CLINICAL ARTICLE

Ankle arthroscopy: Indications, techniques and complications

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Abstract

Ankle arthroscopy is increasingly used as a technique for dealing with a wide range of ankle pathologies. Technological advancement and a more thorough understanding of the anatomy have resulted in improved ability to perform ankle arthroscopy. Arthroscopic surgery offers the advantages related to any minimally invasive procedure, such as fewer wound infections, less blood loss, smaller incisions and less morbidity. This article defines the major indications of arthroscopy and presents current techniques.

Introduction

The first reported arthroscopic inspection of a cadaveric joint was performed by Takagi.[1] In 1931 Burman was the first orthopaedic surgeon to attempt ankle joint arthroscopy in vivo.[2] He concluded that the ankle joint was unsuitable for arthroscopy, in respect to its narrow inter-articular access. Because of the fibre-optic arthroscope improvement in the 1970s, Wantanabe was the first to report on a series of 28 ankle arthroscopies in 1972.[3] From the 1980s on several publications followed.[4-11] Since then ankle arthroscopy has been applied as a powerful diagnostic and therapeutic instrument.

The main indications for anterior ankle arthroscopy are the treatment of anterior impingement syndrome, talar osteochondral defects, removal of loose bodies, ossicles, adhesions and synovitis.[12,13] With the introduction of a two-portal endoscopic hindfoot approach in 2000,[14] access to the posterior aspect of the ankle and subtalar joint has become possible. Also extra-articular structures of the hindfoot such as the os trigonum, flexor hallucis longus and the deep portion of the deltoid ligament can be assessed.[14]

Advantages of the arthroscopic technique over open techniques include low post-operative morbidity and absence of limb-threatening complications, less blood loss, shorter hospital stay, faster rehabilitation and mobilisation, and a decreased complication rate.[15-19] To achieve these advantages the surgeon should be thoroughly familiar with the anatomy of the region[20] and endoscopic techniques. In order to become familiar to the different endoscopic techniques in foot and ankle surgery, international courses are organised yearly in which surgeons can train themselves in a cadaveric setting.[21]

However, complications in ankle arthroscopy do occur, such as neurologic-, tendon- and ligament injuries, wound complications, infections and instrument breakage.[22]

Indications and contraindications

Numerous indications for ankle arthroscopy exist both for diagnosis and treatment. The main therapeutic indications include soft tissue and bony impingement, flexor hallucis longus tendinopathy, osteochondral defects, loose bodies and synovitis.

Anterior ankle impingement

Anterior ankle impingement syndrome is a pain syndrome that is characterised by anterior ankle pain on (hyper)dorsiflexion.[23] Symptoms are caused by impingement of hypertrophied soft tissue and bony spurs within the anterior ankle joint. The most frequent cause of chronic pain after an ankle sprain is known as soft tissue impingement syndrome,[24] and the primary aetiology of this condition is injury to the ligamentous structures. In bony impingement mechanical factors are believed to play an essential role. Repeated capsuloligamentous traction by, for example, repetitive kicking with the foot in full plantar flexion may induce formation of traction spurs.[25] This hypothesis is supported by the fact that these spurs are found frequently in athletes,[4,6,25,26] who repetitively force their ankle into hyper plantar flexion, which results in repetitive traction to the anterior joint capsule.[27] It assumes however, that the capsular attachment is located at the anterior cartilage rim at the location where spurs originate.

On physical examination there is recognisable pain on the anteromedial or anterolateral aspect of the ankle joint. Some swelling and/or limitation of dorsiflexion is present.[26] A plain lateral radiograph may reveal the cause of the impingement; the oblique anteromedial impingement (AMI) view is usually even more useful to detect bony ankle impingement *(Figure 1)*.[28] When conservative treatment fails, arthroscopic excision of soft tissue overgrowths and osteophytes is an effective way of treating anterior impingement of the ankle in patients without joint space narrowing. Tibial and talar osteophytes can easily be detected at arthroscopy with the ankle in forced dorsiflexion *(Figure 2).* The capsule does not need to be detached to locate these osteophytes.

