POSTERIOR IMPINGEMENT IN THE ANKLE

ARE THERE ANY LIMITS TO THE ARTHROSCOPIC APPROACH?

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INTRODUCTION

Posterior ankle impingement refers to a mechanical conflict at the back side of the ankle. In certain sports such as football, ballet, acro-gymnastics and high-jumping, where hyperplantar flexion of the ankle is a must, it is frequently encountered.

Posterior ankle impingement can present in an acute or a chronic fashion, and accounts for 4% of all ankle injuries during explosive sports performance. So, whether you are watching a high level swimming event, a gymnastics competition or fascinating football game, it's statistically likely that you're enjoying the talents of a performer who was previously treated for a posterior ankle impingement condition.

AETIOLOGY

Posterior ankle impingement syndrome is a clinical pain syndrome that reflects the most common cause of posterior ankle pain and it can be provoked by a forced hyperplantar flexion movement of the ankle[5,10,16]. In fact, a recent Aspetar epidemiological study that looked at the incidence of ankle lesions in football players in Qatar showed that up to 14% of the football injuries are ankle-related[1].

Other FIFA data shows that the ankle is the third most injured joint in football, after the thigh and the knee.

In the event of a soft tissue or bony posterior impingement of the ankle, plantar flexion induces a conflict between the posterior malleolus of the distal tibia and the postero-superior calcaneal bone. A prominent posterior processes of the calcaneus occurs in almost 7% of the sports population and can present itself as a hypertrophic posterior talar process or as an os trigonum. Although apparent posterior bony prominences caused by acute or repetitive overload (micro-) trauma can induce posterior ankle pain, it's not necessarily associated with posterior ankle impingement syndrome.

Since an acute forced hyperplantar flexion movement at the ankle or a repetitive overload induces the bony or soft-tissue conflict in the posteriorly located components of the ankle joint, we mainly see these lesions in a sports specific population. The classical example of repetitive overload is seen in ballet dancers, where the forced plantar flexion during 'en Pointe' and 'demi Pointe' positioning induces repetitive impingement on the posteriorly located soft tissue components. Other types of sports related to posterior ankle impingement syndrome include football, swimming, cycling or any other sport in which there is repetitive forced plantar flexion. If the lesion occurs due to compression of the os trigonum between the distal tibia and calcaneal bone, it can lead to displacement of this os trigonum or even fractures of the processus posterior tali or distal tibia (Figure 1).

CLINICAL FEATURES

Patients who suffer from posterior ankle impingement present with posteriorly localised ankle pain during (forced) plantar flexion. Clinically, it presents as a

