Arthroscopic and Endoscopic Management of Posttraumatic Hindfoot Stiffness

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Abstract

Ankle, hindfoot, and toe stiffness can result from hindfoot trauma. It can be due to capsular fibrosis, tendon adhesion, muscle fibrosis, or malunion. For symptomatic stiffness that is resistant to nonoperative treatment, operative treatment should be considered. It is important to tackle the sources of stiffness, and careful preoperative clinical assessment is the key for proper formulation of the surgical plan. Whenever possible, arthroscopic/endoscopic surgery is preferable to open surgery because less extensive dissection and small surgical incisions allow immediate vigorous mobilization of the foot and ankle.

Keywords: *Adhesion, ankle, arthroscopy, endoscopy, fracture, malunion, stiff, subtalar, talocalcaneonavicular, talonavicular, talus, tendon*
MeSH terms: *Arthroscopy; endoscopy; tarsus; ankle*

Introduction

Stiffness problems following hindfoot trauma can result from various injuries to the bones, joints, or soft tissues including skin, muscle, and tendons. This can also partly related to the surgical and nonsurgical treatments that was required for the initial injury. Open surgery can further superimpose trauma on to the injured tissue and implants can cause some sort of impingement problems. Cast immobilization can also result in subsequent stiffness problems. Stiffness following hindfoot trauma may not be limited to the hindfoot region, and can involve the ankle and toes. The cause of stiffness can potentially be a combination of articular, osseous, tendon or other soft tissue causes. In the articular causes of hindfoot stiffness, calcaneal fractures can have an intraarticular extension to the anterior and posterior subtalar joints, and the calcaneocuboid joint and talar fractures can extend to the ankle, anterior and posterior subtalar joints and the talonavicular joint. These intraarticular injuries together with the added surgical trauma of open reduction and internal fixation of these fractures will cause significant fibrosis of the capsule and juxta-articular soft tissues, resulting in ankle or hindfoot stiffness. In addition, posttraumatic arthrosis of the involved joints can also result in stiffness problems. Some implants, especially plating of the calcaneum, can also have the potential to cause impingement and limitation of hindfoot motion. It is important to note that talar and calcaneal malunions, especially the intraarticular ones, can also result in limitation of the ankle or subtalar motion. Extraarticular malunion with the lateral calcaneal cortical bulge and calcaneofibular impingement can lead to the limitation of hindfoot eversion. Open fracture or fracture-dislocation can lead to extensive soft-tissue injury. The resulting tendon impingement or tendon rupture can cause extensive peritendinous fibrous adhesions. This can cause stiffness of the adjacent joints and the joints distal to the fibrosis. Due to the communication between the calcaneal compartment and the deep posterior compartment of the leg, calcaneal fracture can lead to subclinical distal deep compartment syndrome and fibrosis of the distal part of the flexor hallucis longus (FHL) muscle.[1] This can present with deep posteromedial ankle pain, hallux flexus, hallux rigidus, or checkrein deformity of the hallux.

For symptomatic stiffness that is resistant to nonoperative treatment, for example, physiotherapy and orthotic treatment, operative treatment should be considered. Whenever possible, arthroscopic/endoscopic surgery is preferable to open surgery.

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Less extensive dissection and small surgical incisions of arthroscopic/endoscopic surgery allow immediate vigorous mobilization of the foot and ankle which is an important component of rehabilitation. Moreover, the magnified arthroscopic view allows assessment and treatment of concomitant intraarticular and extraarticular pathologies.

Indications and Contra-indications

Surgery for this condition is indicated for symptomatic stiffness due to capsular fibrosis, bony impingement, certain types of fibrosis adhesions of the tendons and muscles.

Surgery for improving motion is contraindicated if there is severe arthrosis of the involved joint. Improvement of the joint motion may accelerate the degeneration process. It is also contraindicated if there is significant malunion of the calcaneus or talus requiring corrective osteotomy. Patient expectation is also important; if the patient cannot understand that surgery is for symptom control rather than substantial improvement of range of motion, operative indication is contraindicated.