Posterior ankle impingement

Posterior ankle impingement syndrome encompasses a group of pathologies that are characterised by posterior ankle pain in plantar flexion. The mechanism can be caused by overuse or trauma. It is important to differentiate between these two groups, because posterior impingement from overuse has a better prognosis[29] and patients are more satisfied after arthroscopic treatment.[18]

The overuse group consists mainly of ballet dancers, downhill runners and soccer players.[29-31] In professional ballet, specific dancing steps force the ankle into hyper plantar flexion. The anatomical structures in-between the calcaneus and the posterior part of the distal tibia thereby become compressed.

Figure 1:
Radiographs of a 22-year-old female professional volleyball player with complaints of anteromedial right ankle pain. (A) Weightbearing lateral radiographs. An arrow points at a scarcely visible osteophyte on the anterior distal tibia. (B) Oblique anteromedial impingement (AMI) view radiographs of the same patient. In this view, the beam is tilted in a 45° craniocaudal direction with the leg in 30° of external rotation and the foot in plantar flexion. Anteromedial osteophytes at the talus and tibia (arrows) are now clearly visible.

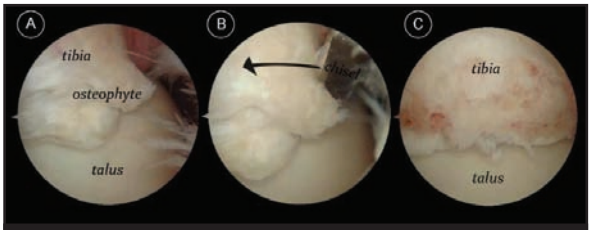

Figure 2:
Arthroscopic treatment of a 42-year-old male patient with anteromedial pain in the left ankle. (A) An osteophyte is visualised. (B) The bony rim is removed with a chisel. (C) Post-operative results.

Through exercise the dancer will attempt to increase the range of motion and joint mobility, ultimately decreasing the distance between the calcaneus and talus. As a result, the anatomical structures at the back of the ankle joint become compressed. Running with more pronounced plantar flexion, such as downhill running, imposes repetitive stresses on the anatomical structures of the posterior ankle area.[32] Kicking a ball with the foot in plantar flexion results in high forces on the anatomical structures in the hindfoot. These repetitive high forces can eventually cause posterior ankle impingement.

An isolated or combined hyper plantar flexion and supination trauma can damage these structures and may finally lead to a chronic posterior ankle impingement syndrome. Congenital anatomic anomalies such as a prominent posterior talar process, os trigonum or talus bipartitus[33] could facilitate the occurrence of the syndrome, especially in combination with an overuse injury.[24,34-36] An os trigonum is estimated to be present in 1.7–7% and occurs bilaterally in 1.4% people.[34-36]

During plantar flexion the soft tissue structures such as synovium, posterior ankle capsule or one of the posterior ligamentous structures can get pinched and compressed, eventually resulting in swelling, partial rupture or fibrosis.

The diagnosis is made by means of physical examination. The forced passive hyper plantar flexion test is positive when the patient complains of recognisable pain during the test. A negative test rules out the posterior ankle impingement syndrome. A positive test is followed by a diagnostic infiltration with Xylocaine®. Disappearance of pain following infiltration confirms the diagnosis. For radiographic detection of posterior impingement, the anteroposterior (AP) ankle view typically does not show abnormalities. On a lateral view, the posterolateral part of the talus is often superimposed on the medial talar process. Therefore detection of posterolateral talar process or os trigonum is often not possible. We recommend lateral radiographs with the foot in 25° of external rotation in relation to the standard lateral radiographs *(Figure 3)*.[37]

In case conservative treatment fails, excision of soft tissue overgrowth and osteophytes results in good functional and clinical outcome in symptomatic posterior ankle impingement.[18,19]

Flexor hallucis longus tendinopathy

Posterior ankle impingement syndrome is often accompanied by tenosynovitis or degeneration of the flexor hallucis longus (FHL), especially in ballet dancers.[38-42] The patient experiences pain in the posteromedial part of the ankle.[38] On physical examination the tendon can be palpated behind the medial malleolus. By asking the patient to repetitively flex the big toe, while the ankle is in 10-20 degrees plantar flexion, the FHL tendon can be identified in its gliding channel, in-between the medial and lateral talar process. In case of tendinitis or chronic inflammation, crepitus and recognisable pain can be provoked by the examiner putting the palpating/compressing finger just behind the medial malleolus. In some cases a painful nodule in the tendon might exist. Arthroscopic treatment should be considered if non-operative treatment fails to improve symptoms. In that case nettoyage of the FHL and release of the flexor retinaculum and tendon sheath up to the level of the sustentaculum tali should be performed in order to achieve unrestricted movement of the tendon *(Figure 4)*.

