6 Ankle arthritis

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6.1 Introduction

Ankle arthritis can occur for a variety of reasons, but unlike the hip or knee, primary arthritis of the ankle is unusual. Most patients with ankle arthritis have sustained prior trauma or have conditions such as inflammatory arthritis as a cause. Multiple treatment options are available for arthritis of the ankle, and determining the ideal option requires taking into account patient factors, alignment of the extremity, and patient expectations.

Figure 1.
6.2 Anatomy

The tibiotalar articulation occurs between the distal tibia and fibula and proximal talus. Congruity of the tibiotalar joint is from the shape of the bony surfaces, and at the extremes of motion, stability is more dependent on the ligament. The anterior and posterior tibiofibular ligaments form the distal extent of the syndesmotic complex. This complex maintains an exact relationship between all three bones and articulating surfaces. A shift of only 1 mm of lateral talar displacement can decrease the contact area of the ankle joint by >40%.¹

The ankle joint can be subdivided into three distinct articulating surfaces:

- **Lateral surface**, between the lateral talar surface and the lateral malleolus of the distal fibula
- **Medial surface**, between the medial talar surface and the medial malleolus of the tibia
- **Central surface**, between the distal tibia and the superior dome of the talus

The superior dome of the talus is slightly concave in the frontal plane; the distal tibia has a concavity that matches this. The central depression in the talus separates the tibiotalar articulation into medial and lateral compartments. In the sagittal plane, the radius of curvature of the distal tibia closely matches the proximal talus.

6.3 Biomechanics

Normal ankle range of motion is 20 degrees of dorsiflexion and 50 degrees of plantar flexion. The distal tibial articular surface is slightly oblique to the long axis of the tibia, averaging 3 degrees of valgus. The transmalleolar axis averages 8 degrees of varus due to the fibula being more distal than the medial malleolus of the distal tibia. The transmalleolar axis provides a rough clinical estimate of the degree of obliquity of the axis of tibiotalar articulation.² The oblique axis of the ankle results in outward deviation of the foot with dorsiflexion and inward deviation with plantarflexion. In this respect, the ankle joint is often described conceptually as a "mitered hinge." The amount of deviation is proportional to the obliquity of the ankle joint axis. Throughout the range of motion of the ankle joint, the center of rotation constantly changes.

6.4 Pathogenesis

Most cases of ankle arthritis are post-traumatic in nature. There are distinct physiologic and mechanical differences between ankle cartilage and cartilage of the knee and hip, which may explain the lack of primary atraumatic arthritis:

- Ankle cartilage has a higher equilibrium modulus and dynamic stiffness and a lower hydraulic permeability.
- Chondrocytes in the ankle produce significantly more proteoglycan. Ankle chondrocytes also seem to be more responsive to anabolic factors and have a better potential for repair of damaged matrix.³
- Cartilage in the ankle has a higher water content.
- Compared with knee cartilage, ankle cartilage has an increased resistance to loading and is less sensitive to mechanical damage.
Other common causes of ankle arthritis include:

- Inflammatory arthritis
- Arthritis resulting from crystalline arthropathy
- Talar avascular necrosis
- Post-infectious arthritis
- Mixed connective tissue disorders
- Pigmented villonodular synovitis
- Hemophilic arthropathy

### 6.5 Clinical Presentation

Most patients with ankle arthritis report symptoms of pain, stiffness, and swelling of the ankle region. In cases of inflammatory arthritis, the ankle joint will not usually be a presenting symptom.

Patients with ankle arthritis can present wearing high top work boots or high top shoes, having figured out that these can help with symptoms of pain. While obtaining a history from the patient, ask about a history of any trauma, including fracture, ankle sprain, or recurrent ankle instability. Determine if the symptoms are predominately located in a region of the ankle joint or with specific motions, and if any loose body sensations are present.