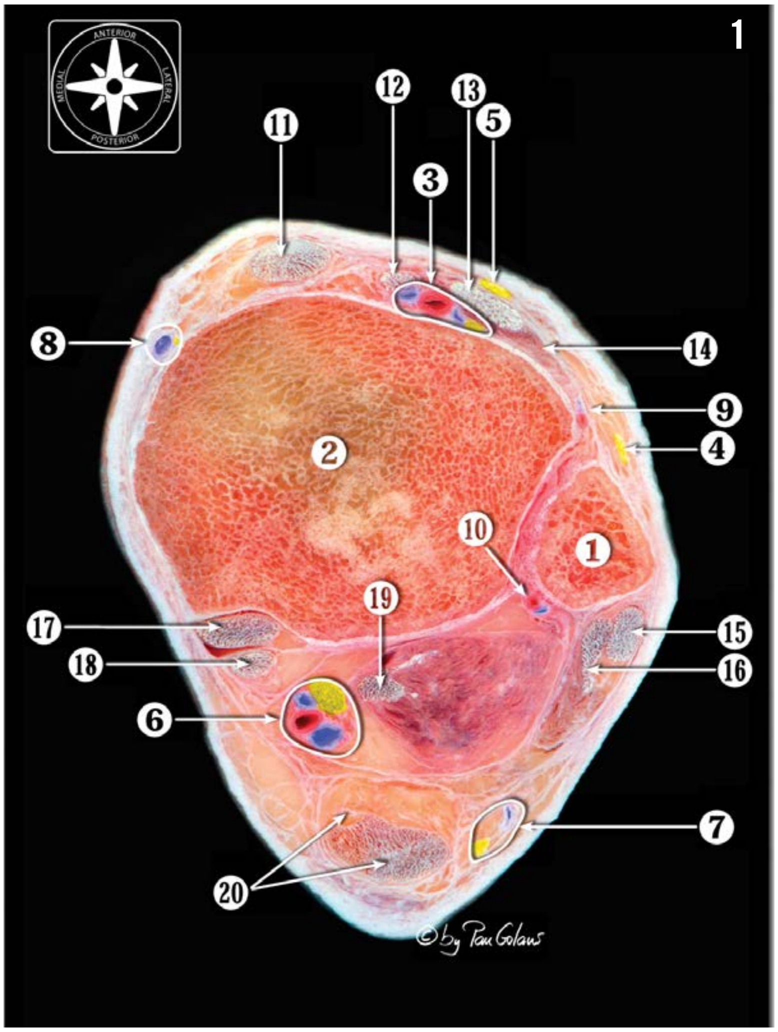


Figure 1: Transverse section at the level of the tibiofibular syndesmosis showing important structures susceptible to injury during ankle arthroscopy. 1=lateral malleolus, 2=tibia, 3=anterior neurovascular bundle (deep peroneal nerve and anterior tibial artery and veins), 4=intermediate dorsal cutaneous nerve (lateral branch of the superficial peroneal nerve), 5=medial dorsal cutaneous nerve (medial branch of the superficial peroneal nerve), 6=posterior neurovascular bundle (posterior tibial nerve and posterior tibial artery and veins), 7=sural nerve and small saphenous vein, 8=saphenous nerve and great saphenous vein, 9=anterior peroneal artery, 10=posterior peroneal artery, 11=tibialis anterior tendon, 12=extensor hallucis longus tendon, 13=extensor digitorum longus tendon, 14=peroneus tertius muscle belly, 15=peroneus brevis longus, 16=peroneus brevis tendon, 17=tibialis posterior tendon, 18=flexor digitorum longus tendon, 19=flexor hallucis tendon (musculotendinous), 20=calcaneal and plantaris tendons.

> ***Relief of pain following local anaesthetic injection can easily confirm the condition***

recognisable local pain on palpation along the posterior aspect of the talus. Since the neurovascular structures and tendons are localised in the posteromedial region of the ankle, this area is not always easily palpated as compared to the clinical examination of the posterolateral part of the ankle.

The posterior ankle impingement test is a pathognomonic test to identify the clinical diagnosis of posterior ankle impingement. To have a positive test the ankle is passively and quickly forced from neutral to hyperplantar flexion position. During this movement the patient encounters suddenly recognisable posteriorly located ankle pain. To increase compression on the posterolateral structures of the ankle, plantar flexion, external rotation and eversion movements are considered during clinical testing.

Inversion and internal rotation movements of the ankle are performed during the clinical setup while performing a posteromedial compression. In addition, a diagnostic infiltration with Bupivacaine can be an excellent extra tool to diagnose posterior ankle impingement. Relief of pain following local anaesthetic injection can easily confirm the condition.

ARTHROSCOPY OF THE ANKLE

In the early 1930s the ankle joint was found unsuitable for arthroscopy[2], mainly because of its anatomic features. Forty years later, in 1970, Tagaki and later Watanabe made considerable contributions

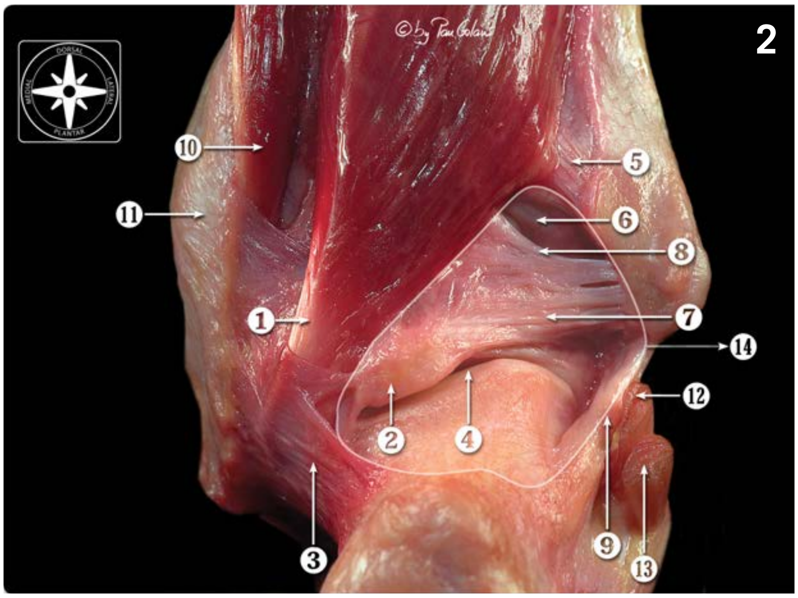


Figure 2: Posterior view of the anatomical dissection of showing the boundaries and principal anatomical details to be recognised during posterior ankle arthroscopy. The neurovascular structures were removed. 1=flexor hallucis longus tendon and muscle belly, 2=lateral talar process, 3=flexor hallucis longus retinaculum, 4=subtalar joint line, 5=superficial component of the posterior tibiofibular ligament, 6=deep component of the posterior tibiofibular ligament or transverse ligament, 7=posterior talofibular ligament, 8=posterior intermalleolar ligament or tibial slip, 9=calcaneofibular ligament, 10=flexor digitorum longus tendon and muscle belly, 11=tibialis posterior tendon covered by the flexor retinaculum, 12=peroneal brevis tendon (cut), 13=peroneal longus tendon, 14=boundaries of the safe anterior working area.

