Ankle Arthroscopy

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Abstract

Ankle arthroscopy has evolved rapidly within the last twenty-five years and is now the principal method of treatment of ankle disorders. It would be prudent for an aspiring orthopaedic surgeon to include this technique in his or her armamentarium of surgical techniques. This will provide the surgeon an inclusive option to obtain accurate diagnosis and to discuss management options with the patient. The minimally invasive technique is biologically friendly by preserving the soft tissue envelope. This will also meet patient expectations to achieve an earlier and predictable functional recovery from ankle pathology. This review article will briefly mention historical aspects and outline the basic technique and relevant benefits of ankle arthroscopy. Indications and contra-indications of ankle arthroscopy will be discussed with pertinent review of literature. Complications and outcomes of the procedure will also be highlighted.

Keywords: Ankle arthroscopy, technique, indications

Introduction

Historical perspectives:

The first ankle arthroscopy was attempted with limited success by Burman in 1931 [1]. The next major contribution was from Professor Takagi from Japan, considered as 'Father of arthroscopic surgery'. Dr. Masaki Watanabe, who was Takagi's understudy, first published the results of ankle arthroscopy performed in 28 patients in 1972[2]. The potential for arthroscopy to succeed as a major innovation was recognised and led to the formation of 'International Arthroscopy Association (IAA)' in 1974 with Professor Watanabe nominated as the first president. Subsequently, in 1976, Chen reported his experience of ankle arthroscopy in in 67 clinical and 17 cadaver cases [3]. He described compartments in the ankle with the relevant surgical anatomy. Dr. Richard D. Ferkel from United States of America, Mr. Ian Winson from Bristol, United Kingdom and Dr. Niek van Dijk from Netherlands have significantly contributed to the advancement of ankle arthroscopy.

Benefits of ankle arthroscopy:

The use of small incisions preserves the soft tissue envelope around the ankle. This allows for a shorter duration of hospitalisation, minimises complication rates and also promote earlier functional recovery. Ankle arthroscopy has an increased diagnostic capability. Kim et al.have compared the results of MRI and arthroscopic findings in 79 patients [4]. Their results indicate that MRI has a high sensitivity (87.5%) and positive predictive value (93.5%) in the diagnosis of anterior talofibular ligament injuries. The sensitivity (80%) and the negative predictive value (65.5%) were relatively low. Similar findings were published by the senior author in their study on 24 patients emphasizing the fact that arthroscopy may still be required in the definitive diagnosis and treatment of ankle disorders [5].

Patient positioning, basic instrumentation and portals:

It is mandatory for the novice surgeon to orient with patient positioning, basic instrumentation and set-up required to perform ankle arthroscopy. There are numerous modifications of individual steps but the main objective is to perform a safe and a successful procedure. It is of paramount importance that the surgeon has a complete working knowledge of the anatomy of the ankle as seen through an arthroscope and it is highly recommended that it is well practiced in cadaveric labs before proceeding to live operation.

Patient positioning:

The senior author prefers a supine position of the patient on the operating table with a bump under the ipsilateral hip. A thigh tourniquet with a right angle support proximal to the popliteal fossa is used obtaining a hip flexion of around 30 degrees. An adhesive tape is used to rotate the limb internally as flexing the knee over the support will result often in an externally rotated limb and make axial traction clumsy and difficult to achieve. A commercial non-invasive ankle strap with a distraction device attached to the end of the table is used to obtain a sustained traction of the ankle joint (Fig.1). Dowdy et al. have recommended a distraction force of less than 30 pounds for less than one hour to minimize nerve compression injury [6]. van Dijk CN et al. have reported the use of non-distraction methods with the procedure being performed in ankle dorsiflexion [7]. This technique has gained recognition in Europe but is yet to gain world-wide acceptance.

Basic instrumentation:

This consists of the following as mentioned in table 1. Ankle scopes are available in 1.9 mm, 2.7 mm, and 4.0 mm diameter. Each of these has a 30 deg or 70deg set viewing angle. The most commonly used scope is the 4.0mm or 2.7 mm with a 30 degviewing angle as shown in figure 2. The 70 deg is rarely used to visualize the posterior aspect of the ankle. Fibre optic cable with a light source The fibre

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Figure 1: A: Thigh tourniquet with a right angle support. B: Adhesive tape to internally rotate the thigh. C & D:Ankle strap with distraction device. van Dijk CN et al. have reported the use of non-distraction methods with the procedure being performed in ankle dorsiflexion [7]. This technique has gained recognition in Europe but is yet to gain world-wide acceptance.

