Ankle Arthroscopy: I. Technique and Complications

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Abstract

Arthroscopic surgery of the ankle allows the direct visualization of all intra-articular structures of the ankle without an arthrotomy or malleolar osteotomy. Technological advances and a thorough understanding of anatomy have resulted in an improved ability to perform diagnostic and operative arthroscopy of the ankle. The decreased morbidity and faster recovery times make it an appealing technique compared with open arthrotomy. A keen understanding of the anatomy of the foot and ankle is critical to safe performance of arthroscopic procedures and prevention of complications.

J Am Acad Orthop Surg 1996;4:17-23

Arthroscopic surgery of the ankle is a relatively new and exciting addition to the armamentarium of the orthopaedic surgeon. Direct visualization of all intra-articular structures without an arthrotomy or malleolar osteotomy is now possible. Major technological advances in video cameras, fiberoptic light transmission, small-joint instrumentation, and distraction, combined with a sound knowledge of safe anatomic portals, have resulted in an improved ability to perform diagnostic and operative arthroscopy of the ankle.

Portal Anatomy

An understanding of the surface and intra-articular anatomy of the ankle region is essential to the successful performance of arthroscopy of the ankle. The superficial anatomy serves as a guide to the successful placement of arthroscopic portals in the ankle.[1] The neurovascular and tendinous structures are most at risk. Before portal placement, a skin marker is used to mark important anatomic landmarks, including the joint line, the dorsalis pedis artery, the greater saphenous vein, the anterior tibial tendon, and the peroneus tertius tendon.

The superficial peroneal nerve and its branches should be identified, if possible, because of their proximity to the anterolateral portal. These branches frequently can be seen as they are pulled taut beneath the skin when the fourth toe is grasped and the forefoot is pulled into plantar flexion and adduction. The superficial peroneal nerve divides into the intermediate and medial dorsal cutaneous branches approximately 6.5 cm proximal to the tip of the fibula (Fig. 1).[2] The intermediate dorsal cutaneous nerve passes superficial to the inferior extensor retinaculum, crosses anterior to the common extensor tendons of the fourth and fifth toes, and then runs in the direction of the space between the third and fourth metatarsals before it divides into dorsal digital branches. The medial terminal branch of the superficial peroneal nerve, the medial dorsal cutaneous nerve, crosses the anterior aspect of the ankle superficial to the common extensor tendons. The nerve runs parallel and just lateral to the extensor hallucis longus tendon and divides distal to the inferior extensor retinaculum into the dorsal digital branches.

Portal Placement

Before portal placement, the ankle joint should be distended with 10 to 15 mL of lactated Ringer's solution injected into the ankle joint medial to the anterior tibialis tendon with the use of an 18- to 20-gauge needle. This injection also helps to establish the exact location of the anteromedial portal. Care should be taken to avoid directing the needle either too far anteriorly or too far posteriorly in the ankle joint. To prevent injury to neurovascular structures, the inci-