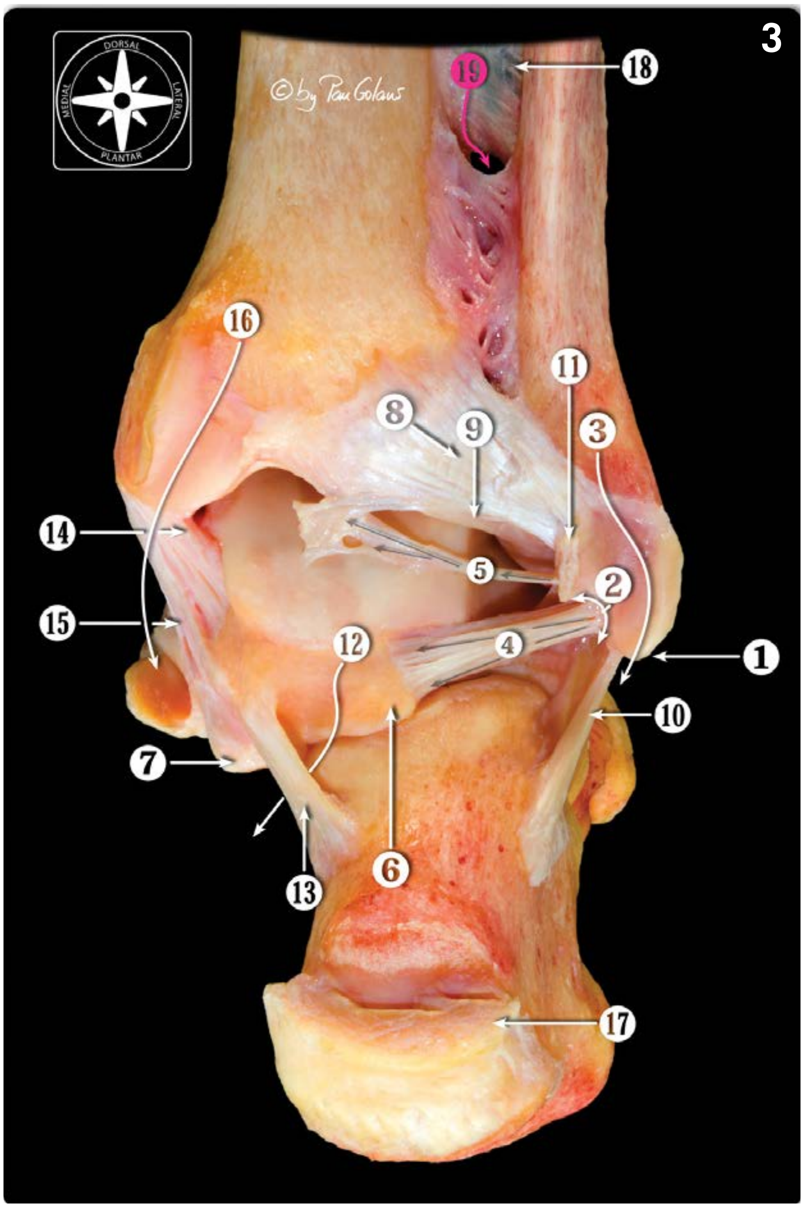


Figure 3: Posterior view of the anatomical dissection of ankle ligaments (dorsal flexion). The capsule was removed. 1=lateral malleolus, 2=malleolar fossa, 3=peroneal groove of the fibula and peroneal tendons traject, 4=posterior talofibular ligament, 5=posterior intermalleolar ligament or tibial slip (capsular insertion cut), 6=lateral talar process, 7=medial talar process, 8=superficial component of the posterior tibiofibular ligament, 9=deep component of the posterior tibiofibular ligament or transverse ligament, 10=calcaneofibular ligament, 11=malleolar insertion of fibulotalocalcaneal ligament or Rouvière and Canela-Lazaro ligament (cut), 12=tunnel for flexor hallucis longus tendon, 13=flexor hallucis longus retinaculum, 14=deep posterior tibiotalar ligament of the medial collateral ligament (deep layer), 15=tibiocalcaneal ligament of the medial collateral ligament (superficial layer), 16=tibialis posterior tendon (cut) and tendon traject, 17=calcaneal or Achilles tendon (cut), 18=interosseous membrane, 19=foramen in the interosseous membrane for the anterior peroneal artery.

to arthroscopic surgery of the ankle, publishing a series of 28 ankle arthroscopies in 1972. Since then, numerous publications have followed[3].

Over the last three decades, ankle arthroscopy of the ankle joint has become a standardised and important procedure, with numerous indications for both anterior and posterior intra-articular pathology, as well as for its tendinous problems around the ankle.

The advantages of ankle arthroscopy include the ability of direct visualisation, improved assessment of the articular cartilage, faster rehabilitation and earlier return to sports. Today there is enough evidence that there is limited value in performing diagnostic arthroscopy with the increased improved imaging modalities available. However, because of the lack of direct access, the nature and deep location of the hindfoot structures, posterior ankle problems still pose a diagnostic and therapeutic challenge nowadays.

Historically, the hindfoot was approached by a three-portal technique, anteromedial, anterolateral and posterolateral portals, with the patient in the supine position. It is known that the traditional posteromedial portal is associated with potential damage to the tibial nerve, the posterior tibial artery and the surrounding tendons. Therefore, a two-portal endoscopic technique was introduced in 2000 and since then, this technique has been shown to give excellent access to the posterior compartment, the subtalar joint and the surrounding extra-articular posterior ankle structures[4].

Posterior ankle arthroscopy has modified classic arthroscopic tools and skills and demonstrates a need for specific anatomical knowledge. It has also introduced a broad spectrum of new indications in posterior ankle pathology[4,5,13,14].