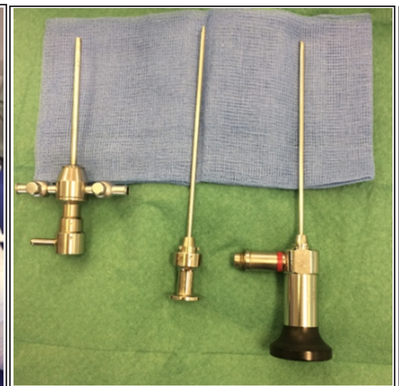


Figure 2: Arthroscope with trocar and cannula

Figure 3: Arthroscopy stack

Figure 4: Forceps, grasper, punch and scissors

Figure 5: Shaver blades and handpiece set.

Figure 6: Anterior arthroscopic portal creation: A) Anteromedial B) Anterolateral

Figure 7: Ringer lactate injection into the anteromedial portal.

Figure 8: Nick and spread technique

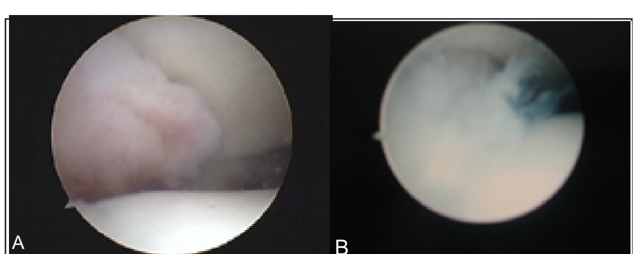


Figure 9: Arthroscopic appearance of soft tissue impingement. A: Meniscoid lesion, B: Lateral impingement.

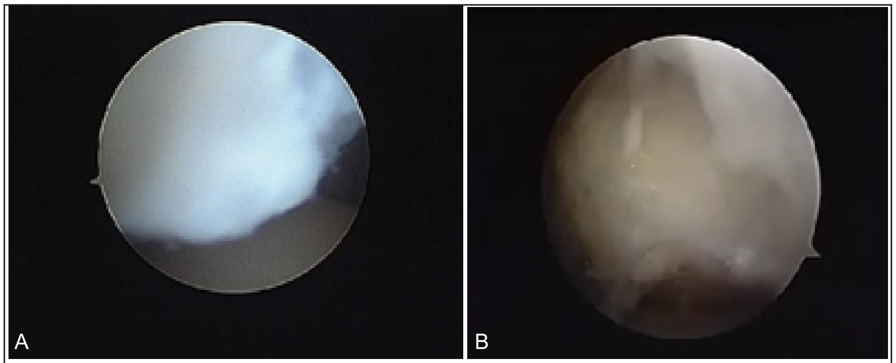


Figure 10: Arthroscopic treatment of bony impingement. A: Anterior osteophyte. B: Appearance post- shaving the lesion.

optic cable is attached to the arthroscope and great care must be taken to ensure that it is sterile throughout the procedure. There are various light sources available including xenon bulbs and LED lights. It is critical to ensure that the heat generated from the light source does not cause thermal necrosis of the articular tissue by continuously irrigating the joint. Cold light sources are also available currently.

Irrigation fluid

The preferred solution is the ringer lactate over normal saline. Gulihar et al. have reported that ringer lactate had the least effect on cartilage metabolism and normal saline caused a greater inhibition of cartilage metabolism [8].

Ingress pump

It is essential to have a continuous inflow of irrigating fluid in to the joint. This can be achieved by gravity flow or pressure bags. Commercially available ingress-egress pumps with safety features are commonly used to allow a controlled flow into the joint. It is critical to monitor for fluid extravasation into soft tissue and compartment syndrome with the use of pressure pumps.

Arthroscopic stack

The arthroscopy stack as shown in figure 3 consists of a high definition monitor, camera box, shaver control unit, radiofrequency unit and a printer. Power Shaver system is essential as every ankle arthroscopy will require at least some debridement for better visualisation. These require to be of various sizes and functions from synovectomy shavers to bone burrs. Digital media equipment allows images to be saved, edited, recorded and printed for medical records.

Manual instruments

These include various instruments such as, forceps, graspers, punch, scissors, probes, microfracture picks, powered shavers, burrs, bone cutters, curettes, and osteotomes. Some of these are shown in figures 4 and 5.

Arthroscopic portals

The most common portals used for ankle arthroscopy are anteromedial and anterolateral. It is essential to identify appropriate land marks before portal placement. The following landmarks need to be marked on the ankle prior to distraction to avoid distortion by traction Articularline: this is identified on the medial side by palpating along the anterior tibia just medial to the crest until the flare of the distal tibial plafond after which there is a sudden dip where the resistance of the bone disappears: the so called 'soft spot'. This is immediately medial to the tendon of tibialis anterior at the articular level and marks the site of the anteromedial portal. Before creating the anterolateral portal, it is critical to identify the intermediate branch of the superficial peroneal nerve. This nerve can be identified by inverting the ankle and plantar flexing the fourth toe. In most patients the nerve tautens and can be felt and marked. By this manoeuvre, the nerve moves medially, and the portal can be created lateral to the nerve. This usually corresponds to the lateral border of the peroneus tertius tendon. The creation of these portals is shown in figure 6. Posterior portals may be used to treat posterior ankle pathology with the patient in prone position. These include the posteromedial and posterolateral portals on medial and lateral side of Achilles. A postero-central (trans-Achilles) portal has also been described.

