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Treatment of hindfoot and ankle pathologies with posterior arthroscopic techniques

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- The two-portal hindfoot arthroscopy is an effective procedure enabling direct visualisation of posterior ankle pathology with low invasiveness.
- An important stage of the hindfoot endoscopy is localisation of the flexor hallucis longus (FHL) tendon to protect the neurovascular bundle which is located just medial to it.
- Posterior ankle impingement syndrome and FHL tenosynovitis are common causes of posterior ankle pain and frequently occur together.
- Posteriorly localised talar osteochondral lesions, Achilles tendon disorders, osteoarthritis, talar bone cysts and talar fractures are among the other pathologies that can be treated with hindfoot arthroscopy.

Keywords: hindfoot; posterior ankle; arthroscopy; FHL tenosynovitis; posterior ankle impingement syndrome

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Introduction

Hindfoot pathologies can be seen after acute traumatic incidents or as a sequelae of chronic conditions. In general, traditional open approaches can be used effectively for the treatment of these pathologies but open surgery of the hindfoot needs extensile dissections that can cause wound healing problems, require post-operative immobilisation and prolonged recovery. Since the description of the two-portal endoscopic approach to the hindfoot by van Dijk in 2000, it is a technique increasingly used for the treatment of hindfoot pathologies.[1] Posterior ankle impingement syndrome, flexor hallucis longus (FHL) tendon problems, osteochondral lesions, subtalar coalitions, osteoarthritis, talar bone cysts, talar fractures, Achilles paratendinitis, retrocalcaneal bursitis and Haglund's syndrome are the primary operative indications for arthroscopic treatment.[2,3]

Hindfoot abnormalities

Posterior Ankle Impingement Syndrome (PAIS)

PAIS is considered a clinical disorder which is characterised by posterior ankle pain that is usually aggravated by forced plantar flexion.[4,5] It can result from acute trauma or overuse.[6] Hyper-plantar flexion, supination or a combination of these are traumatic mechanisms that may displace the os trigonum or fracture a prominent posterolateral talar tubercle (Stieda process) and may cause posterior impingement.[3] PAIS associated with overuse is mainly found in ballet dancers, football players and downhill runners.[7,8] Forceful plantar flexion related to these activities can increase the pressure on anatomical structures between the calcaneus and tibia. In the presence of abnormalities such as os trigonum, hypertrophied posterior talar process or post-traumatic calcification, compression of these structures can cause hindfoot pain.

Clinical presentation

Diagnosis of PAIS is based on the history, physical examination and radiographic findings. Patients complain of pain over the posterior aspect of the ankle especially with forced plantar flexion.

Physical Examination

On examination, there may be posteromedial, posterolateral or diffuse posterior pain. The passive forced plantar flexion test is the most important test for diagnosis and a negative test rules out PAIS diagnosis.[9] A positive result should be followed by a posterolateral diagnostic infiltration. If the pain disappears after infiltration, the diagnosis is confirmed.

Diagnosis

Radiographic evaluation starts with standing anteroposterior (AP) and lateral ankle views. The AP view generally does not show any abnormalities. On the lateral view, an os trigonum can be seen or a predisposition to impingement can be predicted when a Stieda process, prominence of the

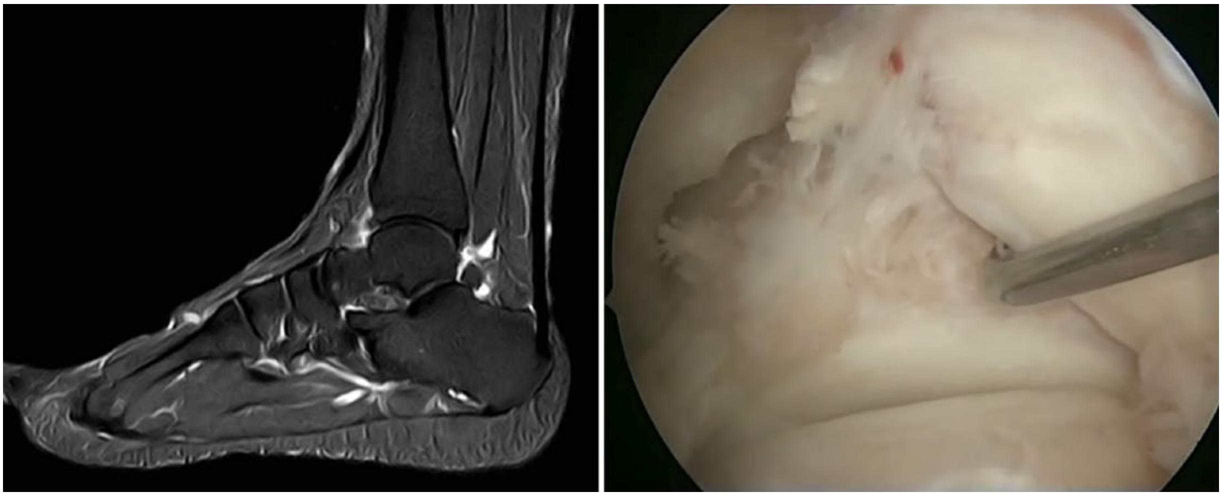

Fig. 1 MRI illustrating os trigonum and intra-operative view after release of symptomatic os trigonum.

posterior malleolus of the tibia or the posterior process of the calcaneus is seen.[10] The lateral view can also show osteophytes, calcification, loose bodies, chondromatosis and opacification of the Kager triangle.[3] If an os trigonum or calcifications cannot be detected on the lateral view, van Dijk recommends the use of lateral radiographs in 25° of external rotation to limit the superimposition of the posterolateral part on the medial talar tubercle.[9] CT shows the osseous abnormalities and can be used to determine the extent of injury and location of bony fragments in post-traumatic cases.[3] MRI is chosen to evaluate soft-tissue abnormalities including the FHL tendon. In post-traumatic cases, if radiographs do not show abnormalities, a bone scan can be performed and positive scans can be followed by CT (Fig. 1).[6]

Treatment

Conservative treatment includes rest, icing, bracing, anti-inflammatory drugs, physical therapy and discontinuing activities that aggravate symptoms by forced hyper-plantar flexion of the ankle joint.[11] If conservative treatment fails, surgical intervention should be considered. In cases of PAIS, the direct posterolateral approach may be used but with the development of hindfoot arthroscopy, its use is limited.