Osteochondral defects

A traumatic insult is widely accepted as the most important aetiologic factor of an osteochondral defect (OD) of the talus. Trauma has been described in 93-98% of lateral talar lesions and in 61-70% of medial lesions.[43,44] ODs can either heal and remain asymptomatic or progress to deep ankle pain on weightbearing, prolonged joint swelling, recurrent synovitis, diminished range of motion and formation of subchondral bone cysts. However, absence of swelling and diminished range of motion does not rule out an (osteo)chondral defect.

Figure 3:
Radiographs of a 22-year-old professional dancer with complaints of posterior ankle pain on plantar flexion of the right ankle. (A) Weight bearing lateral standing radiograph of the affected ankle shows a hypertrophic posterior talar process (arrow). (B) Posterior impingement (PIM) view which is manufactured with foot in 25° of external rotation in relation to the standard lateral radiographs shows an os trigonum (arrow).

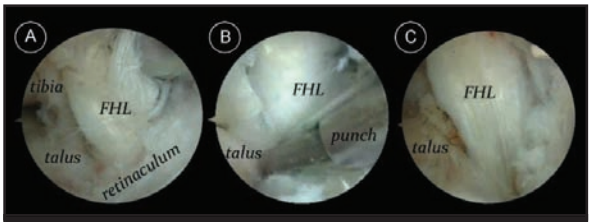

Figure 4:
Posterior endoscopic view of a 27-year-old male professional ballet dancer with a stenosing flexor hallucis longus (FHL) tendon of the left ankle. (A) The FHL is degenerative and thickened. (B) To correct stenosing of the tendon, the flexor retinaculum is cut with a punch to create more space for the FHL to freely move in its gliding channel. (C) Nettoyage of the FHL tendon is performed. This can be done with a bone cutter shaver or electrocautery.

Routine radiographs of the ankle should be obtained after careful history-taking and physical examination of the ankle. These consist of weightbearing anteroposterior (mortise) and lateral views of both ankles. Initially the damage may be too small to be visualised on a routine radiograph. The OD sometimes becomes apparent on radiographs at a later stage. A posteromedial or posterolateral defect may be revealed by a heel rise mortise view with the ankle in plantar flexion.[45] Additionally, computer tomography (CT) can be performed to confirm diagnosis and plan arthroscopic treatment *(Figure 5)*.

In case of asymptomatic OD, arthroscopic debridement and bone marrow stimulation remain the best treatment currently available for defects up to 15 mm in diameter.[44,46]

With this technique all unstable cartilage including the underlying necrotic bone is removed. Any cysts underlying the defect are opened and curetted. After debridement, multiple connections with the subchondral bone are created by drilling or microfracturing. The objective is to partially destroy the calcified zone that is most often present and to create multiple openings into the subchondral bone. Intra-osseous blood vessels are disrupted and the release of growth factors leads to the formation of a fibrin clot. The formation of local new blood vessels is stimulated, marrow cells are introduced into the OD and fibrocartilaginous tissue is formed.[47]

Deep portion of the deltoid ligament/Cedell fracture

Hyper dorsiflexion or eversion trauma can result in avulsion of the posterior talotibial ligament at its insertion into the medial tubercle of the talus. This may result in post-traumatic calcifications or ossicles in the deep portion of the deltoid ligament *(Figure 6).* These patients typically present with posteromedial ankle pain which is aggravated by running and walking on uneven grounds. Cedell was the first to report four cases of young athletes with ligament avulsion of the deep portion of the deltoid ligament.[48]

Synovitis

Ankle joint synovitis may be defined as inflammation and hypertrophy of the synovial lining of the ankle joint, and can be either acute or chronic. The diagnosis of synovitis is largely subjective. Vague complaints of pain within the ankle joint, with or without effusion, are common. In general conservative treatment is quite successful in decreasing (acute) synovitis in the ankle. Patients may respond to non-steroidal anti-inflammatory medications, intra-articular cortisone injections, or physical therapy modalities. Chronic synovitis, caused by diseases such as rheumatoid arthritis or synovial chondromatosis, which does not respond well to conservative treatment may sometimes require an arthroscopic nettoyage.