Operative Planning

The surgical plan should be individualized and should focus on tackling all the causes of stiffness. The types of injury and prior or primary surgery gives clue about the cause of stiffness. Calcaneal fractures, especially after open reduction and internal fixation through the lateral approach, usually result in limitation in hindfoot inversion. Talar fractures also can result in either limitation in inversion or eversion. In addition, the surgical approach used for the reduction and fixation of the talar fracture can have some bearing on the direction of symptomatic stiffness. For example, the anteromedial approach to the talus can result in fibrous adhesion of the medial capsule of the talo-calcaneonavicular joint and limitation in hindfoot eversion.

To determine the cause of stiffness, the location of symptomatic stiffness should be determined clinically. The range of motion of the affected joint should be checked, and direction of motion that is symptomatic should be determined. In case of stiff ankles[2,3] as a result of talar fracture, symptomatic limitation of ankle dorsiflexion can be due to posterior ankle contracture problems (capsular fibrosis, FHL tendon adhesion, FHL muscle fibrosis, Achilles tendon fibrosis) or anterior ankle impingement problems (anterior osteophytes as a result of posttraumatic arthrosis or talar neck malunion). Similarly, symptomatic limitation of ankle plantar flexion can be a result of anterior ankle contractures (capsular fibrosis, extensor tendon adhesion) or posterior ankle impingement (posterior calcaneal bone spike following malunion of joint depression type calcaneal fracture,[4] posterior talar body malunion, prominent posterior screw head of the talus or posterior osteophytes as a result of posttraumatic arthrosis). Symptomatic limitation of hindfoot inversion is usually due to fibrosis of the lateral capsule of the posterior subtalar (talocalcaneal) joint and/or anterior subtalar (talocalcaneonavicular) joint or fibrosis around the peroneal tendons. Symptomatic limitation of hindfoot eversion can be due to lateral impingement (calcaneofibular impingement or lateral calcaneal implants) or medial contracture (fibrosis of FHL, flexor digitorum longus [FDL], and posterior tibial tendons or fibrosis of medial capsule of the anterior subtalar (talocalcaneonavicular) joint).

The location of pain on the motion is identified and any corresponding local tenderness should be noted. The site of tenderness is the most important sign to determine what structures are involved. Any check-rein or fixed toe deformity may signify fibrous adhesions of the toe flexor or extensor tendons around the ankle and hindfoot region. Radiographs of the foot and ankle can detect any posttraumatic arthrosis of the involved joint and the locations and status of implants if present. Any malunion of the talus or calcaneus causing impingement is noted. Computed tomogram can be useful to study the geometry of the bony impingement. Magnetic resonance imaging can be helpful to evaluate the condition of the juxta-articular soft tissues, for example, fibrosis around the tendons, but an experienced radiologist trained in musculoskeletal radiology is mandatory. Arthrogram is an invasive investigation, which is sometimes used to confirm capsular contracture of the involved joint. However, all these investigations cannot replace detailed clinical assessment.

Case Illustration

A 31-year-old female had screw fixation of her left talar neck fracture through anteromedial approach. The fracture healed without evidence of avascular necrosis of the talus or arthrosis of the talonavicular or subtalar joint [Figure 1]. She was referred to our clinic for persistent medial heel pain on walking. Clinical examination revealed that there was no hindfoot malalignment. The hindfoot inversion motion is comparable to the contralateral foot but no hindfoot eversion can be demonstrated. The patient complained of medial heel pain on the hindfoot eversion stress test. There was mild tenderness over medial side of the talocalcaneonavicular joint. The symptoms did not relieve by conservative treatment including physiotherapy and insole. Arthroscopic release of medial half of the talocalcaneonavicular joint was performed 2 years after the injury. The patient was put into the supine position with the legs spread. Medial talonavicular arthroscopy was performed with the medial and dorsomedial midtarsal portals [Figure 2]. The medial midtarsal portal was just above the navicular insertion of the tibialis posterior tendon. The dorsomedial midtarsal portal is at the dorsal apex of the talonavicular joint. The portals were interchangeable as the viewing and working portals. The dorsomedial capsule of the talonavicular joint was released with an arthroscopic shaver [Figure 3]. Following this, medial subtalar arthroscopy is performed with the

