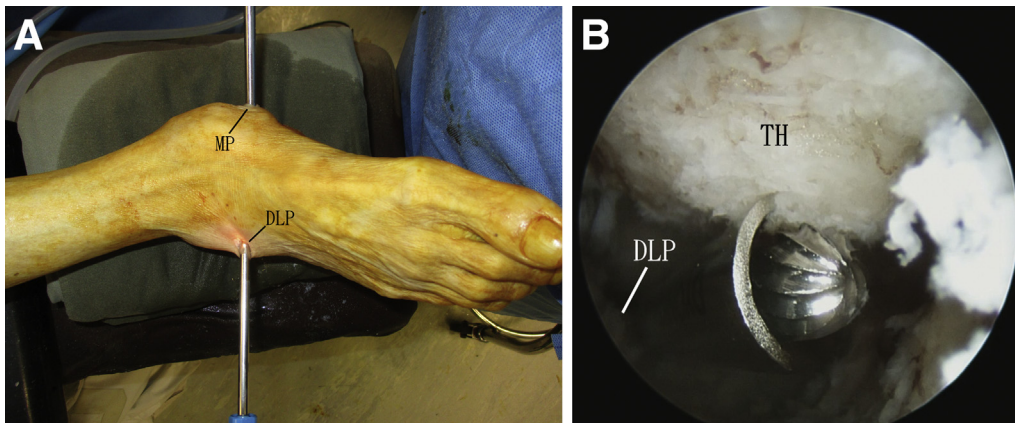
articulation. The portals are interchangeable as viewing and working portals. The cartilage and the subchondral bone of the anterior talocalcaneal articulation are removed by means of the shaver and acromionizer (Fig 4).

The talonavicular articulation is accessed via the dorsolateral and medial midtarsal portals. Because of the severe deformity, the surface landmarks of the medial midtarsal joint are distorted. The medial midtarsal portal is established by inside out technique. The arthroscopic trocar-cannula is inserted via the dorsolateral midtarsal portal through the plantar part of the articulation to the medial midtarsal portal. The hindfoot valgus deformity is corrected manually and the great toe is dorsiflexed during passage of the trocar-cannula. This can facilitate passage of the trocar-cannula and reduce the risk of medial plantar nerve injury (Fig 5).<sup>7</sup> With the dorsolateral midtarsal portal as the viewing portal and the medial midtarsal portal as the working portal, the cartilage and subchondral bone of the medial part of the anterior talocalcaneal articulation are removed (Fig 6).

The dorsolateral and medial midtarsal portals are interchangeable as the viewing and working portals for arthroscopy of the talonavicular arthroscopy. The cartilage and the subchondral bone are removed (Fig 7).

### Calcaneocuboid Arthroscopy

Calcaneocuboid arthroscopy is performed with the medial midtarsal portal as the viewing portal and the dorsolateral midtarsal portal as the working portal. The arthroscope passes through the medial portal and the talonavicular joint to get a bird's-eye view of the calcaneocuboid joint. The cartilage and subchondral bone are removed (Fig 8).



**Fig 7.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. (A) The medial midtarsal portal is the viewing portal and the dorsolateral midtarsal portal is the working portal. (B) Cartilage of the plantar part of the talar head is removed with an arthroscopic acromionizer. (DLP, dorso-lateral midtarsal portal; MP, medial midtarsal portal; TH, talar head.)

### Deformity Correction

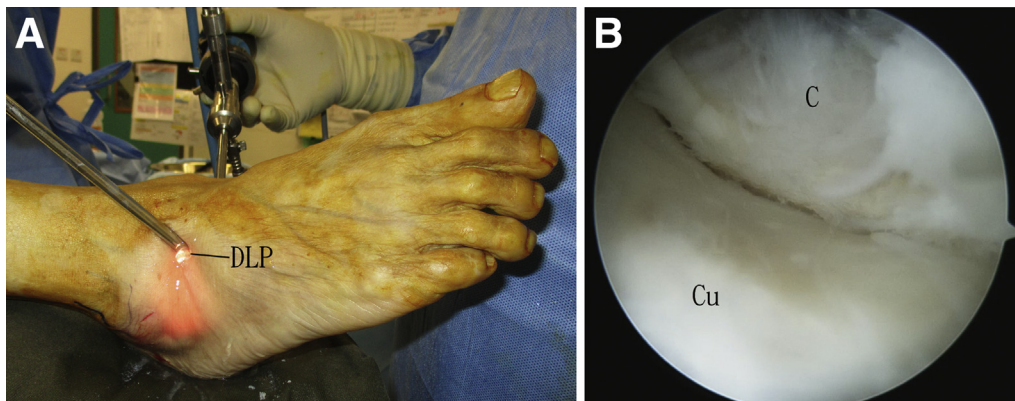
The hindfoot deformity is corrected and the subtalar joint are transfixated with 7.3-mm cannulated screws (Synthes, West Chester, PA).