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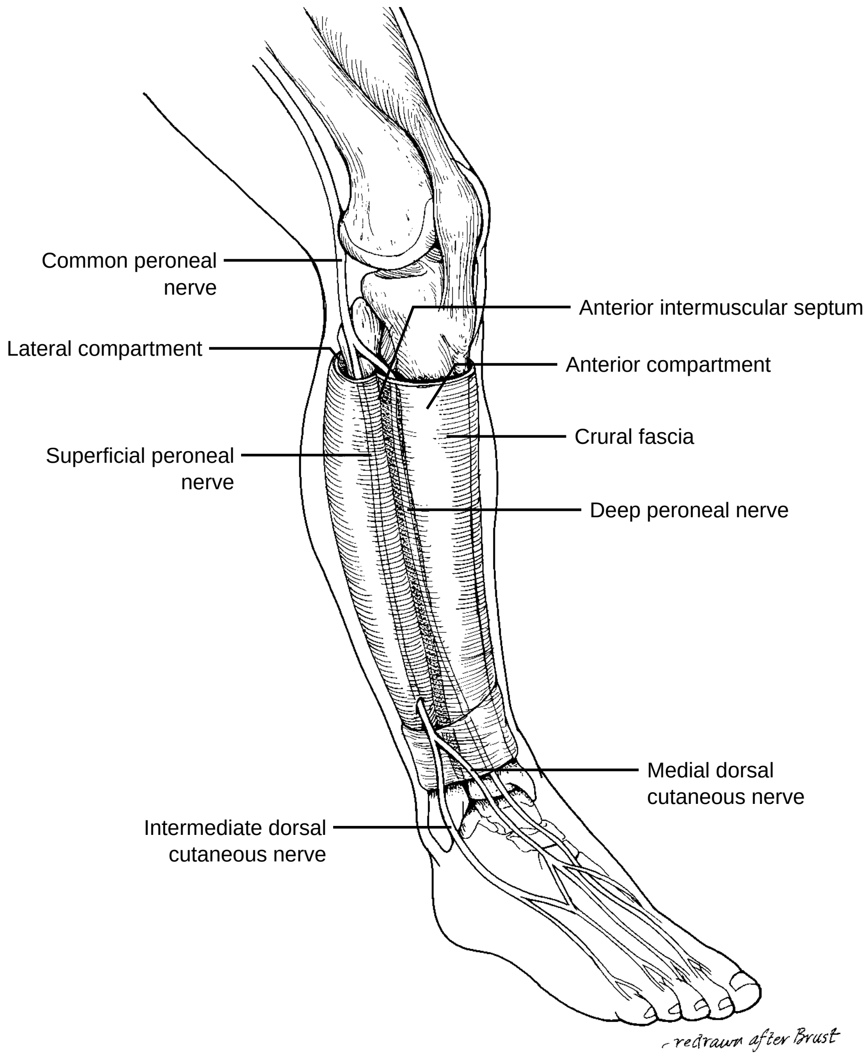


Fig. 1 The superficial branch of the peroneal nerve divides into the medial dorsal cutaneous nerve and the intermediate dorsal cutaneous nerve as it penetrates the fascia of the lateral compartment.

sions for the portals should be made vertically and through the skin only. The deeper layers should be penetrated with a mosquito clamp followed by a blunt obturator, not with a sharp knife or a trocar. The anterolateral, anteromedial, and posterolateral portals are most commonly used. In a recent anatomic study,[3] they were found to be the safest areas for portal placement, allowing no penetration of neurovascular structures.

The anteromedial portal is made just medial to the tendon of the anterior tibialis at, or just proximal to, the joint line (Fig. 2, A). This portal is made first because it is easy to establish and is located in a region devoid of any major neurovascular structures. With the use of a blunt trocar, the arthroscope is carefully introduced into the joint. Lactated Ringer's solution is infused through a syringe into the joint through the side port of the arthroscopic cannula. The greater saphenous vein and nerve are at greatest risk when establishing this portal. The portal is, on average, 9 mm lateral to the greater saphenous vein and 7.4 mm lateral to the greater saphenous nerve.[3]

The anterolateral portal is used for placement of the inflow cannula and is established under direct visualization with the use of a 25-gauge 1.5-inch needle. It is usually made just lateral to the tendon of the peroneus tertius at, or just proximal to, the level of the joint line. However, its location is also determined on the basis of the type and location of the pathologic tissue. This portal can sometimes be determined more easily by transilluminating the skin with the arthroscope to assist in the avoidance of neurovascular structures and tendons. The branches of the superficial peroneal nerve are most at risk. The mean distance of the anterolateral portal from the intermediate branch of the superficial peroneal nerve is 6.2 mm (range, 0 to 24 mm).[3]

An anterocentral portal may be created between the tendons of the extensor digitorum communis, at the level of the joint or proximal to the joint line. Care must be taken to avoid injury to the dorsalis pedis artery and the deep branch of the peroneal nerve, which lies between the extensor hallucis longus tendon and the medial border of the extensor digitorum communis tendon. Use of this portal is discouraged because of the inherent risk of neurovascular injury. Feiwell and Frey[3] found that the average distance (in either direction) of the portal from the artery, vein, and nerve is 3.3 mm (range, 0 to 10 mm). In five cases, the arthroscope either penetrated (one case) or was in contact with (four cases) the neurovascular bundle.