FHL Tendon Disorders

FHL tendon disorders are another cause of posterior ankle pain. Isolated injuries of the FHL generally occur at the level of the fibro-osseous tunnel behind the medial malleolus. This may be explained with the tendon's avascular zone at this level and relative incongruence of the tendon with the tunnel.[7,12] Hypertrophy of the tendon, a nodule, accessory FHL, or a low-riding muscle belly may also be associated with isolated tenosynovitis.[3,13] Because of the anatomical proximity of the FHL to the posterior talar process, tendonitis and posterior impingement may co-exist. Scholten et al reported that, among the patients with posterior impingement, 63% of them experienced involvement of the FHL tendon,[14] whereas Ögüt et al reported that all 60 feet with posterior ankle pain were accompanied by FHL tenosynovitis.[15]

Clinical Presentation

Patients with FHL tenosynovitis report pain at the posteromedial ankle and it is exacerbated by ankle motion and hallux dorsiflexion but diminishes with rest. Physical examination often reveals focal tenderness over the entrance to the FHL tunnel. Crepitus or a moving nodule may be felt.

Treatment

Conservative treatment is typically the first choice for the treatment of FHL disorders but it is a prolonged process and often does not completely resolve the symptoms.[3] Therefore patients who do not require an early return to athletic activity are suitable for conservative treatment.[11] In FHL tenosynovitis, stretching exercises of the FHL tendon should be considered as the initial treatment along with the traditional measures such as rest, ice, bracing and anti-inflammatory drugs.[10] Patients who are unresponsive to conservative treatment and athletes suffering from FHL tenosynovitis require surgical intervention.

Osteochondral Lesions (OLS) of the Talus

OLs of the talus are focal articular cartilage injuries which can involve the articular surface and/or the subchondral bone.[16] Medial lesions occur more frequently than lateral lesions. However, only 61% to 73% of medial lesions can be attributed to a traumatic incident. Laterally placed lesions are mostly attributed to a traumatic injury (93% to

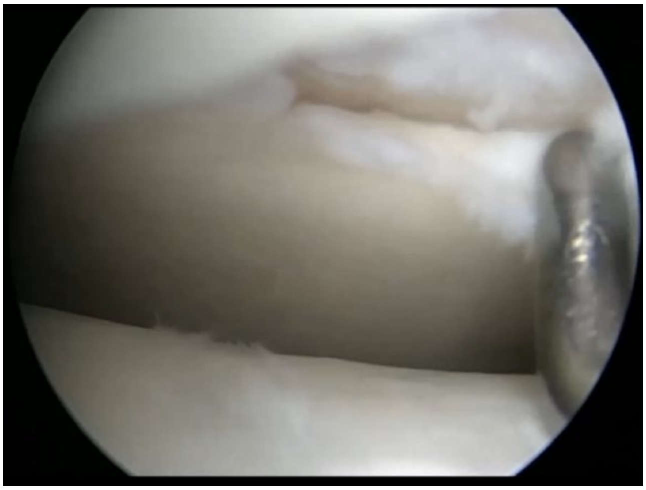

Fig. 2 Posteriorly localised tibial osteochondral lesions.

98%).[17] Arthroscopic management of talar OLs is considered the first-line treatment option.[18] But pre-operative determination of whether a lesion can be reached by anterior arthroscopy or not may be confusing. van Dijk proposed that 95% of all OLs in the ankle can be treated by an anterior arthroscopic approach but this can still be confusing for inexperienced surgeons.[19] To solve this problem, van Bergen et al proposed the evaluation of the ankles with a CT scan in full plantar flexion. In their study, they showed that almost half of the talar dome is situated anterior to tibial plafond when the ankle is held in full plantar flexion and, according to their findings, they concluded that talar OLs can be treated with anterior arthroscopy if the anterior border of the lesion can be reached.[20] Most lesions can be reached with an anterior approach but lesions located in the posterior third of the talus or lesions of the posterior tibial plafond can be treated with hindfoot arthroscopy alone.[19]

Clinical Presentation

Patients with OLs commonly present with pain and limited ankle movement. Effusion, locking or giving away can also occur and symptoms are usually exacerbated with prolonged weight-bearing. On physical examination, there is no specific test for diagnosis and findings on examination may vary from patient to patient. Palpation of the affected area may elicit pain. Posteromedial lesions may produce tenderness on the posterior aspect of the medial malleolus when the ankle is dorsiflexed.[21]

Diagnosis

Radiological evaluation starts with plain radiographs. If an OL is recognised, a CT is obtained to determine the size and location of the lesion. If no pathology is seen on radiographs, MRI is recommended because of its ability to show bony and soft-tissue lesions.

Treatment

Conservative treatment gives good results in children and adolescents, especially in the early stages of OLs.[22] It can also be chosen for asymptomatic lesions but this treatment is less successful in the adult population.[23] In their systematic review, Verhagen et al found that among 201 patients, only 91 patients (45%) reported a successful outcome.[24] Similarly, Zengerink et al reported a 49.1% success rate with conservative treatment.[25] For the acutely displaced lesions and for the ones who are unresponsive to conservative treatment, operative treatment is indicated. Common operative treatment methods include fixation of the acutely displaced fragment, debridement and microfracturing, osteochondral autograft transfer and mosaicplasty, matrix-induced autologous chondrocyte transplantation, autologous chondrocyte implantation and bulk allograft transplantation.[26] Among these, debridement and microfracturing is often used as first-line treatment and this is the most frequently performed technique for posteriorly localised lesions.[27]

Few studies reported long-term outcomes of debridement and microfracturing. In a recent study, Polat et al assessed the long-term clinical and radiographic outcomes of 82 patients with a mean follow-up of 121.3 ± 35.1 months (61 to 217).[18] They reported an improvement in mean AOFAS scores from 58.7 to 85.5 and concluded that arthroscopic microfracture is a good treatment option for OLs. Although it is an effective and relatively simple technique with low complication rates; location of the lesion (medial *vs* lateral), patient's age, deep lesions and medial lesions which are uncovered with medial malleolus are found to have inferior clinical outcomes.[28] Lesion size also seems to be an important parameter for outcome after arthroscopic treatment of OLs but there is confusion whether a cut-off that is associated with poorer outcomes exists or not. Choi et al hypothesised that a defect size may exist at which clinical outcomes become poor and evaluated the results of 125 ankles after microfracture.[29] Their linear regression analysis showed a cut-off defect size of 150 mm^2 and only 10/95 ankles (10.5%) smaller than 150 mm^2 showed clinical failure whereas defects $\geqslant$ 150 mm^2 had an 80% failure rate. Similarly, Chuckpaiwong et al reported a 100% success rate in patients with lesions > 15 mm in diameter (73 ankles) and only one of the 32 patients with lesions > 15 mm in diameter had a successful outcome.[30] Based on these findings, current literature suggests that microfracture is enough for lesions up to 15 mm in diameter but for larger lesions the risk of clinical failure is high. Thus use of replacement strategies are advised for a successful outcome (Fig. 2).[3,23,31-33]

Achilles Tendon-Related Disorders

Achilles tendon-related disorders can be simply classified as insertional, non-insertional (mid-portion) tendinopathies and retrocalcaneal bursitis.