Pain with dorsiflexion may indicate anterior pathology or impingement, and pain with plantarflexion can result from pathology in the posterior tibiotalar joint region. Posteriomedial pain often indicates a tendinous problem or medial compartment arthritis, and peroneal tendon pathology can cause posterolateral pain. Unlike hindfoot arthritis, isolated tibiotalar arthritis may or may not be worsened by walking on uneven surfaces.

### 6.6 Imaging and Diagnostic Studies

Weight-bearing ankle radiographs consisting of an anterior-posterior, lateral, and mortise views should be obtained. Additionally, three views of the foot should be obtained; the anterior-posterior and lateral views should be weight-bearing views. If there is any concern for limb alignment or limb length discrepancies, long leg films or a scanogram should be obtained.

Computerized tomography with reconstructions can provide additional information about the surface of the tibial plafond or can better visualize talar wear or collapse. In cases without excessive deformity, plain film radiographs are typically adequate for an arthritic ankle.

Magnetic resonance imaging (MRI) rarely plays a significant role in diagnosis or treatment of ankle arthritis. It can be useful in cases where areas of focal arthritis are present, such as osteochondral lesions of the talus. MRI also is very useful in cases where there is concern for concomitant soft tissue pathology around the ankle joint or cartilage wear in adjacent joints.

Bone scan can be useful to help differentiate between ankle and hindfoot arthritis. Additionally, a radiolabeled white blood cell scan can help determine if areas of osteomyelitis are present.
6.7 Classification

- Stage 0 - Normal joint or subchondral sclerosis
- Stage 1 - Presence of osteophytes without joint-space narrowing
- Stage 2 - Joint-space narrowing with or without osteophytes
- Stage 3 - Subtotal or total disappearance or deformation of joint space

Canadian Orthopaedic Foot and Ankle Society Classification for End-Stage Ankle Arthritis

- Type 1 - Isolated ankle arthritis
- Type 2 - Ankle arthritis with intra-articular varus or valgus deformity or a tight heel cord, or both
- Type 3 - Ankle arthritis with hindfoot deformity, tibial malunion, midfoot ab- or adductus, supinated midfoot, plantarflexed first ray etc.
- Type 4 - Types 1-3 plus subtalar, calcaneocuboid, or talonavicular arthritis

6.8 Treatment

6.8.1 Nonoperative Treatment

Nonoperative treatment of ankle arthritis typically starts with shoewear modification, bracing, and oral anti-inflammatory drugs and can progress to intra-articular injections.

The goal of bracing is to minimize motion across the ankle joint, and to do this, support above and below the ankle joint is necessary. Patients with arthritic ankles often discover on their own that high top boots or shoes are more comfortable. When considering bracing, there are many options, ranging from over-the-counter lace-up type athletic ankle braces to a custom-molded ankle foot orthoses (AFO). In the most severe cases, a patellar tendon weight-bearing orthosis can help to offload the ankle and limit motion, but these are often poorly tolerated. An Arizona brace (lace-up leather brace) is often a good choice because it provides good support of the ankle joint while still fitting in many types of shoes, although the shoe needs to be bigger to accommodate the brace. A cushioned heel and rocker bottom shoe modification can help absorb the impact of heel strike and transfer sagittal plane motion from the ankle joint to the bottom of the shoe.

Corticosteroids may have a role in the treatment of arthritic symptoms, but are not without risk. When used judiciously, they can be safe; however, due to their catabolic nature, routine injection can cause damage to the soft tissue envelope around the ankle joint and often effectiveness decreases after several injections. The role of viscosupplementation injections in the ankle joint remains controversial, with limited evidence to support their use.

6.8.2 Operative Treatment

Many surgical options are available to treat ankle arthritis:

- Tibiotalar fusion, the gold standard for end-stage arthritis
• Total ankle arthroplasty (TAA)
• Total ankle allograft transplantation
• Distraction arthroplasty

When deciding on a surgical treatment option, close attention must be paid to other medical comorbidities, patient expectations, the presence of hindfoot arthritis, and overall limb and foot alignment.