Contraindications for ankle arthroscopy are few but important. Relative contraindications for arthroscopy of the ankle include moderate degenerative joint disease, severe oedema and a tenuous vascular status. More absolute contraindications include localised soft-tissue infection and severe degenerative joint disease. Obesity, although not a contraindication, significantly contributes to a prolonged intraoperative surgical time and postoperative morbidity.[49]

Contraindications for ankle arthroscopy include localised soft-tissue infection and severe degenerative joint disease

Figure 5:
CT-scan images of a 27-year-old male patient with long duration of deep ankle pain (5 years) in his left ankle after an inversion trauma. A medially and fairly posterior location of a osteochondral defect of the talus is shown. This patient is planned for debridement and drilling of this defect through anterior arthroscopy. (A) Axial view. (B) Sagittal view. (C) Coronal view.

Figure 6:
CT-scan images of a 45-year-old male patient with long-term complaints of deep pain in his right ankle after an eversion trauma. A bony avulsion fragment (arrows) of the deep deltoid ligament was seen. (A) Axial view. (B) Sagittal view. (C) Coronal view.

Techniques

Anterior ankle arthroscopy

Anterior ankle arthroscopy is carried out as an outpatient procedure under general or spinal anaesthesia. Patients are placed in a supine position with slight elevation of the ipsilateral buttock. A support is placed at the contralateral side of the pelvis to be able to turn the table sideward for straight positioning of the ankle. The involved leg is marked pre-operatively to avoid wrong-side surgery. The heel of the affected foot rests on the very end of the operating table; in this way the surgeon can fully dorsiflex the ankle by leaning against the foot sole, and use the table as a lever when maximal plantar flexion is needed *(Figure 7).* Correct placement of the arthroscopic portals is the key to successful arthroscopy. The anteromedial and anterolateral portal will provide adequate access to the ankle joint and will minimise surgical trauma to the soft tissue surrounding the joint. Accessory portals are located just in front of the tip of the medial or lateral malleolus.

Figure 7:
Positioning for anterior ankle arthroscopy

Figure 8:
Positioning for posterior ankle arthroscopy

The anteromedial portal is made first with the ankle in slight dorsiflexion. After the skin incision has been made just medial to the anterior tibial tendon, the subcutaneous layer is bluntly dissected with a haemostat at the level of the ankle joint. Different scope diameters can be used, but we prefer a 4 mm 30° angled arthroscope. The scope will be introduced while the ankle is in full dorsiflexion. Hereby the talar cartilage is covered and thus protected by the tibial cartilage. For irrigation normal saline is used, and flow is obtained by gravity. By looking laterally, the location of the anterolateral portal is determined. A spinal needle is introduced just lateral to the peroneus tertius tendon. A vertical skin incision is made with special attention being paid not to damage the superficial peroneal nerve. The nerve is identified by palpating it along its course anterior and inferior to the lateral malleolus by placing the foot into inversion and plantar flexion. The subcutaneous layers are bluntly dissected with a haemostat and the desired instrument can be introduced.

The contour of the anterior tibia is identified and in the case of an osteophyte, soft tissue superior to this osteophyte is removed with a shaver. The extent of the osteophyte is determined and the osteophyte is subsequently removed using a 4 mm chisel and/or shaver. When an osteophyte is located at the medial distal tibial rim or the front of the medial malleolus, the arthroscope is moved to the anterolateral portal and the instruments are introduced through the anteromedial portal. Osteophytes at the tip of the medial malleolus and ossicles or avulsion fragments in this area can be removed in a similar manner. We use a non-invasive soft-tissue distraction device when indicated.[50] An accessory portal in front of the tip of the medial malleolus is sometimes helpful. In the case of osteophytes at the tip of the medial malleolus, overcorrection of the tip is usually feasible using a bone cutter shaver.