A posterolateral portal is established just lateral to the Achilles tendon, approximately 1.0 to 1.5 cm

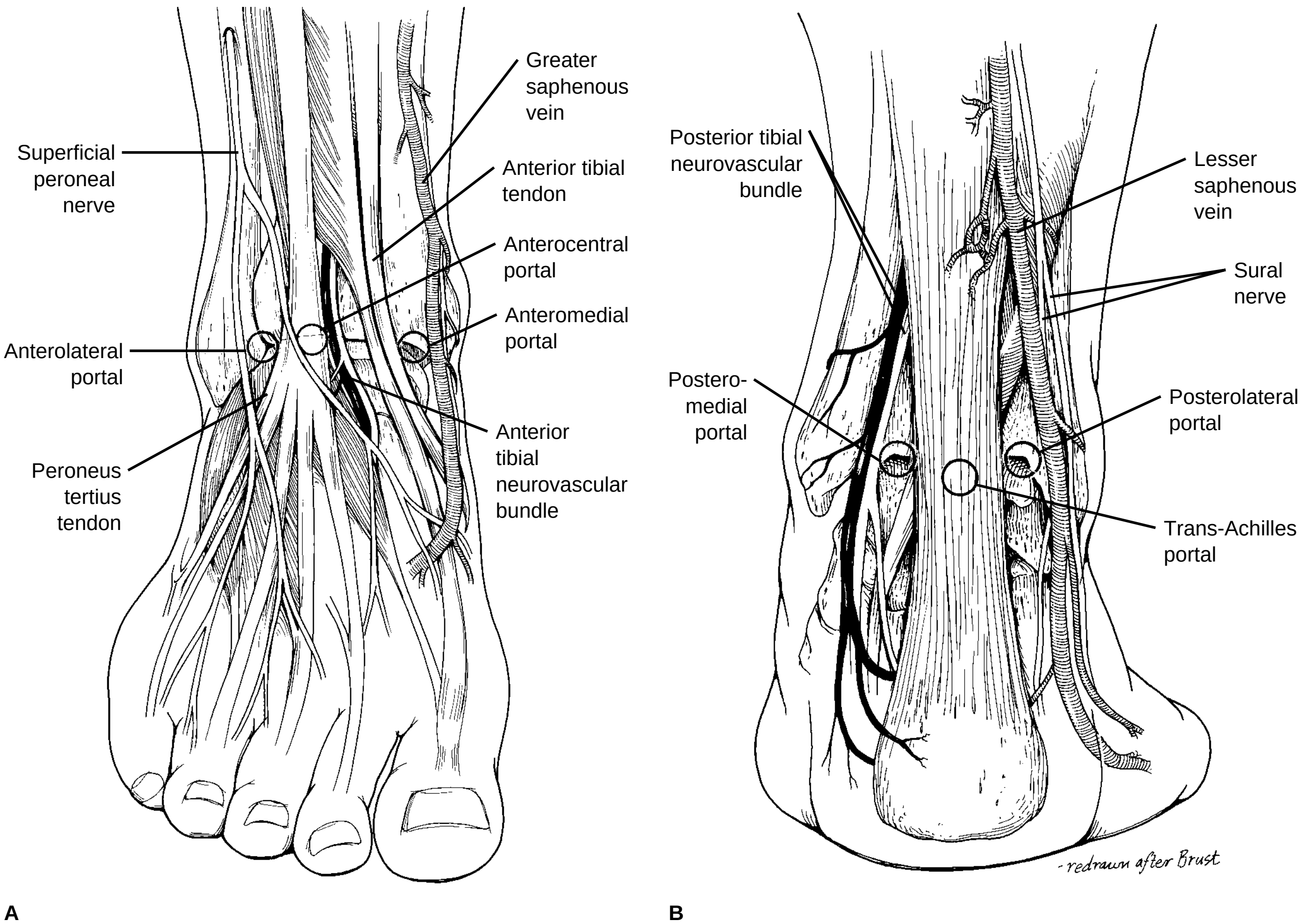


Fig. 2 **A,** Location of the anteromedial, anterolateral, and anterocentral portals. The central portal should be avoided. **B,** The posterolateral portal is established just lateral to the Achilles tendon, approximately 1.0 to 1.5 cm proximal to the distal tip of the fibula. The posteromedial and trans-Achilles portals are also shown but not recommended.

proximal to the distal tip of the fibula (Fig. 2, B). The portal can be made under direct visualization by placing the arthroscope from the anteromedial portal through the notch of Harty, looking posteriorly. An 18-gauge spinal needle is inserted just lateral to the Achilles tendon at a 45-degree angle toward the medial malleolus. The posterior aspect of the capsule is usually punctured just medial to the transverse tibiofibular ligament.