Insertional Achilles Tendinopathy

Insertional Achilles tendinopathy occurs as a result of degeneration at the insertion of the tendon to the calcaneus. Along with the degeneration, varying degrees of calcification in the tendon and formation of bone spurs can be seen. It may be related to increased age, inflammatory arthropathies, obesity, hypertension, diabetes, lipidaemias and use of quinolone antibiotics.[34] Genetics, inappropriate training methods or equipment may also play a role in the development of tendinopathy.[35]

Clinical Presentation

Patients complain of pain that worsens with activity and stiffness in the morning. Difficulties with footwear may also be reported. On physical examination, the tendon insertion at the posterior aspect of the calcaneus is painful. In addition, a bony spur may be felt at the posterior border of the calcaneus.

Diagnosis

Although insertional Achilles tendinopathy is primarily a clinical diagnosis, radiographs may reveal a bony Haglund's deformity and MRI can be helpful to evaluate the degenerative process in the tendon.[34,36]

Retrocalcaneal Bursitis

Retrocalcaneal bursitis is a distinct entity and patients present with tenderness just anterior to the Achilles tendon insertion. Ankle dorsiflexion compresses the bursa between Achilles tendon and posterosuperior calcaneus thus producing an irritation that leads to bursitis.[34] Frequently, a posterosuperior calcaneal prominence (Haglund's deformity) accompanies bursitis.[36] The complex of superolateral calcaneal prominence, retrocalcaneal bursitis and Achilles tendinitis is referred as Haglund's syndrome.

Clinical Presentation

Patients usually present similarly to those with insertional Achilles tendinopathy and have a painful, irritated heel with a palpable osseous prominence over the posterosuperior heel.[34] The 'two-finger' squeeze test, squeezing the thickened bursa in a mediolateral direction, often elicits pain in patients with retrocalcaneal bursitis.[37]

Treatment

Treatment of insertional tendinopathy and retrocalcaneal bursitis is largely conservative and includes activity modification, non-steroidal anti-inflammatory medication, the use of orthoses or shoe-lifts, and physical therapy. Surgical treatment is rarely indicated, but in recalcitrant cases it may be useful to remove the degenerated parts of the tendon, the inflamed bursa and Haglund's deformity. Open and endoscopic approaches can be used for the treatment but delayed return to pre-operative activity level and high complication rates associated with open approaches favours the use of endoscopic surgery.

Mid-Portion Achilles Tendinopathy

Mid-portion Achilles tendinopathy is a painful condition of the tendon located 2 cm to 7 cm proximal to its calcaneal insertion. It is characterised by pain, swelling and impaired activity. Multiple factors such as gender, obesity, overuse or poor vascularity is linked to its development and it is usually accepted as an overuse injury seen in athletes and older individuals.[38,39]

Clinical Presentation

On presentation, the most common symptom is pain and accompanying nodular masses may be palpated. Nodularities within the tendon are usually associated with tendinopathy, whereas erythema and oedema may indicate an acute-onset paratendinopathy.[39]

Treatment

Initial treatment is conservative and includes rest, activity modification and eccentric Achilles exercises, but approximately 25% of patients need surgical intervention.[40] Open debridement, percutaneous tenotomies, minimally invasive tendon stripping, mini-open scraping, endoscopic debridement, plantaris tendon release and gastrocnemius recession are used surgical techniques with variable results.[41]

Subtalar Coalition

Subtalar coalition is an abnormal connection between talus and calcaneus that may produce pain and limitation of foot motion. Patients typically present between the ages of 12 and 16 years. Activity-related hindfoot and/or mid-foot pain is usually the initial complaint and occasionally patients may report recurrent ankle sprains because of restricted subtalar motion.[42]

Physical Examination

The major physical finding is decreased subtalar joint motion. Passive inversion and eversion of the calcaneus are limited or absent. Because of the limited subtalar motion, no hindfoot inversion occurs during toe raise.

Diagnosis

Radiographic examination should include AP, lateral, oblique and Harris views. The lateral view may show an anterior beak on the talus. On the Harris view, talocalcaneal coalition may appear as a bony bridge across the medial subtalar joint. However, CT is the best study for assessing a bony talocalcaneal coalition and MRI is more accurate in demonstrating fibrous coalitions.

Treatment

For skeletally mature patients with subtalar coalition or an adolescent patient with a painful subtalar coalition with the involvement of more than 50% of the subtalar joint, posterior arthroscopic subtalar arthrodesis can be the procedure of choice. In younger patients, without evidence of arthritis, arthroscopic coalition excision can be done.

Osteoarthritis of the Ankle and Subtalar Joints

Osteoarthritis of the ankle and subtalar joints primarily occur as a result of post-traumatic degeneration, thus it often affects younger patients. Other conditions that may lead to degeneration include posterior tibial tendon dysfunction, rheumatoid arthritis, primary osteoarthritis, osteonecrosis of the talus, post-infectious arthritis, crystalline arthropathies, haemochromatosis and neuropathic degenerative disease.

Treatment

Patients with end-stage arthritis who are unresponsive to conservative treatment are candidates for arthrodesis. Well-aligned ankles and those that are easily re-aligned are excellent candidates for arthroscopic fusion. Patients with soft-tissue compromise (e.g. those with prior trauma, burn victims and patients with skin grafts) or vasculopathy are also considered for an arthroscopic approach.[43] Isolated subtalar or combined tibiotalar and subtalar arthrodesis can be performed with the help of hindfoot arthroscopy.