To prevent sinus formation, at the end of the procedure the skin incisions are sutured with 3.0 Ethilon. The incisions and surrounding skin are injected with 10 ml of a 0.5% bupivacaine/morphine solution. A sterile compressive dressing is applied. Prophylactic antibiotics are not routinely given.

Posterior ankle arthroscopy

The procedure is carried out as outpatient surgery under general anaesthesia or spinal anaesthesia. The patient is placed in a prone position. The involved leg is marked pre-operatively to avoid wrong-side surgery, with a tourniquet inflated around the thigh. The patient's ankle is placed slightly over the distal edge of the table and a small support is placed under the lower leg, making it possible to move the ankle freely. A support is placed at the ipsilateral side of the pelvis to safely rotate the table when needed *(Figure 8)*. A 4 mm arthroscope with an inclination angle of 30° is routinely used as in anterior ankle arthroscopy. Normal saline is used for irrigation. Apart from the standard excisional and motorised instruments for treatment of osteophytes and ossicles, a 4 mm chisel and periosteal elevator can be useful.

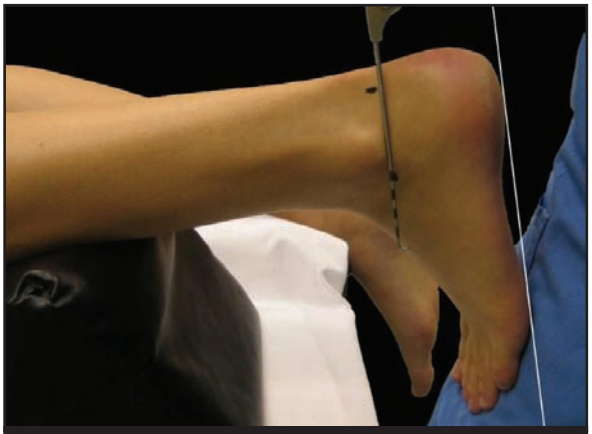

Figure 9:
Placement of lateral portal for posterior ankle arthroscopy. The foot is placed in a 90° position. A probe is hooked under the tip of the fibula, parallel to the foot sole (white line). The posterolateral portal is made directly in front of the Achilles tendon just proximal of this line. The medial portal is placed medial to the Achilles tendon, at the same level as the posterolateral portal (not shown).

The anatomical landmarks on the ankle are the lateral malleolus, medial and lateral border of the Achilles tendon and the foot sole. The ankle is kept in a 90° position. A straight line is drawn from the tip of the lateral malleolus to the Achilles tendon, parallel to the foot sole *(Figure 9).*

The posterolateral portal is made directly in front of the Achilles tendon just proximal to this line. After making a vertical stab incision, the subcutaneous layer is split by a mosquito clamp. The mosquito clamp is directed towards the interdigital web space between the first and second toe. When the tip of the clamp touches the bone, it is exchanged for a 4.5 mm arthroscopic shaft with the blunt trocar pointing in the same direction. By palpating the bone in the sagittal plane, the level of the ankle joint and subtalar joint can often be distinguished since the prominent posterior talar process or os trigonum can be felt as a posterior prominence in-between the two joints. The trocar is situated extra-articularly at the level of the ankle joint. The trocar is then exchanged for the 4 mm arthroscope with the direction of view 30° to the lateral side.

The anatomical landmarks on the ankle are the lateral malleolus, medial and lateral border of the Achilles tendon and the foot sole

The posteromedial portal is made medially of the Achilles tendon, at the same level as the posterolateral portal, just above the line from the tip of the lateral malleolus. After making a vertical stab incision, a mosquito clamp is pointed in the direction of the arthroscopic shaft at a 90° angle. When the mosquito clamp touches the shaft of the arthroscope, the shaft is used as a guide to 'travel' anteriorly in the direction of the ankle joint, all the way down while contacting the arthroscope shaft until it reaches the bone. The arthroscopic shaft is subsequently pulled slightly backward until the tip of the mosquito clamp becomes visible. The clamp is used to spread the extra-articular soft tissue in front of the tip of the lens. After exchanging the mosquito clamp for a 5 mm full radius resector, the fatty tissue overlying the posterior ankle capsule, lateral from the FHL tendon, is resected. The tip of the shaver is directed in a lateral and slightly plantar direction towards the lateral aspect of the subtalar joint.