medial midtarsal and medial tarsal canal portals [Figure 4]. The medial tarsal canal portal was at the level of subtalar joint, just posterior to the tibialis posterior tendon. The portals are interchangeable as the viewing and working portals. The capsule is stripped from the sustentaculum tali with an arthroscopic shaver [Figure 5]. Active and passive mobilization was started on the postoperative day 1. The symptoms were subsided, and the hindfoot eversion motion was restored [Figure 6].

Arthroscopic Capsular Release

During the arthroscopic joint release, ligamentous structures are inevitably in the way. The surgeon should determine whether to release them for improvement of motion or preserve them for the stability of the joint.

Arthroscopic release of the ankle joint is performed with the patient in prone position. Posterior ankle endoscopic is performed with endoscopic resection of the posterior ankle capsule. This can improve the ankle dorsiflexion. The patient's knee is then flexed, and anterior ankle arthroscopy is performed in upside down manner. The anterior ankle capsule is stripped from the distal tibia to gain the ankle plantarflexion motion.[2,3] After that, any anterior ankle impingement should be assessed with the ankle dorsiflexed. The anterior ankle impinging bone should also be resected. Posterior ankle endoscopy is repeated after anterior ankle release to detect any posterior ankle impingement. The posterior ankle impinging bone is then resected.[4]

The release of the talocalcaneal joint is performed through the anterolateral, posterolateral, and middle subtalar portals.[5,6] The lateral capsule should be released, and the sinus tarsi and the posterior subtalar gutter should be cleared. The interosseous ligament should be preserved. The lateral release should be extended downward beyond the previous surgical scar to deal with both intraarticular and extraarticular causes of talocalcaneal stiffness. The same approach can be used for lateral calcaneal cortectomy in the case of calcaneofibular impingement.[7,8]

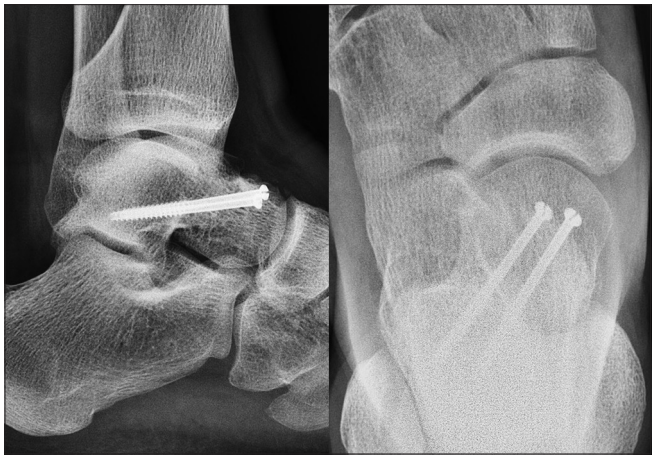

Figure 1: Radiographs of ankle and foot showing that the talar fracture healed without any degeneration of the talonavicular or subtalar joint

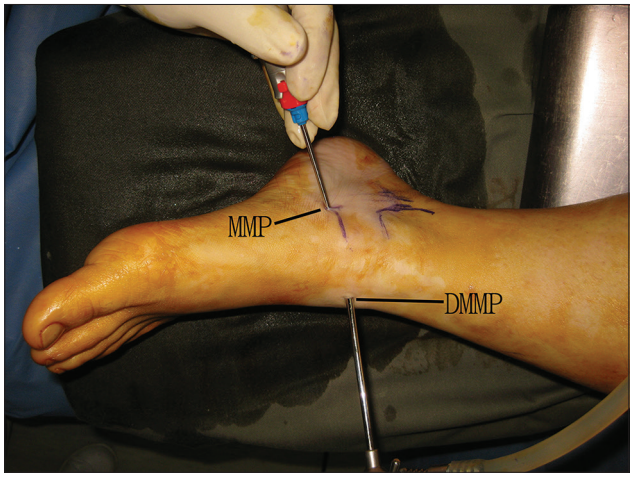

Figure 2: Medial talonavicular arthroscopy was performed with the medial and dorsomedial midtarsal portals. MMP: Medial midtarsal portal; DMMP: Dorsomedial midtarsl portal