Talar Cysts

Talar cysts are rare and they commonly present as simple bone cysts, intra-osseous ganglia and aneurysmal bone cysts. Patients typically complain of pain which increases with activity. The treatment of choice is curettage followed by cancellous bone grafting either with open surgery or arthroscopy/endoscopy.[44]

Talar Fractures

Talar fractures are rare and account for less than 2.5% of all fractures.[45] These injuries are usually associated with high-energy trauma, thus accompanying soft-tissue injuries are common. Because of the risk of soft-tissue compromise, which can be associated with the trauma or open surgery, the use of arthroscopy assistance has been proposed.[46-49] Two-part fractures of the talus without severe soft-tissue injury are the most suitable but arthroscopy-assisted surgery may also be combined with open surgery for comminuted fractures that require removal of loose bodies.[50] Although the use of arthroscopy has to be decided on a patient-specific basis, hindfoot arthroscopy can be used, especially for fractures that involve the posterior one-third of the talus.[50]

Contra-indications to hindfoot arthroscopy

Localised soft-tissue infection is the only absolute contra-indication to surgery, whereas severe oedema, vascular disease and moderate degenerative joint disease can be listed as relative contra-indications.[51]

Surgical technique

Pre-Operative Considerations

The surgical procedure can be performed on an outpatient basis with the patient under spinal or general anaesthesia. The patient is placed in a prone position with the foot and ankle positioned at the end of the table with a triangular cushion under the distal tibia. A thigh tourniquet is applied and inflated before the start of the procedure. Normal saline or Ringer solution can be used according to the surgeon's preference and gravity-aided flow is preferred. Routine use of distraction is not recommended but if needed we prefer to apply manual traction to the calcaneus.[51]

Portal Placement and Procedure

With the ankle maintained in a neutral position, a straight line, parallel to the sole of the foot, is drawn from the tip of the lateral malleolus to the Achilles tendon. The posterolateral portal is positioned just above this line, in front of the Achilles tendon. After making the skin incision, mosquito forceps are introduced to spread the subcutaneous layer. Then, the foot is plantarflexed and the mosquito is directed anteriorly in the direction of interdigital space between the first and second toe. When the forceps touch the bone, it is replaced by the arthroscopic cannula and trocar. They are positioned extra-articularly at the level of the posterior talar process and then the trocar is changed and replaced with a 4.0-mm 30° arthroscope

The posteromedial portal is made at the same level. After the skin incision, mosquito forceps are introduced towards the arthroscope shaft. When the forceps touch the shaft, the shaft is used as a guide and the forceps are directed with blunt dissection anterior to the scope. Once the arthroscope and clamp are both touching bone, the forceps are left in this position and the arthroscope is pulled slightly and tilted until the tip of the forceps comes into view. When the forceps are visualised, they are exchanged with a shaver. The shaver is introduced with the same steps as those used for forceps and then directed toward the lateral aspect of the subtalar joint to remove

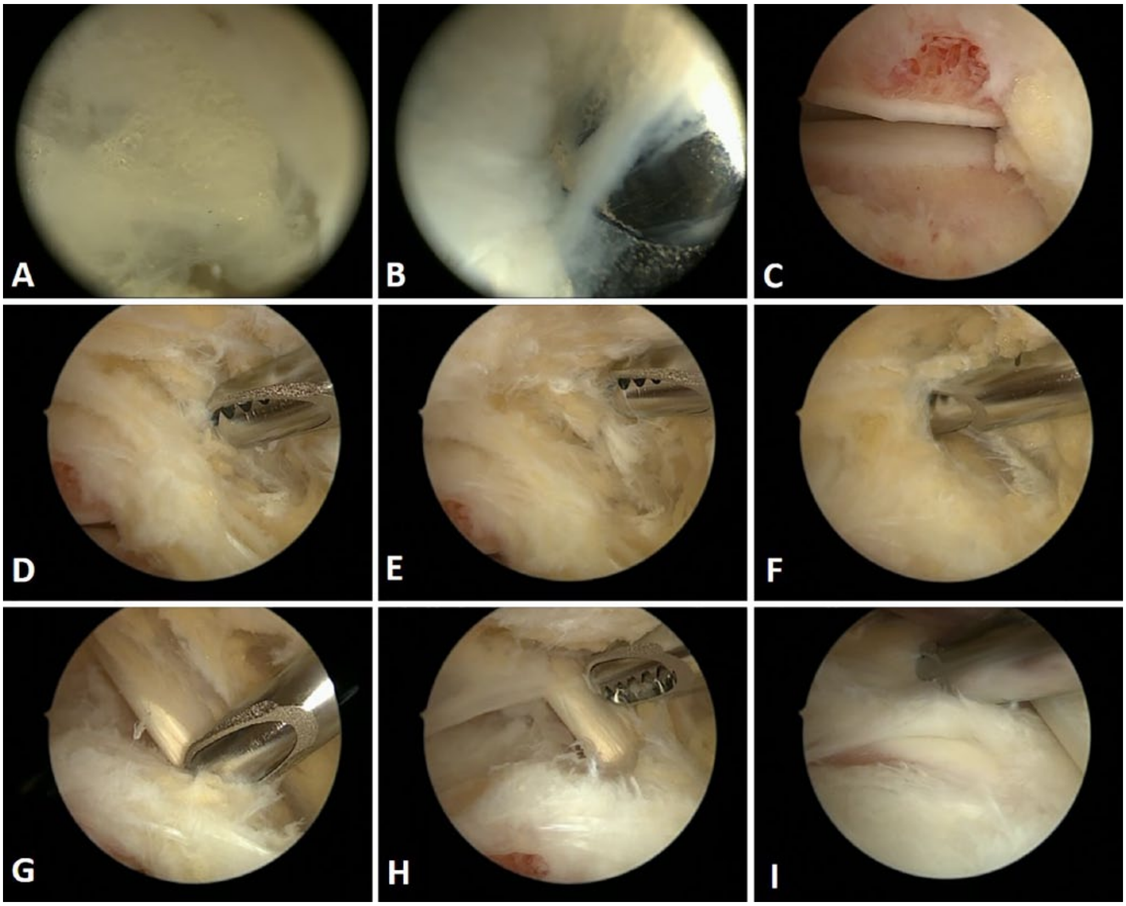

Fig. 3 Steps of hindfoot arthroscopy: a) initial look, once the arthroscope is introduced; b) shaver is brought into the view of the arthroscope; c) after a few turns of the shaver, fatty tissue and subtalar joint capsule are removed, d-h) identification of the flexor hallucis longus proximally and its release; i) transvers (posterior tibiofibular) ligament and ankle joint.

fatty tissue and the subtalar joint capsule. After removal of the joint capsule, the posterior aspect of the subtalar joint can be visualised.

Identification of the FHL tendon is an important step in order to prevent damage to the neurovascular bundle. The posterior talar process can be freed from Rouvière ligament and crural fascia to identify the FHL tendon. Motion of the first metatarsophalangeal joint can aid to differentiate FHL fibres. After identification of the FHL, surgery commences to treat the underlying cause (Fig. 3).

Removal of the os trigonum or posterior talar process requires partial detachment of the posterior talofibular ligament, release of flexor retinaculum and release of the posterior talocalcaneal ligament.[3] After the release of these structures, the os trigonum can be removed with an osteotome or chisel.