A 2-mm K wire (Zimmer, Warsaw, IN) is inserted into the navicular as a joystick to correct the forefoot supination deformity before insertion of the guide pin (Fig 9). The talonavicular joint is then transfixated with 2 to 3 4.0-mm cannulated screws (Synthes) (Fig 10, Table 2, Video 1).

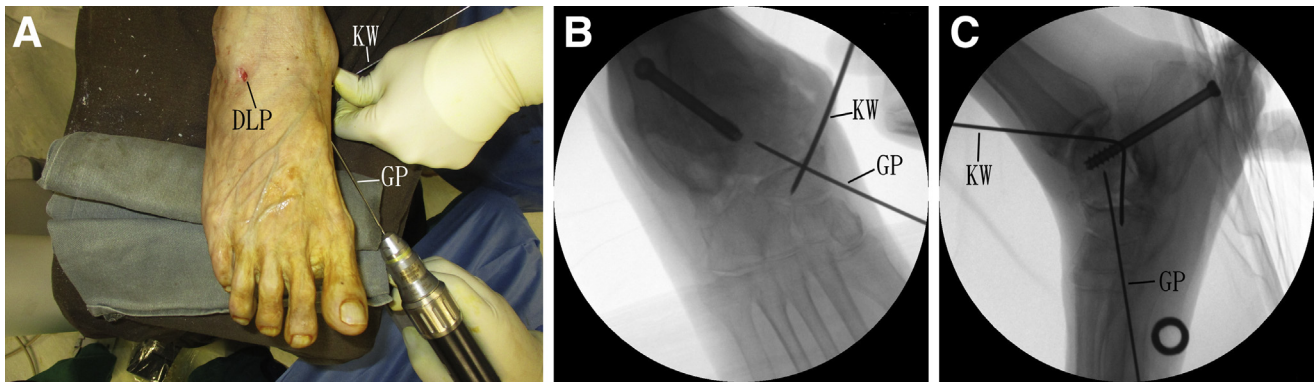
Postoperatively, the foot is immobilized in a short leg cast and the patient is advised to be non-weightbearing for 6 to 8 weeks. After that, the patient can start partial weightbearing walking with a removable rocker boot for another 4 weeks before full weightbearing is allowed.

### Discussion

The inclusion of the anterior subtalar joint in this arthroscopic triple arthrodesis approach increases the



**Fig 8.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. (A) Calcaneocuboid arthroscopy is performed with the medial midtarsal portal as the viewing portal and the dorsolateral midtarsal portal as the working portal. (B) The arthroscope passes through the medial portal and the talonavicular joint to get a bird eye view of the calcaneocuboid joint. (C, calcaneus; Cu, cuboid bone; DLP, dorsolateral midtarsal portal.)

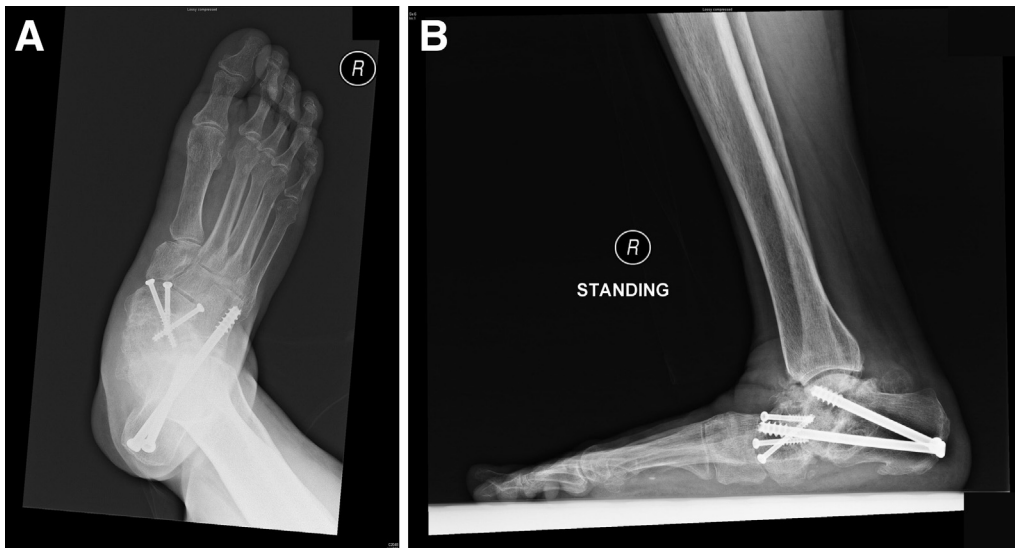


**Fig 9.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. (A) K wire is inserted into the navicular and is used as a joystick to derotate the midfoot. Fluoroscopic views: (B) dorsoplantar, (C) lateral); correction of the flatfoot deformity is shown. DLP, dorsolateral midtarsal portal; GP, guide pin; KW, K wire.)