FUNCTIONAL ANATOMY

Anatomical knowledge is particularly important in ankle arthroscopy because of the significant risk of associated complications which can be prevented or decreased only by profound familiarity with the anatomy of the region. Adequate knowledge of the anatomy of the joint to be treated should cover not only the most common anatomic configurations (extra-articular and intra-articular) in statistical terms but also the possible anatomic variations to avoid confusion and serious technical errors[6,7] (Figure 2).

The main anatomical structure used for orientation and determining a safe working area is the flexor hallucis longus tendon (FHL). Just medial to this tendon runs the posterior neurovascular bundle (tibial nerve and posterior tibial artery and veins). Therefore posterior ankle arthroscopy should routinely be performed lateral to the FHL tendon.

Proper positioning of the ankle and the hallux results in better visualisation of the tendinous portion of the FHL muscle and avoids unnecessary resection of some of the muscle fibres that reach the lateral tendinous border in a semipeniform morphology. Plantar flexion of the ankle or hallux flexion facilitates visualisation of the FHL tendon proximal to the lateral talar process.

The posterior ankle ligaments are also important for orientation during posterior ankle arthroscopy[7]. These ligaments include the posterior talofibular ligament, the posterior intermalleolar ligament (also referred to as the tibial slip in arthroscopic literature) and the posterior tibiofibular ligament (which is composed of a superficial and deep component or transverse ligament)(Figure 3).

When the posterior ankle compartment is visualised arthroscopically, the location of the FHL tendon should first be determined. Then the detailed anatomy of the posterior ankle can be identified more carefully.

The posterior talofibular component of the lateral collateral ligament originates from the malleolar fossa, located on the medial surface of the lateral malleolus, coursing almost horizontally to insert on the posterolateral surface of the talus. The ligament is an important reference point in posterior ankle arthroscopy that allows the arthroscopist to know the site they are working in: subtalar and talocrural (Figure 4).

The posterior subtalar recess is plantar to this ligament and the talocrural joint is located dorsally[6,7].

Figure 4: The os trigonum, a possible bony impingment trigger in a right ankle.

SURGICAL PROCEDURE

Hindfoot arthroscopy allows the surgeon to more easily assess the posterior ankle compartment. At the time this technique was first described, the main indications to

> ***The advantages of ankle arthroscopy include faster rehabilitation and earlier return to sports***

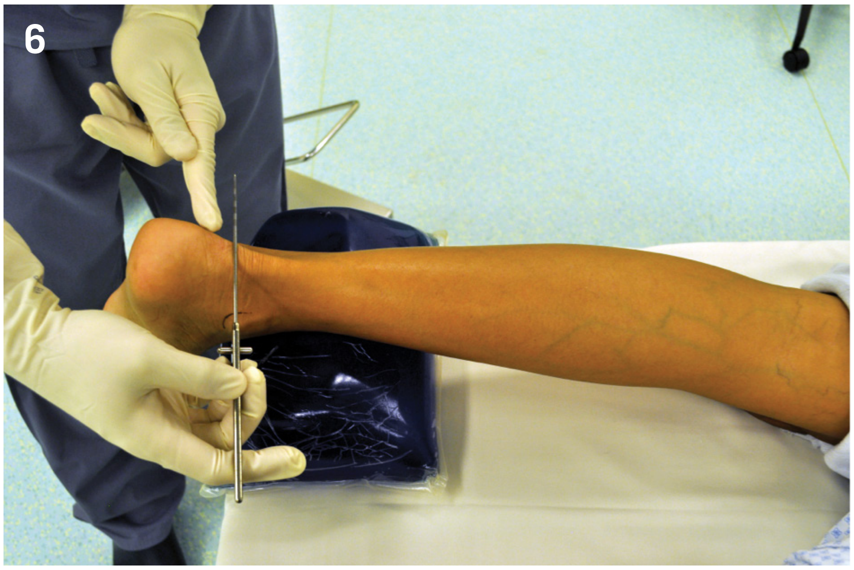


Figure 5: Positioning the patient for left ankle posterior arthroscopy.

Figure 6: Portal preparation in left ankle posterior arthroscopy.

Figure 7: The preoperative setup in positioning and portal preparation for posterior ankle arthroscopy.

perform a posterior ankle arthroscopy are the treatment of an os trigonum and FHL pathology[4,5,13,14]. However, today, numerous ankle pathologies in athletes can be treated through this minimal invasive technique and indications continue to be added.

The patient is positioned in the prone position with a tourniquet above the knee on the affected side, which should be carefully marked preoperatively. The affected ankle is positioned just over the edge of the operation table and is supported to allow free ankle movement (Figure 5).

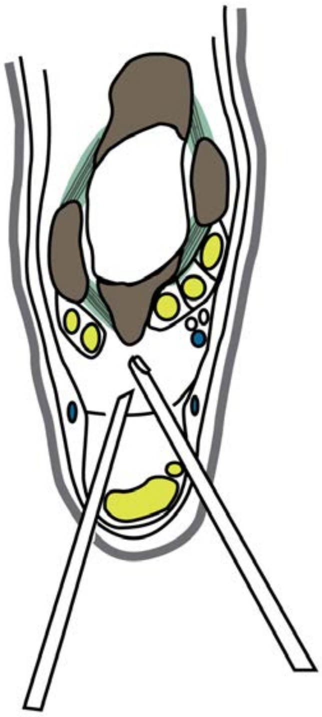
The anatomical landmarks used for portal placement are the sole of the foot, the lateral malleolus and the medial and lateral borders of the Achilles tendon. With the ankle in the neutral position (90°), a straight line, parallel to the sole of the foot, is drawn from the tip of the lateral malleolus to the Achilles tendon and is extended over the Achilles tendon to the medial side. The posterolateral portal is located just proximal to and 5 mm anterior to the intersection of the straight line with the lateral border of the Achilles tendon (Figure 6).