Release of the FHL tendon requires detachment of the flexor retinaculum from the posterior talar process. The distal aspect of the FHL tendon can be further released under direct vision with a shaver or punch. After these procedures, smooth sliding of the FHL tendon is checked by passive dorsal and plantar flexion of the ankle and hallux.

For the treatment of OLs or talar cysts, the ankle joint must be visualised. To access the ankle joint, first the posterior talofibular and then the intermalleolar and posterior tibiofibular ligaments are identified. The intermalleolar and posterior tibiofibular ligaments can be elevated to enter and inspect the ankle joint.[51] The talar dome is inspected and the defect is localised with the help of a probe. Once the unstable cartilage is removed by probe, curette or shaver, microfracture can be performed with the help of a microfracture probe.[19] A soft-tissue distractor can be used to aid visualisation of intra-articular pathology but we prefer to use manual distraction of the calcaneus and dorsiflexion of the ankle (Fig. 4).

Calcaneoplasty and resection of the retrocalcaneal bursa can be performed endoscopically. For the endoscopic approach, portals should be located as close as possible to the superior edge of the calcaneus.[52] Then, the arthroscope is positioned in the retrocalcaneal space and retrocalcaneal bursa is resected with a shaver. After this,

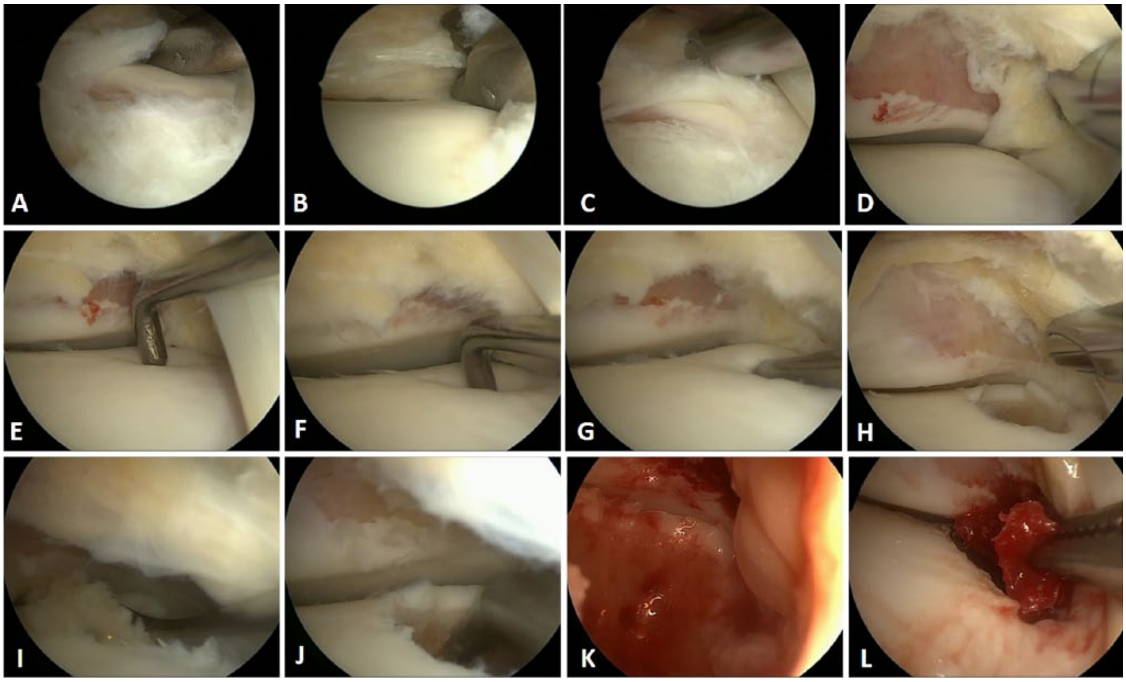

Fig. 4 Hindfoot arthroscopy for a posteriorly localised talar cyst and accompanying osteochondral lesions. a-d) step-by-step visualisation of the ankle joint; e-g) localisation of the lesion with the probe; h) pathological chondral fragments are removed; i) removal of the soft-tissue component of the cyst; j) after through debridement, microfracture is performed; k) fluid flow is stopped prior to autograft application; l) introduction of the autografts with the help of a forceps.

the posterior surface of the calcaneus opposite the Achilles tendon and calcaneal exostosis are resected. For a complete resection, portals may be used interchangeably and the amount of resection can be checked fluoroscopically.

Endoscopic approach to Achilles tendinopathy and paratendinopathy involves the release of adhesions of the paratendineum, denervation of the tendon, removal of pathological peritendinous tissue and endoscopic release of the plantaris tendon.[53] The distal portal is made first, 2 cm to 3 cm distal to the pathological nodule and located on the lateral border of the Achilles tendon. The proximal border is located on the medial side, 2 cm to 3 cm proximal to the nodule. Next, a blunt trocar is used to release the peritendinous tissue from the Achilles.[53] The trocar is then replaced by the arthroscope and under direct vision the proximal portal is prepared. Once both portals are established, adhesions, the tendinopathological area, plantaris tendon and paratenon can be identified and removal or release of pathological tissues can be performed.[54]

In the presence of subtalar coalitions, a shaver and burr may be used to excise the coalition. When the coalition involves less than 50% of the subtalar joint without arthritis or a posterior arthroscopic subtalar arthrodesis procedure is performed, this requires a preliminary removal of the coalition and remaining cartilage.[33]

Arthritic ankle and subtalar joints can be debrided and osteophytes resected[15] or, in cases with combined involvement, both joints can be fused simultaneously by hindfoot arthroscopy. Use of the arthroscope reduces the size of wounds and therefore the potential for post-operative bleeding and soft-tissue complications such as haematoma and infection.[55] It also allows better control of alignment, ease of fixation with a hindfoot fusion nail or screws and protects the major blood supply to the talus.[33]

Selected talar body fractures can be treated arthroscopically. Arthroscopy-assisted surgery permits removal of free-floating, intra-articular osteochondral fragments, direct visual assessment of fracture reduction and fixation stability as in the open technique, while causing minimal disruption to the remaining intact talar blood supply.[56]

Post-Operative Management

Typically, the patient is instructed to keep the foot elevated as often as possible for the first seven to ten days after surgery to prevent excessive post-operative swelling. Partial weight-bearing may be allowed as tolerated but when more severe osseous pathology is addressed, the management is modified. Early range of motion exercises may be started and finally patients may be directed to a physical therapy regimen to restore strength and range of motion to the great toe and ankle.[3]