6.8.3 Tibiotalar Fusion

Ankle fusion (arthrodesis) is an excellent treatment option for pain relief. Unfortunately, the lack of motion at the ankle joint leads to accelerated arthrosis in many of the remaining joints of the foot – subtalar, talonavicular, calcaneocuboid, naviculocuneiform, first tarsometatarsal, and first metatarsophalangeal. Typically, the knee is spared from signs of accelerated arthritis. Ankle fusion is possible using arthroscopic techniques or a variety of open approaches with a variety of fixation methods. If necessary, allograft or autograft bone block interposition or osteotomies of the lower leg or foot can be used to achieve neutral alignment and restore length. The ultimate position of fusion is critical for success.

The ideal position of ankle arthrodesis is:

- 5 degrees of valgus
- Neutral dorsiflexion/plantarflexion
- Rotation equal to contralateral side, or slightly more externally rotated (5-10 degrees)
- Talus aligned under tibial plafond or slightly posterior; use the anterior aspect of tibial dome and anterior aspect of tibia as reference points

Ideally, after ankle fusion, the hindfoot rests in 5-7 degrees of valgus. Excessive hindfoot valgus will result in an inability to lock the transverse tarsal joints during the stance and push-off phases of gait, resulting in an excessively flexible mid- and forefoot. Excessive hindfoot varus will result in locking of the transverse tarsal joints, excessive mid- and forefoot rigidity, and overloading of the lateral forefoot. Both are poorly tolerated by patients.

Arthroscopic ankle fusion is a proven method that works well in patients without significant deformity. Typically, this approach can be considered in joints that require less than 5 degrees of angular correction. An arthroscopic fusion is typically performed through the anterolateral and anteromedial portals with percutaneous large diameter screw fixation (6.5-7.5 mm size approximately) (Figure 2). In multiple studies, fusion rates for arthroscopic fusion were similar to those of open procedures; arthroscopic fusion also typically resulted in a shorter hospital stays and less intraoperative blood loss. The literature indicates that while ultimate fusion rates are similar between open and arthroscopic techniques, time to fusion with arthroscopic techniques is shorter.
Mini-open, or miniarthrotomy, ankle fusion bridges the gap between arthroscopic techniques and full open techniques. Two incisions are typically made in the locations where anterolateral and anteromedial arthroscopic portals would be placed. Through these incisions, lamina spreaders can be utilized to distract the tibiotalar joint. Fixation is similar to arthroscopic fusion – large diameter cannulated screws placed percutaneously with fluoroscopic guidance. Two, three, or four screw constructs can be utilized. Unlike arthroscopic or full open techniques, it is nearly impossible to denude the posterior one-third of the joint with miniarthrotomy. Despite this, small studies have shown excellent fusion rates and adequate stability with fusion of the anterior two-thirds of the joint.

Numerous methods for open ankle fusion have been described. The exposure can be obtained through anterior, lateral/transfibular, or medial approaches. Fixation can be achieved with lag screws, plating, external fixation, or a combination of these. As with minimally invasive ankle fusion approaches, large diameter cannulated screws in the 6.5-7.5-mm range are utilized if screws are used in isolation. Standard plates can be fashioned to fit, or commercially available precontoured plates can be utilized (Figure 3).
Total ankle arthroplasty has seen resurgence in the past decade after poor results in the 1970s and 1980s. This is a technically demanding procedure, with a documented learning curve. Indications for TAA include patients with end-stage arthritis who ideally meet the following criteria:

- Less than 20 degrees of varus or valgus deformity
- Age greater than 50 years
- BMI in the normal range
- Weight less than 250 pounds

Good candidates for TAA must be willing to avoid any contact sports, high-impact activities, or manual labor. With TAA, preoperative range of motion usually correlates to postoperative range of motion, so a preoperative arc of motion of 20 degrees or more is ideal. Indications for TAA may be expanded in cases where ankle fusion would be poorly tolerated, such as:

- Contralateral ankle fusion
- Ipsilateral hind or midfoot arthritis
- Ipsilateral triple arthrodesis

Absolute contraindications include:

- Active infection
- Severe osteoporosis
- Inadequate soft tissue envelope around the ankle
- Massive talar avascular necrosis
- Poor vascular supply to the leg
Currently, there are several FDA-approved models available for use. Current TAA designs include fixed and mobile bearing systems with cemented or ingrowth fixation. Most systems rely on proximal fixation in the tibia, but one system requires a syndesmotic fusion for proximal fixation in the tibia and fibula (Figure 4). One modular total ankle system allows for intramedullary fixation which can be adjusted to the length necessary for the patient (Figure 5). In patients with ipsilateral hip or knee arthritis, proximal arthroplasties or osteotomies should be performed first, as these may change limb alignment. In some cases, TAA can be performed in conjunction with osteotomies of the lower leg or foot to achieve neutral alignment.

![Figure 4. Total ankle system requiring syndesmotic fusion](image)

![Figure 5. Total ankle system with free polyethylene component (note the calcaneal osteotomy performed at time of ankle replacement)](image)

### 6.8.5 Total Ankle Allograft Transplantation
Total ankle allograft transplantation, also known as total ankle shell allograft reconstruction, is a technically demanding procedure in which the ankle is replaced using allograft tissue. This procedure requires the availability of side- and size-matched cadaveric distal tibia, fibula, and talus. Typically, a total ankle cutting jig is used to prepare the patient's recipient ankle joint, and a total ankle cutting jig one size larger is used to prepare the tibial and fibular allograft.

Indications for this procedure are extremely limited, and surgeons must expect an extremely high failure rate and need for revision surgery. An ideal candidate for this procedure is a patient with

- End-stage arthritis
- No significant angular deformity
- Excellent range of motion
- Normal body mass index
- An unwillingness to accept ankle fusion as a treatment option

In a recent retrospective analysis, Jeng et al showed a 69% failure rate at a mean follow-up of 2 years. Only 9 of 29 ankles were deemed as successful in this series, with the majority requiring conversion or awaiting conversion to bone block ankle fusion, total ankle replacement, or revision ankle joint transplantation.

6.8.6 Distraction Arthroplasty

Distraction arthroplasty of the ankle is another treatment modality available for advanced ankle arthritis. This technique involves placing an external fixator to produce mechanical separation of opposing articular cartilage surfaces.

Studies have shown this helps with pain, function, radiographic appearance, and clinical scores in most patients. Distraction can be done with or without movement. At the 2010 American Orthopaedic Foot and Ankle Society Summer Meeting, the results were presented of a prospective randomized controlled trial of motion versus fixed distraction with 104-month follow-up. This study showed that either method of distraction provided improvement in symptoms, but at final follow-up of 104 months, the motion group had an Ankle Osteoarthritis Scale improvement of 56.6%, vs. 29.7% for the static distraction group. Other studies have shown that after distraction, patients have regained and maintained joint space and shown significant resolution of subchondral cysts radiographically.

6.9 Controversy

The treatment of ankle arthritis is rapidly evolving. Treatment modalities that avoid fusion are currently becoming more common. For nonoperative treatment, the use of viscosupplementation injection therapy remains a question. Long-term studies will be necessary to definitively determine if options such as total ankle allograft transplantation or distraction arthroplasty are reasonable.

Currently, there are multiple total ankle replacement designs on the market. It is still unknown if any are superior designs. Indications for total ankle replacement are constantly being expanded. Time will tell if it is wise to attempt total ankles in younger patients, heavier patients, extremely active patients, or patients with preoperative deformity at the ankle. Long-term outcome studies using current third-generation total ankle prostheses are necessary to answer these questions.
6.10 References