The posteromedial portal is located at the same level as the posterolateral portal but on the medial side of the Achilles tendon (Figure 7).

Before addressing any pathology, the FHL tendon should be localised to avoid the posterior neurovascular bundle which is located just medially to it[11]. The FHL tendon determines the working area, basically only lateral to the tendon (Figures 8 and 9).

Once this working area is determined, the whole spectrum of posterior pathology can be addressed supero-inferiorly from the tibiotalar joint down to the subtalar joint towards the Achilles tendon insertion and mediolaterally from the tarsal tunnel release towards the peroneal tendons.

Now pathology can be addressed, including debridement of soft tissues, removal of an os trigonum or FHL tendon release from its adjacent structures. Also, a groove deepening procedure in case of recurrent peroneal tendon dislocation, 8



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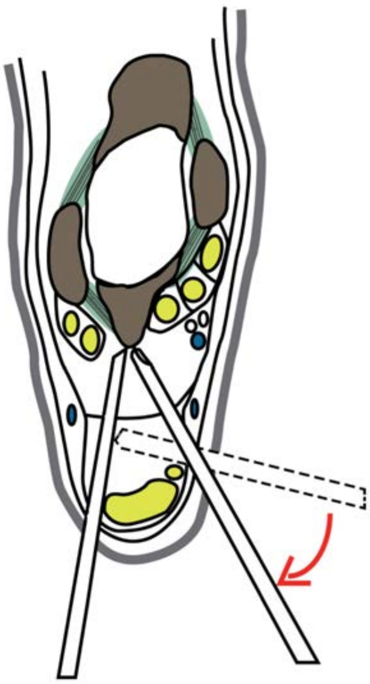


Figure 8: Determining the working area for arthroscopy in posterior ankle pathology: during insertion, the arthroscope is aimed towards the first foot webspace. This enables the surgeon to determine a safe working area.

Figure 9: Determining the working area for arthroscopy in posterior ankle pathology: after insertion, the arthroscope is turned in a horizontal fashion to broaden the working area after identification of the flexor hallucis longus.

Figure 10: Posterior arthroscopy assisted talar body fracture treatment with a compression screw in a displaced stress fracture case.

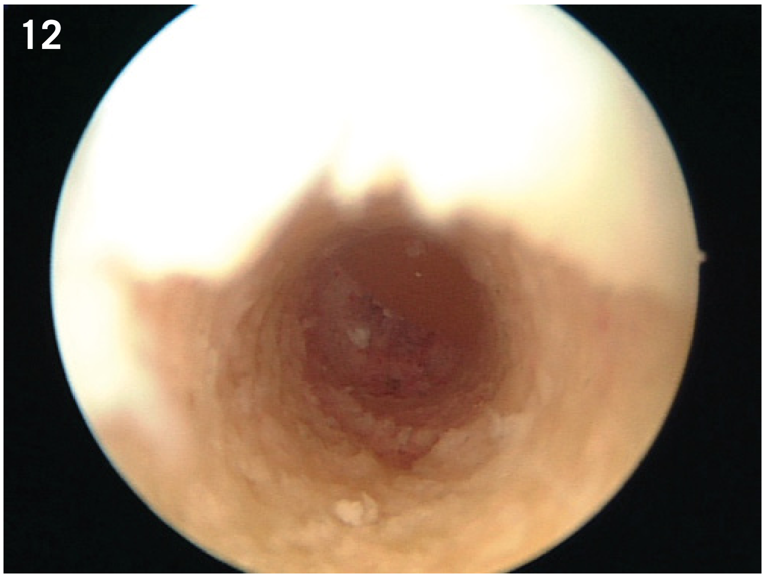
an endoscopic tarsal tunnel release, addressing a Cedell fracture or prominent posteromedial talar tubercle and treating a posteromedial talar dome lesion can now be addressed using this method of treatment.

Hindfoot arthroscopy can be also used for the treatment of talar body fractures, intraosseous talar cysts (that are localised posteriorly in the ankle) and for Pigmented Villo Nodular Synovitis (PVNS) (Figure 10).

This is a condition that can be localised in the posterior ankle compartment and it can invade the whole posterior part of the talus, extending proximally up to the FHL tendon sheath[8] (Figures 11 and 12).

Furthermore, Achilles tendinopathy/ denervation and Haglund's syndrome pathology can be successfully addressed by the minimally invasive posterior two-portal endoscopic technique in the sports population. This condition requires a more distally aimed two-incision technique that

> *numerous ankle pathologies in athletes can be treated through this minimal invasive technique*



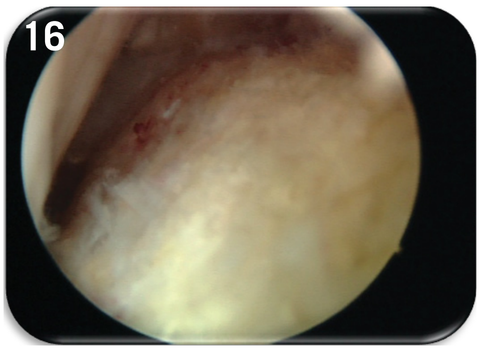


Figure 11: Radiographic view of a subchondral talar cyst presentation.