An alternative for placement of the posterolateral portal is to place a switching stick (a smooth metal rod) from the anteromedial portal. The switching stick is inserted through the capsule, and the cannula is placed over the rod through the posterolateral portal. This can be done only with marked distraction of the joint. If the joint is not distracted sufficiently, this portal may be established too far proximally. The lesser saphenous vein and the sural nerve are at risk in establishing this portal. These two structures run parallel to each other along the posterolateral aspect of the ankle joint, an average of 3.5 mm apart. The sural nerve is consistently posterior to the lesser saphenous vein. On average, the posterolateral portal is 6 mm (range, 0 to 12 mm) posterior to the sural nerve and 9.5 mm (range, 2 to 18 mm) posterior to the lesser saphenous vein.[3]

The posterocentral portal is made just below the joint line through the middle of the Achilles tendon. This portal is not recommended because of its limitations and potential associated morbidity.

The posteromedial portal is generally contraindicated because of the proximity of the posterior tibial artery and nerve. The flexor hallucis and flexor digitorum longus tendons are also at risk, along with branches of the calcaneal nerve.

A transmalleolar portal may be necessary to drill osteochondral lesions of the talus. These portals are made by creating small incisions over the medial or lateral malleolus. A small-joint drill guide is helpful in directing the tip of the Kirschner wire to the lesion. Transtalar portals can be used by drilling from the sinus tarsi or the medial talus.

Arthroscopic Setup and Instrumentation

Arthroscopy of the ankle may be performed with general, regional, or local anesthesia. The position of the patient may also vary, depending on the surgeon's preference. We prefer supine placement of the patient, with the hip flexed 45 to 50 degrees on a nonsterile thigh holder. This supports the thigh proximal to the popliteal fossa. Adequate padding is added to avoid injury to the sciatic nerve.[1]

An alternative method includes flexion of the knee over the end of the operating table with the patient supine. This permits some distraction by gravity and by an assistant. However, access to posterior portals is somewhat difficult with this technique.[4]

Positioning the patient in the lateral decubitus position, with the body supported by a beanbag and kidney rest and tilted posteriorly, has also been described.[5] This technique does not require the use of a thigh or ankle holder.

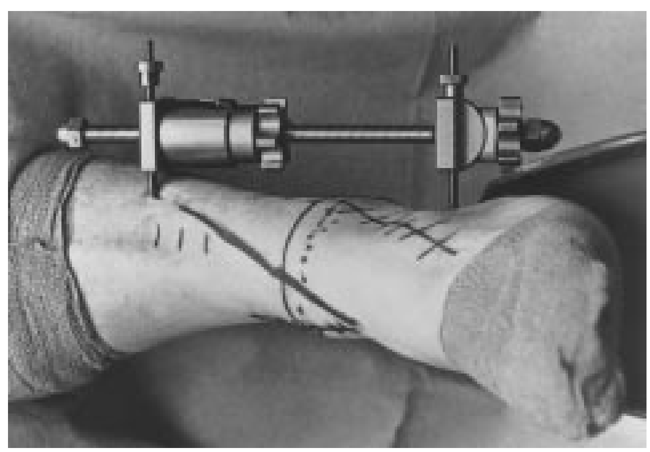
For anterior portals, the ipsilateral hip is rotated externally; for posterolateral portals, the hip is rotated internally.[6] Guhl[7] described the technique of placing the supine patient's ipsilateral hip and knee on a padded support. The foot and ankle are secured to an ankle holder, and a mechanical ankle distractor is used. A tourniquet may be used at the surgeon's discretion.