Outcomes

In 2008, Scholten et al reported the results of 55 patients with PAIS.[14] After a mean follow-up of 36 months, they reported that the median AOFAS score improved from 75 points pre-operatively to 90 points post-operatively with only one complication (temporary loss of sensation of the posteromedial heel). Their study also revealed a 63% frequency of co-existence between PAIS and FHL tendon disorders. Willits et al reported the clinical results of hindfoot arthroscopy for impingement in 16 ankles of 15 patients.[57] In their series, all patients were able to return to sporting activities within an average of 5.8 months and the mean AOFAS score was 91 post-operatively.[57]

Similar to Scholten's results, Ögüt et al and Hamilton et al also reported a high frequency of co-existence between posterior ankle pain and FHL tendon disorders.[7,15] In their patients, Ögüt et al found FHL tenosynovitis in all 60 feet. After a mean follow-up of 26.7 months, AOFAS scores improved from a mean of 56.7 points to 85.9 points post-operatively with two complications (3.4%).[15] They also reported clinical results following isolated endoscopic FHL tenolysis/release with no other concomitant procedures in 11 patients, showing AOFAS score improvement from 48.7 to 83.2.

For isolated FHL stenosing tenosynovitis, Corte-Real et al reported 70% good or excellent results after an arthroscopic approach and 81% of their patients returned to their previous level of activity in work and sports.[58]

There are several studies that compare the results after open and endoscopic surgery. In 2010, Guo retrospectively evaluated 41 patients with posterior impingement and reported a quicker return to activity (6.0 *vs* 11.9 weeks, respectively ($p < 0.001$) with endoscopic surgery with no difference in complication rates.[59] Zwiers et al conducted a systematic review and analysed the results of open and arthroscopic surgery for PAIS. They reported significantly lower complication rates (7.2% *vs* 15.9%) and earlier return to full activity (11.3 *vs* 16 weeks) with arthroscopic surgery.[60]

In FHL tenosynovitis, one study showed 85.2% to 90% satisfaction with open surgery *versus* 80% patient satisfaction with an arthroscopic approach.[10] They also reported similar results for the percentage of the patients that can return to sports after surgery but the average time to return to activities is longer following open surgery (12 to 25 weeks *vs* 6 to 8 weeks).

Four case-series cited the treatment of OLs with hindfoot arthroscopy.[2] Ögüt et al's case-series was the only one to report the results of posterior debridement and microfracture and they found an improvement in AOFAS scores from 64 to 93 points.[2]

For the insertional Achilles tendinopathies and retrocalcaneal bursitis cases, we prefer to use arthroscopy for the cases with pain just anterior to the Achilles tendon over the fat pad, bursa or posterosuperior prominence. In their first series, van Dijk et al reported the outcomes in 20 patients. They reported 19 good to excellent results and return to sports after 12 weeks.[52] In their study, Ögüt et al reported the initial results with endoscopic calcaneoplasty after a mean follow-up of 58.4 months and found an increase in AOFAS scores from 52.6 to 98.6.[37] All patients were satisfied with the surgical outcome and return to sports took three months at most. Similarly, Jerosch et al studied the results of 164 patients and reported that more than 90% of patients showed good to excellent results according to the Ogilvie-Harris score. For open surgery, Angerman reported the results of 40 patients that were treated with a posterolateral incision. Of the patients, 50% were cured whereas 10% of the patients were worse after a mean follow-up of six years.[61] Similarly, Schneider et al reported an improvement of the symptoms in only 69% the patients.[62] Thus, endoscopic surgery has the advantages of reduced morbidity and post-operative pain and earlier rehabilitation.[61]

Steenstra and van Dijk were the first to report the outcomes after endoscopic Achilles surgery.[54] In their 16-patient series, after a mean follow-up of six years, they reported comparable AOFAS and SF-36 scores between endoscopically treated patients and a cohort of people without Achilles tendon complaints. Maquirriain et al reported the outcome of seven patients with similar results.[63] They found an improvement from 39 pre-operatively to 89 post-operatively in a 100-point scale. In their systematic review, Baltes et al found that the success rates after endoscopic procedures were between 73% and 100% with a 0% to 7.4% complication rate.[40] They also demonstrated that minimally invasive and endoscopic procedures have lower complication rates with comparable patient satisfaction when compared with open procedures.

Open surgical resection and fat interposition is the classical technique for talocalcaneal coalitions.[64] Gantsoudes et al reported good to excellent results in 85% of patients after a mean follow-up of 12 months and their recurrence rate was 3%.[65] In the literature, there are case-series that also report favourable results in 80% to 100 % of patients with open resection, but there are also 33% to 50% reported rates of failure.[66] However, the open approach does not provide adequate exposure of the posterior part of the subtalar joint, thus limiting the assessment of the status of the articular cartilage and adequacy of synostosis resection. To overcome these limitations, arthroscopic excision can be used for selected patients. Knörr et al reported excision of symptomatic talocalcaneal coalition with hindfoot arthroscopy in 16 feet of 15 children.[64] After a mean follow-up of 28 months, AOFAS scores were improved from 56.8 pre-operatively to 90.9 post-operatively. Although endoscopic coalition resection seems to be safe with the possible advantages of faster recovery and reduced local morbidity, its routine use is limited.[67]

There are five patient series in the literature that report post-operative AOFAS scores after posterior arthroscopic subtalar joint arthrodesis.[2] According to their cumulative results, the average post-operative AOFAS score was 80.3 points with an average increase of 40.4 points. In one of the latest series, Thaunat et al reported 86% of fusion rate without the use of bone graft in a group of 14 patients.[68]

Complications

Zengerink and van Dijk reported a complication rate of 2.3% after hindfoot arthroscopy in a prospective study of 311 consecutive cases,[25] whereas Nickisch et al reported an 8.5% complication rate in their series of 189 cases.[27] Of these complications, 44% were neurological and among the 16 complications reported, one case of plantar numbness and one case of sural nerve dysaesthesia failed to resolve.

Recently, Spennacchio et al classified the complications of PAIS surgery as minor and major.[2] Superficial wound infections, transient stiffness, transient numbness or paraesthesia are classified as minor complications and the overall complication rate is defined as < 7%. By contrast, deep infections, persistent pain, dysaesthesia or other causes of dissatisfaction requiring re-operation were listed as major complications and occurred in < 2% of operated ankles.

After the first description of the two-portal hindfoot arthroscopy technique by van Dijk, minimally invasive treatment of posterior ankle and hindfoot pathologies is gaining popularity among the orthopaedic profession. Current evidence shows that two-portal hindfoot arthroscopy is a safe method for the treatment of pathologies such as PAIS, os trigonum or posterior talar OLs and, in our opinion, its use will further increase with increased experience and research.