Figure 12: Intraosseous view of a talar cyst during ankle arthroscopy.

Figure 13: Achilles tendon endoscopic picture with full view on the tendinopathy adhesions between the plantaris and the achilles tendon.

Figure 14: Achilles tendon endoscopic picture after release of the adhesions between the plantaris and the Achilles tendon.

Figure 15: Endoscopic Haglund's syndrome treatment with two more distally localised portals.

Figure 16: Endoscopic view of the distal bony achilles tendon insertion after removal of the bony prominences.

covers the pathology all the way up to the Achilles tendon insertion (Figures 13, 14, 15 and 16).

Significant advantages of this method include lower morbidity, shorter postoperative hospitalisation time and quicker return to full sports. Hindfoot endoscopy is a safe and effective method for treating posterior talar cystic lesions and is an attractive alternative to open surgery for experienced arthroscopic surgeons. The most common indication to perform posterior ankle arthroscopy remains the treatment of os trigonum and FHL release (Figures 17, 18, 19 and 20).

However, new indications arise in line with this arthroscopic technique and stretch the boundaries in treating posterior ankle problems. The latest considerations are the posterior facet subtalar fusion and the tibiotalar fusion which show that we have not yet reached the limits of this posterior approach technique (Figures 21, 22 and 23).

The arthroscopic subtalar posterior facet fusion is the new runner-up treatment in minimally invasive ankle coalition pathology and for this reason it will be addressed in a little more detail.

SUBTALAR POSTERIOR FACET FUSION

The subtalar joint is a complex joint that is functionally responsible for inversion and eversion of the hindfoot. Treatment options are limited when hindfoot discomfort can be isolated to the subtalar joint without radiographic evidence of arthrosis. Medication, physical therapy and orthoses have a limited role. With the introduction of small instruments and precise techniques,