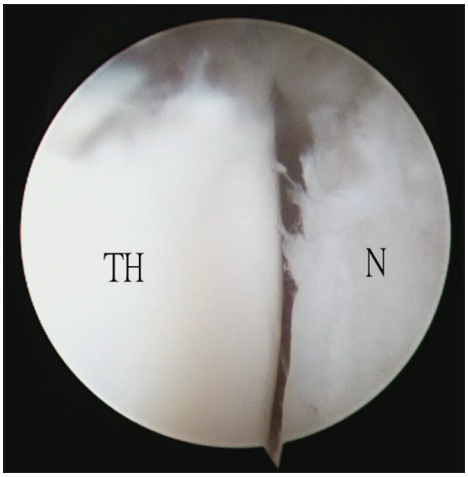

Figure 3: Arthroscopic view showing that the talar head can be moved dorsally upon hindfoot eversion stress test after arthroscopic release. TH: Talar head; N: Navicular

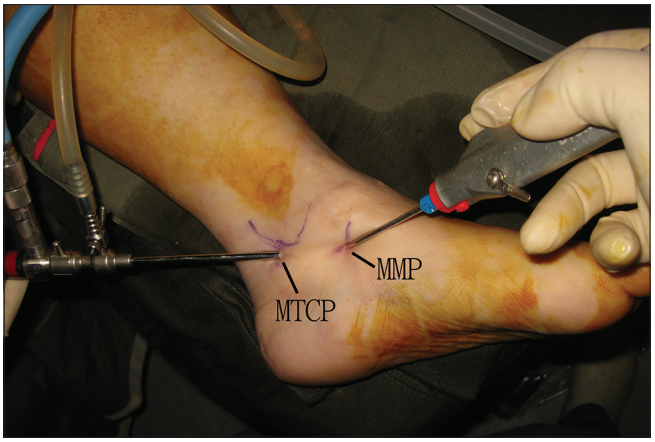

Figure 4: Medial subtalar arthroscopy is performed with the medial midtarsal and medial tarsal canal portals. MMP: Medial midtarsal portal; MTCP: Medial tarsal canal portal

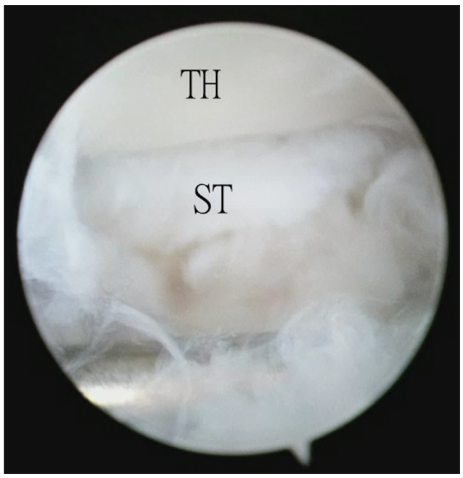

Figure 5: Arthroscopic view showing that the capsule was stripped from the sustentaculum tali. TH: Talar head; ST: Sustentaculum tali

Figure 6: Clinical photograph showing the hindfoot eversion motion restored after arthroscopic release

The symptomatic stiffness of the talocalcaneonavicular joint usually involves either the inversion or eversion motion. The release of the talocalcaneonavicular joint depends on what motion is the limited and complete release of the joint is seldom indicated. The release of the medial half of the joint is indicated if there is a symptomatic limitation of hindfoot eversion due to fibrosis of the medial joint capsule.[9] This is performed through the talonavicular[10,11] and medial subtalar[12] arthroscopy. Release of the lateral half of the joint is indicated if there is symptomatic limitation of hindfoot inversion due to fibrosis of the lateral joint capsule.[13] This is performed via the talonavicular[10,11] and anterior subtalar[14,15] arthroscopy. It is essential to preserve the spring ligament during talocalcaneonavicular release.