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REFERENCES

1. **van Dijk CN, Scholten PE, Krips R.** A 2-portal endoscopic approach for diagnosis and treatment of posterior ankle pathology. *Arthroscopy* 2000;16:871-876.

2. **Spennacchio P, Cucchi D, Randelli PS, van Dijk NC.** Evidence-based indications for hindfoot endoscopy. *Knee Surg Sports Traumatol Arthrosc* 2016;24:1386-1395.

3. **Smyth NA, Zwiers R, Wiegerinck JI, et al.** Posterior hindfoot arthroscopy: a review. *Am J Sports Med* 2014;42:225-234.

4. **Maquirriain J.** Posterior ankle impingement syndrome. *J Am Acad Orthop Surg* 2005;13:365-371.

5. **Ribbans WJ, Ribbans HA, Cruickshank JA, Wood EV.** The management of posterior ankle impingement syndrome in sport: a review. *Foot Ankle Surg* 2015;21:1-10.

6. **van Dijk CN.** Posterior ankle impingement. In: van Dijk CN, ed. *Ankle arthroscopy*. Berlin, Heidelberg: Springer, 2014:231-258.

7. **Hamilton WG, Geppert MJ, Thompson FM.** Pain in the posterior aspect of the ankle in dancers. Differential diagnosis and operative treatment. *J Bone Joint Surg [Am]* 1996;78-A:1491-1500.

8. **Hedrick MR, McBryde AM.** Posterior ankle impingement. *Foot Ankle Int* 1994;15:2-8.

9. **Niek van Dijk C.** Anterior and posterior ankle impingement. *Foot Ankle Clin* 2006;11:663-683.

10. **Rungprai C, Tennant JN, Phisitkul P.** Disorders of the flexor hallucis longus and os trigonum. *Clin Sports Med* 2015;34:741-759.

11. **Miyamoto W, Takao M, Matsushita T.** Hindfoot endoscopy for posterior ankle impingement syndrome and flexor hallucis longus tendon disorders. *Foot Ankle Clin N Am* 2015;20:139-147

12. **Petersen W, Pufe T, Zantop T, Paulsen F.** Blood supply of the flexor hallucis longus tendon with regard to dancer's tendinitis: injection and immunohistochemical studies of cadaver tendons. *Foot Ankle Int* 2003;24:591-596.

13. **Ogut T, Ayhan E.** Hindfoot endoscopy for accessory flexor digitorum longus and flexor hallucis longus tenosynovitis. *Foot Ankle Surg* 2011;17:e7-e9.

14. **Scholten PE, Sierevelt IN, van Dijk CN.** Hindfoot endoscopy for posterior ankle impingement. *J Bone Joint Surg [Am]* 2008;90-A:2665-2672.

15. **Ogut T, Ayhan E, Irgit K, Sarikaya AI.** Endoscopic treatment of posterior ankle pain. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1355-1361.

16. **Savage-Elliott I, Ross KA, Smyth NA, Murawski CD, Kennedy JG.** Osteochondral lesions of the talus: a current concepts review and evidence-based treatment paradigm. *Foot Ankle Spec* 2014;7:414-422.

17. Valderrabano V, Miska M, Leumann A, Wiewiorski M. Reconstruction of osteochondral lesions of the talus with autologous spongiosa grafts and autologous matrix-induced chondrogenesis. *Am J Sports Med* 2013;41:519-527.

18. Polat G, Erşen A, Erdil ME, et al. Long-term results of microfracture in the treatment of talus osteochondral lesions. *Knee Surg Sports Traumatol Arthrosc* 2016;24:1299-1303.

19. van Dijk CN. Posterior approach for osteochondral defect. In: van Dijk CN, ed. *Ankle arthroscopy*. Berlin, Heidelberg: Springer, 2014:259-263.

20. van Bergen CJ, Tuijthof GJ, Maas M, Sierevelt IN, van Dijk CN. Arthroscopic accessibility of the talus quantified by computed tomography simulation. *Am J Sports Med* 2012;40:2318-2324.

21. Mussett S, Henderson WB, Glazebrook M, Tak-Choy Lau J. Osteochondral lesions of the talar dome. In: Amendola A, Stone JW, ed. *AANA advanced arthroscopy: the foot and ankle*. Philadelphia: Elsevier, 2010:97-104.

22. Aurich M, Albrecht D, Angele P, et al. [Treatment of osteochondral lesions in the ankle: A guideline from the group "Clinical Tissue Regeneration" of the German Society of Orthopaedics and Traumatology (DGOU)]. *Z Orthop Unfall* 2016. Epub ahead of print. (In German)

23. Looze CA, Capo J, Ryan MK, et al. Evaluation and management of osteochondral lesions of the talus. *Cartilage* 2017;8:19-30.

24. Verhagen RA, Struijs PA, Bossuyt PM, van Dijk CN. Systematic review of treatment strategies for osteochondral defects of the talar dome. *Foot Ankle Clin* 2003;8:233-242, viii-ix.

25. Zengerink M, Struijs PA, Tol JL, van Dijk CN. Treatment of osteochondral lesions of the talus: a systematic review. *Knee Surg Sports Traumatol Arthrosc* 2010;18:238-246.

26. Wiewiorski M, Barg A, Valderrabano V. Autologous matrix-induced chondrogenesis in osteochondral lesions of the talus. *Foot Ankle Clin* 2013;18:151-158.

27. Nickisch F, Barg A, Saltzman CL, et al. Postoperative complications of posterior ankle and hindfoot arthroscopy. *J Bone Joint Surg [Am]* 2012;94-A:439-446.

28. Yoshimura I, Kanazawa K, Takeyama A, et al. Arthroscopic bone marrow stimulation techniques for osteochondral lesions of the talus: prognostic factors for small lesions. *Am J Sports Med* 2013;41:528-534.

29. Choi WJ, Park KK, Kim BS, Lee JW. Osteochondral lesion of the talus: is there a critical defect size for poor outcome? *Am J Sports Med* 2009;37:1974-1980.

30. Chuckpaiwong B, Berkson EM, Theodore GH. Microfracture for osteochondral lesions of the ankle: outcome analysis and outcome predictors of 105 cases. *Arthroscopy* 2008;24:106-112.

31. Grambart ST. Arthroscopic management of osteochondral lesions of the talus. *Clin Podiatr Med Surg* 2016;33:521-530.

32. Hannon CP, Smyth NA, Murawski CD, et al. Osteochondral lesions of the talus: aspects of current management. *Bone Joint J* 2014;96-B:164-171.