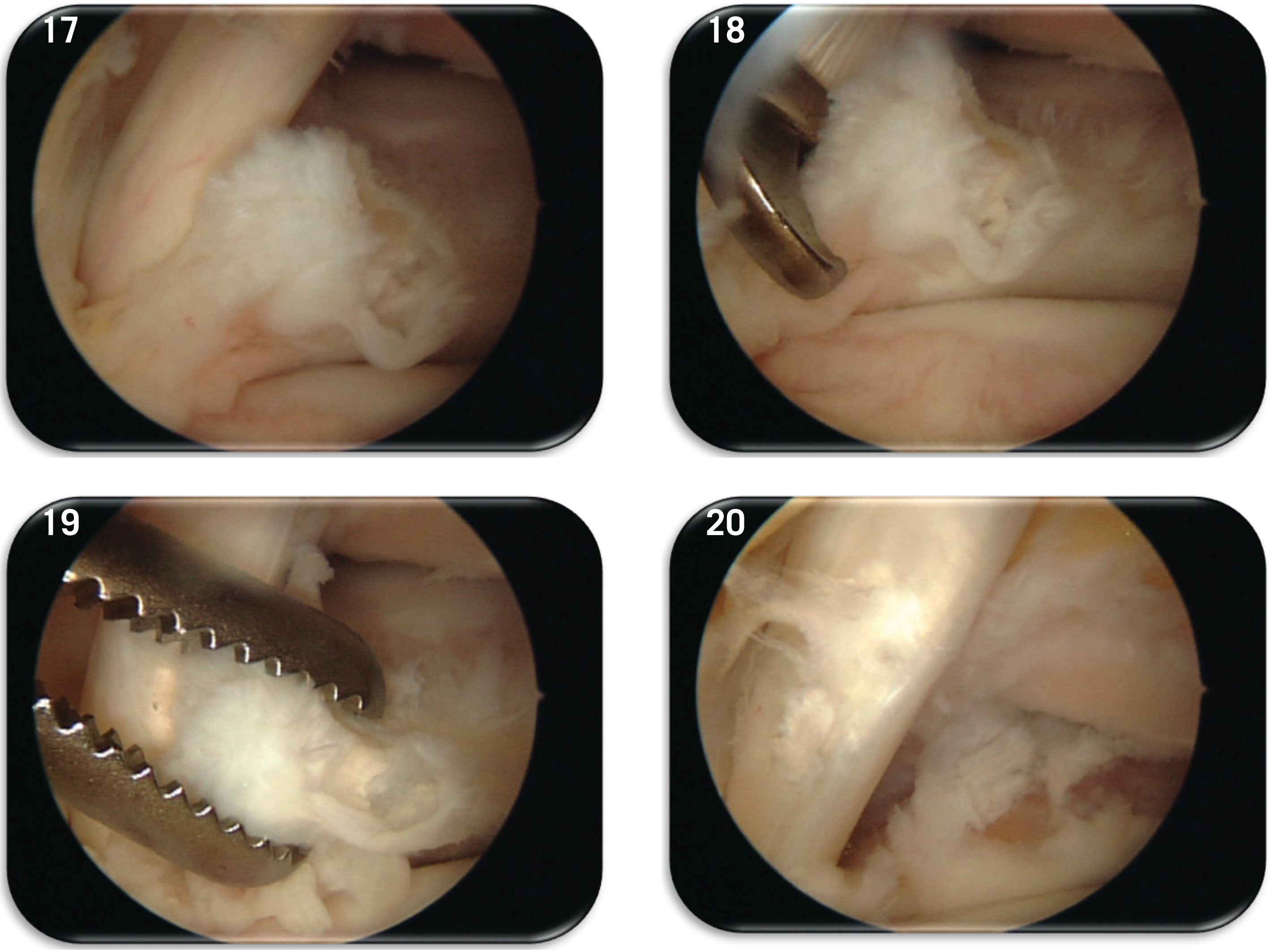


Figure 17 to 20: Posterior ankle arthroscopy: a four step decompression of the flexor hallucis longus tendon from an os trigonum. Mark the impingement signs on the flexor hallucis longus tendon after os trigonum decompression.

> ***Hindfoot endoscopy is an attractive alternative for experienced arthroscopic surgeons***

arthroscopy of the subtalar joint has expanded over the past decade[9,12].

The further techniques that followed have definitely fine-tuned this procedure, with emphasis on:

- The intention to yield less morbidity and preserve blood supply.
- The intention to preserve proprioception and neurosensory input.
- Increase the fusion rate and decrease the time until fusion.
- The decrease in significant complications.

In 2009, a three-portal approach for arthroscopic subtalar arthrodesis was introduced to offer full exposure and treatment on the posterior facet of the subtalar joint[4].

The advantages of the arthroscopic subtalar arthrodesis technique are:

- A good minimal invasive technique for treating ankle coalition and posttraumatic subtalar problems.
- Bony union after 6 weeks.
- Prone position during the procedure offers excellent exposure for alignment positioning and screw placement.
- Time efficient technique.
- The full posterior facet of the subtalar joint can be addressed by using a third accessory portal.

The limitations of the procedure are:

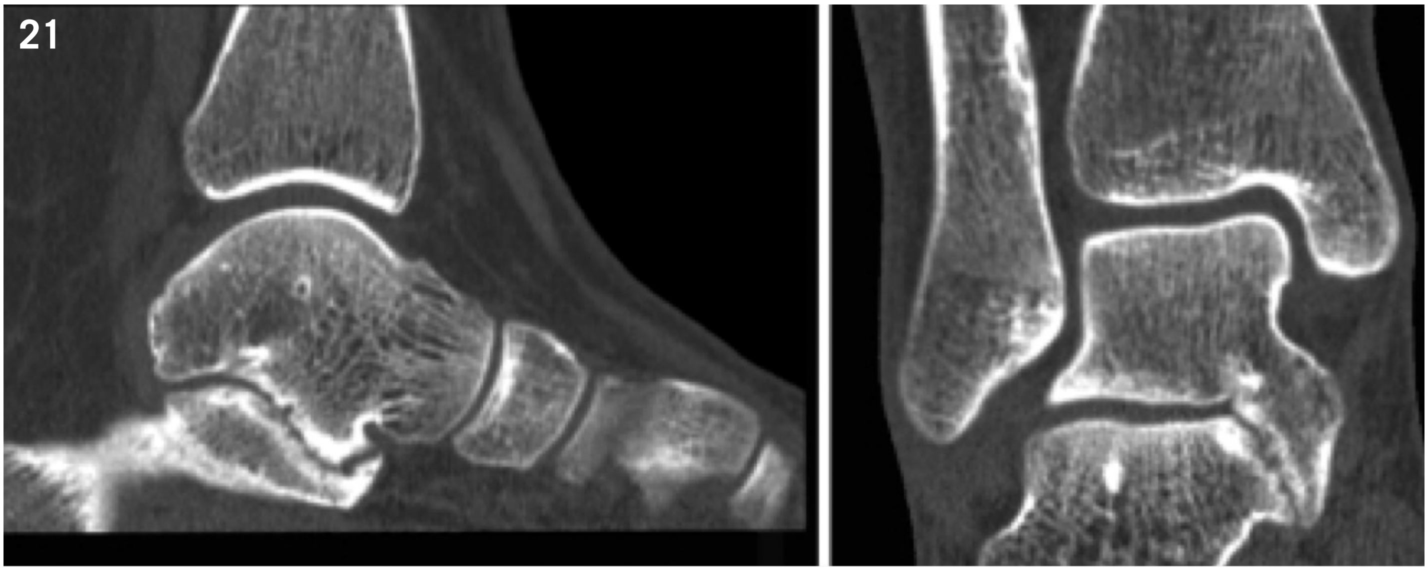
- The technical challenges, especially in the lateral coalition cases.
- Only the posterior facet of the subtalar joint can be treated.
- There is not always a macroscopic idea on the level and amount of resection (Figure 24).

With regards to results in athletes, best improvement in American Orthopaedic Foot and Ankle Society and Tegner outcome scores for this procedure were seen in talo-calcaneal coalition cases with full return to play after 4 to 7 months.

Further studies are now being performed to search for the impact of this treatment on the ankle and its function, especially in the athlete's ankle.