Ankle Distraction

The decision to perform invasive or noninvasive distraction generally is made at the time of surgery and depends on both the laxity of the ankle joint and the location of the pathologic tissue that is to be addressed. With invasive distraction, a tibial pin and a talar or calcaneal pin are placed from the medial or lateral side with a mechanical distractor device. Noninvasive distractors include a clove-hitch-type device wrapped over the anterior aspect of the midfoot and the posterior aspect of the heel (Fig. 3, A).[8]

The technique used by the senior author (R.D.F.) for invasive distraction includes two threaded, trocar-tipped Steinmann pins measuring 4 to 5 inches long and 3/16 inch in diameter. The tibial pin should be placed 2.5 to 3.0 inches (6.5 to 7.5 cm) above the ankle joint line, approximately a thumb's width below the anterior lateral tibial crest. A clamp and then a soft-tissue trocar are used to tunnel through the subcutaneous tissue anterior to the tibialis anterior tendon. A Steinmann pin is placed through the trocar and is drilled across the lateral cortex but not through the medial cortex. The calcaneal pin should be placed approximately 2.5 cm anterior and 2.5 cm superior to the posterior inferior calcaneal margin and directed at a 20-degree caudal inclination. This pin

A



B

Fig. 3 **A,** Clove-hitch-type device wrapped over the anterior aspect of the midfoot and the posterior aspect of the heel for noninvasive distraction. **B,** Invasive distraction device placed laterally with pins in the tibia and calcaneus.

should be unicortical and should not penetrate the medial cortex. The joint is then slowly distracted 4 to 5 mm (Fig. 3, B). Additional distraction is applied as the capsular tissue relaxes.

Distraction should not exceed 7 or 8 mm for more than 1½ hours. Care should be taken to minimize bending of the pins. In a recent cadaver study analyzing ligament strain and ankle-joint opening during ankle distraction, Albert et al[9] recommended avoiding distraction forces greater than 90 N while distracting the ankle in the 20-degree dorsiflexion position. Forces greater than this were shown to produce injury to the calcaneofibular ligament.

The superficial peroneal nerve is at risk near the proximal pin of the ankle distractor. Using a cadaver model, Feiwell and Frey[3] found that the proximal pin was in contact with the superficial peroneal nerve in 6 of 18 cases, and in 1 case the nerve was disrupted by the pin. The average pin was 7 mm (range, 0 to 30 mm) anterior to the nerve. The distal calcaneal distraction pin was located behind the peroneal tendon sheath and branches of the sural nerve and lesser saphenous vein. The average distance from the lesser saphenous vein was 7 to 8 mm (range, 0 to 23 mm), with one disruption. The average distance from the sural nerve to the distal pin was 6.8 mm (range, 0 to 20 mm).

Noninvasive distraction can be done with a strap wrapped over the foot and behind the heel. Yates and Grana[8] have described using a roll of gauze dressing looped around the foot and ankle to open the tibiotalar joint, facilitating passage of arthroscopic instrumentation. The device must be applied with the use of noninvasive distraction, so that it does not exert excessive pressure over the anterior tibial neurovascular bundle. No more than 35 to 50 lb of force should be exerted for more than 1½ hours. Periodic release is recommended in long procedures. The senior author currently uses noninvasive distraction in approximately 90% to 95% of ankle arthroscopic procedures. In the athlete, noninvasive distraction is always preferred, because it avoids the potential stress riser caused by the pins.

Arthroscopic Equipment

A standard 4.0-mm, 25- or 30-degree arthroscope may be used, but a 2.7-mm, 30-degree short arthroscope is preferred because of the shorter lever arm, easier accessibility to the joint, and availability of interchangeable cannulae. Small-joint arthroscopic instruments, 2.0- and 2.7-mm motorized burrs and shavers, miniprobes, 2.7-mm graspers, 4.5- and 7.0-mm curettes, pituitary rongeurs, and small-joint osteotomes and rasps are helpful. A 70-degree, 2.7-mm arthroscope can also be helpful. With the three-portal system, adequate inflow of lactated Ringer's solution can be maintained with gravity drainage. An arthroscopic pump can also be used, but extreme caution must be exercised to avoid complications.

The 21-Point Examination

The normal arthroscopic intra-articular anatomy of the ankle has been well described.[10,11] A 21-point arthroscopic examination enables the surgeon to perform a thorough, systematic evaluation of all areas of the ankle (Table 1).[12] The use of this system allows reproducible documentation of the arthroscopic findings and accurate diagnosis of any intra-articular pathologic changes. In addition, it guarantees that all areas of the ankle joint are carefully inspected and provides a complete videotape record that can be reviewed in the future for both patient care and clinical studies of the patient population undergoing ankle arthroscopy.