Once this tissue is debrided, the ankle and subtalar joints are entered easily by penetrating the very thin joint capsule. At the level of the ankle joint, the posterior tibiofibular ligament is recognised as well as the posterior talofibular ligament. The posterior talar process can be freed from scar tissue and the FHL tendon is identified. This tendon should be located first, before addressing the pathology. The FHL tendon is an important safety landmark, since the neurovascular bundle runs just medial from this tendon. After removal of the thin joint capsule of the ankle joint, the intermalleolar and transverse ligament will be lifted in order to enter and inspect the ankle joint.

On the medial side, the tip of the medial malleolus can be visualised as well as the deep portion of the deltoid ligament. By opening the joint capsule from inside out at the level of the medial malleolus, the tendon sheath of the posterior tibial tendon can be opened when desired, and the arthroscope may then be introduced into the tendon sheath. Inspection of the posterior tibial tendon is then possible. The same procedure can be done for the flexor digitorum longus tendon.

By applying manual distraction to the calcaneus, the posterior compartment of the ankle opens up and the shaver can be introduced into the posterior ankle compartment. We prefer to apply a soft-tissue distractor at this point.[50] A synovectomy and/or capsulectomy can be performed. Inspection of the talar dome is possible over almost its entire surface as well as the complete tibial plafond. Identification of an osteochondral defect or subchondral cystic lesion may lead to debridement and drilling. The posterior syndesmotic ligaments are inspected and debrided if fibrotic or ruptured.

Removal of a symptomatic os trigonum, a non-union of a fracture of the posterior talar process or a symptomatic large posterior talar prominence involves partial detachment of the posterior talofibular ligament and release of the flexor retinaculum, which both attach to the posterior talar prominence. Release of the flexor hallucis longus tendon involves detachment of the flexor retinaculum from the posterior talar process. The tendon sheath can then be entered with the scope, following the tendon under the medial malleolus and a further release can be performed.

Bleeding is controlled by electrocautery at the end of the procedure. Wound closure and dressing are performed as in anterior ankle arthroscopy. After surgery, patients are instructed to weightbear according to what they can tolerated.

Complications

Most arthroscopic complications can be avoided if the surgeon becomes thoroughly familiar with the anatomy of the region.[20] The expanding use of ankle arthroscopy and its risks have been well documented.[7,9,20,22,51-55] Complications in ankle arthroscopy vary widely and rates from 9 to 17% occur.[7,20,22,56] Ferkel *et al* reported in the largest series an overall complication rate of 9.0% in 612 patients.[22] The most common complication was neurological (49%), involving the superficial peroneal nerve (56%), the sural nerve (24%), or the saphenous nerve (20%). Neurovascular injures are cause by incorrect portal placement, pin placement, use of a tourniquet, or prolonged or inappropriate distraction.[12] In a recent survey performed in our department in which 1 300 consecutive patients with ankle arthroscopy without routine joint distraction were included, the overall percentage of complications was 3.4%. This figure includes 1.4% for hindfoot endoscopy.[57] Most investigators have commented that the anterior and the posterolateral portals are safe.

The posteromedial portal is generally not recommended[6,7,54,58-60] because there is significant risk of injury to the medial neurovascular bundle during instrument penetration. However, with the correct technique and experience there is little risk of injury to this neurovascular structure.[14,61]
Other possible complications following joint arthroscopy include infection, instrument breakage, distractor pin site pain or fracture when using invasive distraction and damaging the articular cartilage.[22] One must also be aware of potential injury to the tendons transversing the ankle joint. Careful pre-operative planning, a knowledge of surface anatomy and the use of appropriate distraction and instrumentation techniques help to avoid these complications.

Conclusion

Arthroscopy has become an important operative technique in treating a wide variety of ankle pathology. It provides a minimally invasive approach as a good alternative to the existing open surgical techniques. Complications in ankle arthroscopy are rare, with the most common being neurological. In order to reduce complication rates and to provide good clinical outcome, it is recommended that the surgeon first becomes familiar with the anatomy and uses routine portals in ankle arthroscopy.

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