Endoscopic Adhesiolysis of the Tendons

Posttraumatic fibrous adhesion of the tendon can be classified into 3 types according to its relationship to the adjacent structures, for example, tendon, tendon sheath, bone, or retinaculum [Table 1]. This classification gives hints of what are needed to be released from the adhered tendon. It is much easier to release the adhered tendon from the adjacent bone than the release of the tendon from the fibrous tendon sheath or retinaculum. Fibrous adhesions of the extensor tendons at the ankle level belong to type 1B. The interface between the extensor tendons and the extensor retainculum is indistinct. Dissection can go into the wrong plane and damage the tendon or the retinaculum and putting the superficial and deep peroneal nerves and the anterior tibial artery at risk. Instead, complete anterior ankle arthroscopic capsulotomy[16] can be performed if there is a limitation in ankle plantar flexion due to extensor tendon adhesions to the anterior ankle capsule. The tendons remain to adhere the anterior capsule, which is now floating away from the ankle joint. If there is toe clawing due to extensor tendon adhesions, distal lesser toe extensor tenotomy and arthroscopically-assisted Z-lengthening of the extensor hallucis longus tendon[17] can be performed. Endoscopic adhesiolysis of the peroneal tendons and the posterior tibial, FDL and FHL tendons can be performed via the respective tendoscopic approaches.[18-23] Tendoscopy should be started from the normal nonscarred part of the tendon, the interface between the tendon and the peritendinous adhesions at the scarred zone can be identified. This can assure correct plane of adhesiolysis. The peritendinous adhesions are broken down with a small blunt end dissector and an arthroscopic shaver. It is important to make sure complete circumferential release along the whole span of the scarred zone. Fibrous adhesion of the Achilles tendon following hindfoot trauma can follow a severe crush injury[18] or open reduction and internal fixation of avulsion fracture of the Achilles tendon.[12] This can be treated by endoscopic adhesiolysis of the Achilles tendon with or without endoscopic calcaneoplasty.[18,24-27]

Table 1: Classification of posttraumatic fibrous adhesions of the tendons

Type 1: Single adhered tendon within a fibrous tendon sheath
Type 1A: No turning of the adhered tendon within the tendon sheath e.g., peroneal tendons at the peroneal tubercle level
Type 1B: The adhered tendon turns around fibrous tendon sheath or retinaculum e.g., extensor tendons at the ankle level
Type 1C: The adhered tendon turns around bone e.g., tibialis posterior tendon around the medial malleolus
Type 2: Single adhered tendon without fibrous tendon sheath e.g., Achilles tendon
Type 3: Closely related tendons that adhere to each other with or without a fibrous tendon sheath
Type 3A: With a fibrous tendon sheath e.g., peroneal tendons around the lateral malleolus
Type 3B: Without a fibrous tendon sheath e.g., FHL and FDL tendons at the master knot of Henry

FHL=Flexor hallucis longus, FDL=Flexor digitorum longus

Endoscopic Adhesiolysis of Flexor Hallucis Longus Muscle

Release of the distal part of the FHL muscle from the tibia can be performed via the posterior ankle endoscopy.[28,29] The

release starts from the lateral edge of the muscle and goes medially and proximally. Distal FHL tendon lengthening is indicated if there is extensive fibrosis of the FHL muscle or inadequate correction of the hallux deformity after adhesiolysis of the fibrotic muscle or tendon.

Conclusion

Stiffness after hindfoot trauma may involve the ankle, hindfoot or the toes. This can be due to bone, joint or soft tissue causes and surgical treatment should tackle the causes. Careful preoperative clinical assessment is the key for proper formulation of surgical plan. Whenever possible, arthroscopic/endoscopic surgery is preferable to open surgery because less extensive dissection and small surgical incisions allow immediate vigorous mobilization of the foot and ankle.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her consent for her images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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