Table 1
The 21-Point Arthroscopic Examination of the Ankle

Anterior
Deltoid ligament
Medial gutter
Medial talus
Central talus and overhang
Lateral talus
Trifurcation of the talus, tibia, and fibula
Lateral gutter
Anterior gutter
Central
Medial tibia and talus
Central tibia and talus
Lateral tibiofibular or talofibular articulation
Posterior inferior tibiofibular ligament
Transverse ligament
Reflection of the flexor hallucis longus
Posterior
Posteromedial gutter
Posteromedial talus
Posterocentral talus
Posterolateral talus
Posterior talofibular articulation
Posterolateral gutter
Posterior gutter

The arthroscopic examination is always done initially through the anteromedial portal and subsequently through the anterolateral and posterolateral portals (Fig. 4). Occasionally, one can slip out of the posterior capsule just enough to look down the sheath of the flexor hallucis longus tendon as it runs in its groove on the posterior talus. Extreme caution is necessary to avoid injury to this structure.

Postoperative Management

Compared with other joints that are commonly treated with arthroscopy, such as the knee, wrist, elbow, and shoulder, the ankle joint is subjected to markedly increased hydrostatic

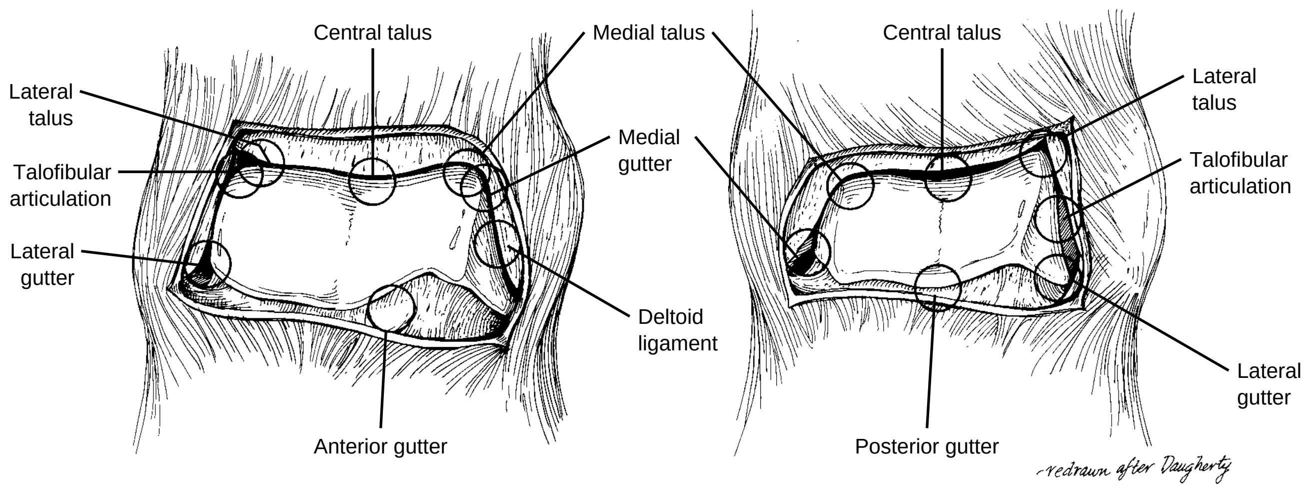


Fig. 4 **Left,** The eight-point anterior examination of the ankle through the arthroscope. **Right,** The seven-point posterior examination.

pressure. The wound-sealing effect of soft tissue is absent at the ankle. Edema, intra-articular hemorrhage, and effusion of the joint pose greater postoperative problems, and careful attention to wound closure is important. After completion of the arthroscopic examination, all wounds are closed with a 4-0 nonabsorbable nylon suture, and a compression dressing is applied. The dressing is then held in place with either a short-leg compression stocking or a short-leg posterior splint, depending on the type of pathologic disorder encountered and the extent of the surgery. Postoperatively, rest with elevation of the limb and ankle immobilization are necessary for 3 to 5 days.