area of fusion without the need of additional portal.<sup>8</sup> Decortication of the fusion surfaces is used in this approach because bone removal may facilitate deformity correction especially reduction of the talonavicular joint and rotatory correction of midfoot deformity.<sup>4,5</sup> In contrast to the 2-portal approach, this 3-portal approach allows a thorough preparation of all fusion surfaces as the 6-portal approach.<sup>8</sup>

This arthroscopic technique has the advantage of improved intra-articular visualization, thorough fusion

surface preparation, preservation of osseous blood supply, and fewer soft-tissue complications such as wound dehiscence and infection, neurovascular damage, and scar tethering. The potential risks of this technique include injury to the superficial and deep peroneal nerves, sural nerve, peroneal tendons, and long extensor tendons, nonunion, and malunion (Table 3).<sup>8,9</sup> This is technically demanding and should be reserved for the experienced foot and ankle arthroscopist.



**Fig 10.** Correction of severe flatfoot deformity of the right foot by 3-portal arthroscopic triple arthrodesis. The patient is in supine position with the legs spread. Postoperative radiographs showed correction of the flatfoot deformity. (A) Dorsoplantar view. (B) Lateral view.



**Table 2.** Pearls and Pitfalls of Correction of Severe Flatfoot Deformity by 3-Portal Arthroscopic Triple Arthrodesis

Pearls	Pitfalls
1) The hindfoot is inverted and the great toe is plantarflexed during establishment of the medial midtarsal portal facilitate passage of the trocar-cannula through the talonavicular joint and reduce the risk of medial plantar nerve injury	1) Uneven decortications of different joints may avoid even compression of the fusion surfaces.
2) Manipulation of the navicular bone by joy-stick technique can ensure correct positioning of the talonavicular joint which is the key to realign the hindfoot and midfoot	2) The trocar-cannula should exit dorsal to the navicular insertion of the posterior tibial tendon to avoid injury to the medial plantar nerve

### References

- Jagodzinski NA, Parsons AM, Parsons SW. Arthroscopic triple and modified double hindfoot arthrodesis. *Foot Ankle Surg* 2015;21:97-102.
- Lui TH. New technique of arthroscopic triple arthrodesis. *Arthroscopy* 2006;22:464.
- Lui TH. Arthroscopic triple arthrodesis in patients with Müller Weiss disease. *Foot Ankle Surg* 2009;15:119-122.
- Lui TH. Case report: correction of neglected club foot deformity by arthroscopic assisted triple arthrodesis. *Foot Ankle Surg* 2014;20:135-139.
- Lui TH. Arthroscopic triple arthrodesis in management of chronic flatfoot deformity. *Arthrosc Tech* 2017;6:e871-e877.

**Table 3.** Advantages and Risks of Correction of Severe Flatfoot Deformity by 3-Portal Arthroscopic Triple Arthrodesis

Advantages	Risks
1) Improved intra-articular visualization	1) Injury to the superficial and deep peroneal nerves and sural nerve
2) Thorough fusion surface preparation	2) Injury to the peroneal tendons and long extensor tendons
3) Preservation of osseous blood supply	3) Nonunion
4) Fewer soft-tissue complications such as wound dehiscence and infection, neurovascular damage, scar tethering	4) Malunion

- Hughes AM, Gosling O, McKenzie J, Amirfeyz R, Winson IG. Arthroscopic triple fusion joint preparation using two lateral portals: A cadaveric study to evaluate efficacy and safety. *Foot Ankle Surg* 2014;20:135-139.
- Lui TH, Mak CYD. Arthroscopic approach to the spring (calcaneonavicular) ligament. *Foot Ankle Surg* 2018;24:242-245.
- Lui TH, Chan LK. Safety and efficacy of talonavicular arthroscopy in arthroscopic triple arthrodesis. A cadaveric study. *Knee Surg Sports Traumatol Arthrosc* 2010;18:607-611.
- Hammond AW, Phisitkul P, Femino J, Amendola A. Arthroscopic debridement of the talonavicular joint using dorsomedial and dorsolateral portals: A cadaveric study of safety and access. *Arthroscopy* 2011;21:228-234.