CONCLUSION

Posterior ankle arthroscopy is a challenging, however safe, reliable and effective technique that can be used in the treatment of posterior ankle impingement. Due to the improved functional outcome after surgery and quicker rehabilitation time, athletes can hugely benefit from this technique. Initially, the indications included flexor hallucis longus and os trigonum pathology. Today however, the technique can be used, with or without an additional portal, for an increasing amount of posterior ankle pathologies. Further studies are now being performed to assess the value the above mentioned indications. These studies are showing that the posterior arthroscopic technique for posterior ankle pathology has not yet reached its limits.



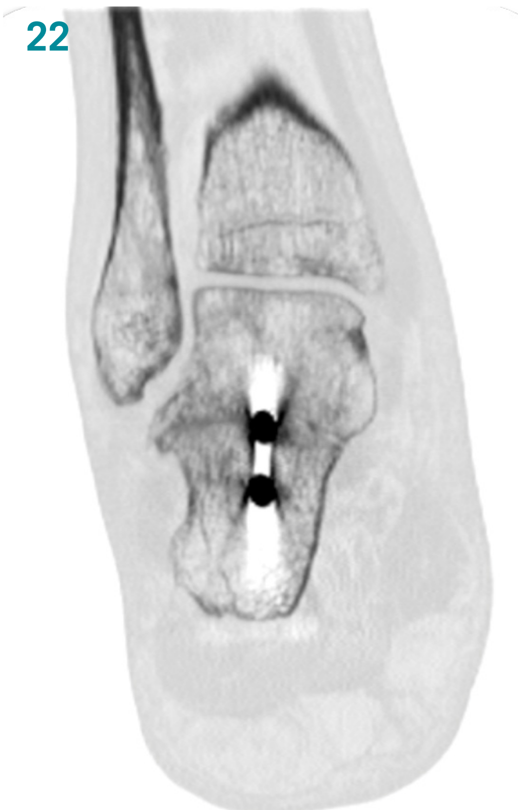


Figure 21: Computed tomograhy scan (lateral and anteroposterior view) of a patient with a medial talo-calcaneal ankle joint coalition for whom an arthroscopic subtalar posterior facet ankle joint fusion was indicated.

Figure 22: 7 weeks postoperative after an arthroscopic subtalar fusion, a computed tomography scan already shows a nice consolidation of the fused talo-calcaneal joint.

Figure 23: A lateral X-ray of a tibiotalar ankle fusion through a posterior arthroscopic procedure.

KEY POINTS

How To Diagnose Posterior Impingement of the Ankle:

- Ask for sport-specific repetitive ankle movements.
- Perform a hyperplantar flexion movement of the ankle.
- Look for palpatory pain along the course of the flexor hallucis longus.

How to Treat Posterior Impingement of the Ankle:

- Perform a diagnostic injection.
- Start with the standardised two-portal technique after initial cadaveric training.
- Search for the flexor hallucis longus tendon and the posterior talo-fibular ligament as primary anatomical landmarks.

Acknowledgment: Pau Golano (Anatomist)

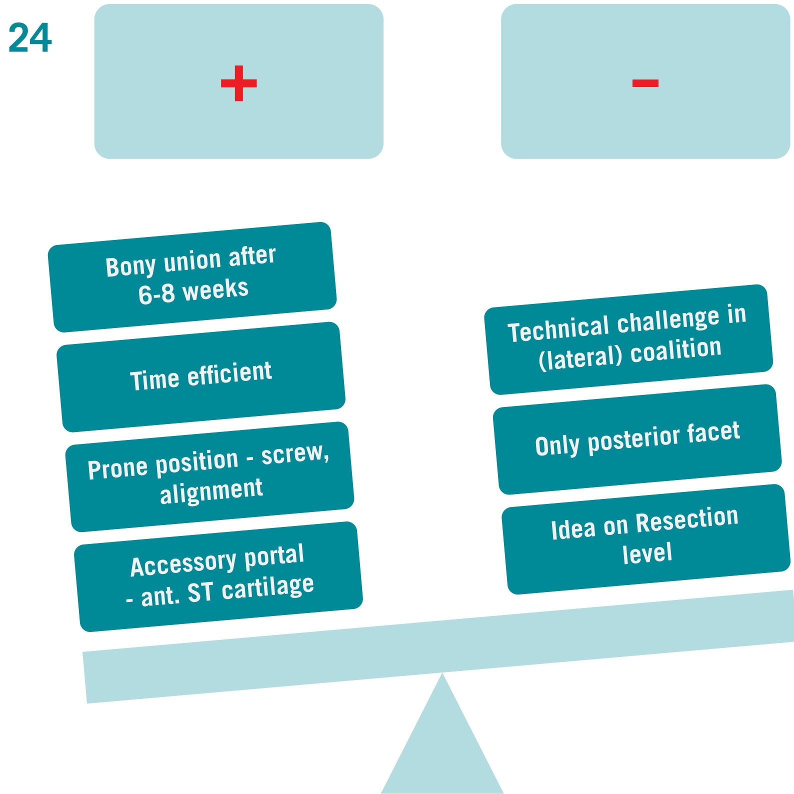


Figure 24: The pro and cons of the arthroscopic subtalar ankle fusion.

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