The fluid that has extravasated about the ankle into the subcutaneous tissues usually is absorbed or leaks out of the portals over a short period of time. If a compression stocking is used, it can be removed at 48 hours, and the bandages can then be thrown away. The stocking is then reapplied, and the patient can start partial weight-bearing with crutches and gentle range-of-motion and strengthening exercises.

Complications

There are many potential complications with ankle arthroscopy (Table 2). Most can be avoided if the surgeon becomes thoroughly familiar with the surface anatomy of the region. Careful preoperative planning and the use of appropriate distraction and instrumentation techniques also help in avoiding complications (Table 3).

Table 2
Potential Complications of Ankle Arthroscopy

Missed diagnosis
Tourniquet complications
Neurovascular injury
Tendon injury
Ligament injury
Wound complications
Infection
Articular cartilage damage
Compartment ischemia
Compartment syndrome
Hemarthrosis
Postoperative effusion
Reflex sympathetic dystrophy
Fluid-management complications
Distraction-related complications (e.g., skin necrosis, pin problems)
Intraoperative fracture
Postoperative stress fracture
Instrument breakage

In a series of 612 cases, Ferkel et al[13] found an overall complication rate of 9%. Neurologic complications were the most common (49%). In the 27 instances of neurologic injury, the superficial branch of the peroneal nerve was involved in 15 (56%); the sural nerve in 6 (22%); the greater saphenous nerve in 5 (18%); and the deep peroneal nerve in 1 (4%).

In the same study, Ferkel et al also reported neurologic and arterial damage with the use of the anterocentral or posteromedial portal, as well as with the use of distraction pins. The invasive distractor was used in 317 of 612 cases. Distraction pins were associated with some transient pin-tract pain, which resolved in all cases. No ligament injuries occurred in the ankle, but two stress fractures in the tibia occurred early in the series, when the pins were placed too far anteriorly or posteriorly in the tibia. One stress fracture occurred when the pin was placed in the fibula.

Table 3
Important Factors in Avoiding Complications

Patient selection
Careful preoperative evaluation, including skin, nerve, and vascular status
Careful physical examination and radiologic evaluation, including stress radiographs, computed tomography, and magnetic resonance imaging when applicable
Thorough knowledge of foot and ankle anatomy
Practicing with plastic bone models and cadaver specimens
Meticulous distraction placement
Careful portal placement
Use of interchangeable cannulae for arthroscopy and instrumentation
Perioperative antibiotic therapy
Limited operative time and tourniquet use
Availability of magnetic retriever
Use of skin sutures in wounds
Brief postoperative immobilization
Postoperative rehabilitation

Ferkel et al also found superficial wound infection in six patients, which appeared to be related to the closeness of portal placement, the type of cannula used, early mobilization, and the use of tapes to close the portals. Deep wound infection occurred in two patients and was correlated with a lack of preoperative antibiotic therapy. Other complications included instrument failure, ligament injury, and incisional pain (two cases of each). Increased experience of the arthroscopist was associated with a lower complication rate.

Compartment syndrome has not been reported in association with ankle arthroscopy. Some fluid extravasation occurs in all cases. The thinness of the skin and the lack of subcutaneous tissues around the ankle joint make postoperative swelling common. This usually responds well to elevation, compression, and application of ice. If an excessive amount of extravasation occurs, the patient should be monitored appropriately, especially for anterior pretibial pain. Thrombophlebitis and reflex sympathetic dystrophy can occur postoperatively, as they can after all operative procedures.

Overall, complications can be avoided by careful preoperative planning, meticulous surgical technique, the use of suitable small-joint instrumentation, and appropriate postoperative care. It is mandatory to have a thorough understanding of the intra- and extra-articular anatomy of the ankle and foot. In addition, practicing on plastic bone models and cadaver specimens can be particularly helpful in developing experience with small-joint instrumentation and surgical procedures.

Summary

Ankle arthroscopy is a relatively new and dynamic tool of the orthopaedic surgeon. The decreased morbidity and faster recovery times make it an appealing technique compared with open arthrotomy. Careful attention to the surrounding anatomy and meticulous use of instrumentation are necessary to avoid complications and achieve the desired result.

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