33. Ferkel RD, Dierckman BD, Phisitkul P. Arthroscopy of the foot and ankle. In: Coughlin MJ, Saltzman CL, Anderson RB, eds. *Mann's surgery of the foot and ankle*. Vol 2. Philadelphia: Saunders, 2014:1725-1830.

34. Uquillas CA, Guss MS, Ryan DJ, Jazrawi LM, Strauss EJ. Everything Achilles: knowledge update and current concepts in management: AAOS exhibit selection. *J Bone Joint Surg [Am]* 2015;97:1187-1195.

35. Roche AJ, Calder JD. Achilles tendinopathy: A review of the current concepts of treatment. *Bone Joint J* 2013;95-B:1299-1307.

36. Weinfeld SB. Achilles tendon disorders. *Med Clin North Am* 2014;98:331-338.

37. Kaynak G, Öğüt T, Yontar NS, et al. Endoscopic calcaneoplasty: 5-year results. *Acta Orthop Traumatol Turc* 2013;47:261-265.

38. Lohrer H, David S, Nauck T. Surgical treatment for Achilles tendinopathy - a systematic review. *BMC Musculoskelet Disord* 2016;17:207.

39. DeCarbo WT, Bullock MJ. Midsubstance tendinopathy, surgical management. *Clin Podiatr Med Surg* 2016. doi:10.1016/j.cpm.2016.10.006.

40. Baltes TP, Zwiers R, Wiegerinck JI, van Dijk CN. Surgical treatment for midportion Achilles tendinopathy: a systematic review. *Knee Surg Sports Traumatol Arthrosc* 2016. [Epub ahead of print].

41. Zwiers R, Wiegerinck JI, van Dijk CN. Treatment of midportion Achilles tendinopathy: an evidence-based overview. *Knee Surg Sports Traumatol Arthrosc* 2016;24:2103-2111.

42. Murphy JS, Mubarak SJ. Talocalcaneal Coalitions. *Foot Ankle Clin* 2015;20:681-691.

43. Gorman TM, Nickisch F, Beals TC, Saltzman CL. Fusion for degenerative arthritis of the ankle. In: Amendola A, Stone JW, eds. *AANA advanced arthroscopy: the foot and ankle*. Philadelphia: Elsevier, 2010:157-169.

44. Ogut T, Seker A, Ustunkan F. Endoscopic treatment of posteriorly localized talar cysts. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1394-1398.

45. Vallier HA. Fractures of the talus: state of the art. *J Orthop Trauma* 2015;29:385-392.

46. Saltzman CL, Marsh JL, Tearse DS. Treatment of displaced talus fractures: an arthroscopically assisted approach. *Foot Ankle Int* 1994;15:630-633.

47. Subairy A, Subramanian K, Geary NP. Arthroscopically assisted internal fixation of a talus body fracture. *Injury* 2004;35:86-89.

48. Dodd A, Simon D, Wilkinson R. Arthroscopically assisted transfibular talar dome fixation with a headless screw. *Arthroscopy* 2009;25:806-809.

49. Sitte W, Lampert C, Baumann P. Osteosynthesis of talar body shear fractures assisted by hindfoot and subtalar arthroscopy: technique tip. *Foot Ankle Int* 2012;33:74-78.

50. Bonasia DE, Rossi R, Saltzman CL, Amendola A. The role of arthroscopy in the management of fractures about the ankle. *J Am Acad Orthop Surg* 2011;19:226-235.

51. van Dijk CN, de Leeuw PA, Scholten PE. Hindfoot endoscopy for posterior ankle impingement. Surgical technique. *J Bone Joint Surg [Am]* 2009;91-A:287-298.

52. Jerosch J. Endoscopic calcaneoplasty. *Foot Ankle Clin* 2015;20:149-165.

53. van Dijk CN. Achilles tendoscopy. In: van Dijk CN, ed. *Ankle arthroscopy*. Berlin, Heidelberg: Springer, 2014:335-353.

54. Steenstra F, van Dijk CN. Achilles tendoscopy. *Foot Ankle Clin* 2006;11:429-438, viii.

55. Younger ASE. Complex ankle, subtalar and triple fusions. In: Amendola A, Stone JW, eds. *AANA advanced arthroscopy: the foot and ankle*. Philadelphia: Elsevier, 2010:177-185.

56. Ogut T, Seyahi A, Aydingoz O, Bilsel N. A two-portal posterior endoscopic approach in the treatment of a complex talus fracture: a case report. *J Am Podiatr Med Assoc* 2009;99:443-446.

57. Willits K, Sonneveld H, Amendola A, et al. Outcome of posterior ankle arthroscopy for hindfoot impingement. *Arthroscopy* 2008;24:196-202.

58. Corte-Real NM, Moreira RM, Guerra-Pinto F. Arthroscopic treatment of tenosynovitis of the flexor hallucis longus tendon. *Foot Ankle Int* 2012;33:1108-1112.

59. Guo QW, Hu YL, Jiao C, Ao YF, Tian DX. Open versus endoscopic excision of a symptomatic os trigonum: a comparative study of 41 cases. *Arthroscopy* 2010;26:384-390.

60. Zwiers R, Wiegerinck JI, Murawski CD, et al. Surgical treatment for posterior ankle impingement. *Arthroscopy* 2013;29:1263-1270.

61. Angermann P. Chronic retrocalcaneal bursitis treated by resection of the calcaneus. *Foot Ankle* 1990;10:285-287.

62. Schneider W, Niehus W, Knahr K. Haglund's syndrome: disappointing results following surgery – a clinical and radiographic analysis. *Foot Ankle Int* 2000;21:26-30.

63. Maquirriain J, Ayerza M, Costa-Paz M, Muscolo DL. Endoscopic surgery in chronic Achilles tendinopathies: A preliminary report. *Arthroscopy* 2002;18:298-303.

64. Knörr J, Soldado F, Menendez ME, et al. Arthroscopic talocalcaneal coalition resection in children. *Arthroscopy* 2015;31:2417-2423.

65. Gantsoudes GD, Roocroft JH, Mubarak SJ. Treatment of talocalcaneal coalitions. *J Pediatr Orthop* 2012;32:301-307.

66. Bonasia DE, Phisitkul P, Saltzman CL, Barg A, Amendola A. Arthroscopic resection of talocalcaneal coalitions. *Arthroscopy* 2011;27:430-435.

67. Bonasia DE, Phisitkul P, Amendola A. Endoscopic coalition resection. *Foot Ankle Clin* 2015;20:81-91.

68. Thaunat M, Bajard X, Boisrenoult P, Beaufils P, Oger P. Computer tomography assessment of the fusion rate after posterior arthroscopic subtalar arthrodesis. *Int Orthop* 2012;36:1005-1010.