Arthroscopic technique:

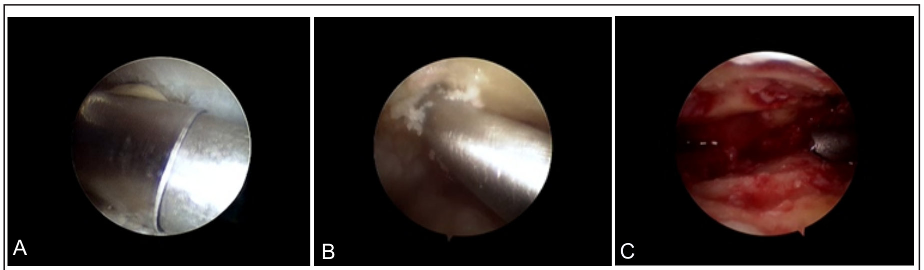
The procedure can be described in the following steps:

1) Identifying the landmarks for portals: The portal entry points are identified as described above and marked with a skin marker.

2) A green (21 gauge) needle is introduced into the anteromedial portal and 25 ml of ringer lactate solution in a syringe is injected into the joint to gently distend it (Figure 7). Intra-articular positioning towards the centre of the joint is confirmed by observing positive pressure flowback into the syringe.

3) A 15 scalpel blade is used to make a vertical incision at the portal site medial to the tibialis anterior tendon

4) Nick and spread technique: at the marked anteromedial portal site,a mosquito clamp is



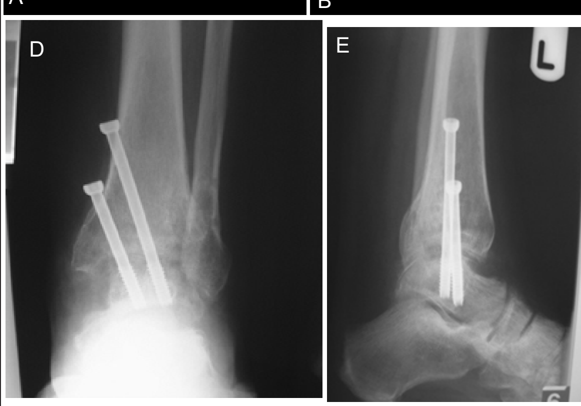


Figure 11: Arthroscopic treatment of ankle arthritis. A & B: Arthroscopic shaving of articular cartilage. C: Bleeding tibial and talar surfaces. D & E: Radiographic appearances post-fusion.

Figure 12: Arthroscopic treatment of talar osteochondral lesion. A &B: Arthroscopic appearance of talar osteochondral lesion. C& D: Shaving of the lesion till a stable rim of articular cartilage. E: Drilling into the defect.

used to spread the skin, subcutaneous tissue and then into the underlying capsuleas described by Ferkel and colleagues [9]. (Figure 8).

5) A blunt trocar with the cannula is introduced into the joint taking extreme care not to force it into the joint.Failure to create an adequate opening in the capsule sometimes will force sudden entry into the joint with significant scuffing damage to the talar articular surface.

6) The trocar is exchanged for the arthroscope to visualize the joint

7) A similar sequence of steps using the needle, scalpel and mosquito clamp is used to gain access from the anterolateral portal. The needle can be accurately positioned on the lateral side by viewing through the scope from medially. This is important as it serves to position the working portal accurately and makes subsequent instrumentation much easier. It is generally recommended that the medial portal be used as the visualisation portal and the lateral as a working portal although these are interchangeable when visualising different parts of the ankle. The orientation of the view from these portals is often confusing for the starting surgeon and the use of instrumentation can be difficult too. Accurate triangulation with instruments needs a lot of practice.

Table 1: Basic instruments
Cannula Blunt Obturator
Arthroscope
Fibre optic cable
Irrigation fluid with or without Ingress pump
Arthroscopic stack with image capture facility
Manual instruments including punches, graspers, chondral picks, arthroscopic curettes and rasps

8) Manual instruments can be used from the anterolateral portal with arthroscope from the anteromedial portal. These can be used interchangeably in either portals to address corresponding joint pathology.

A blunt arthroscopic hook is then used to access and identify various aspects of the ankle joint taking care to check areas often missed such as the gutters posterior ligaments and the neck of the talus. Stetson and Ferkel have described a 21-point arthroscopic examination of the ankle joint [10]. This will ensure that a systematic and a thorough examination is carried out without missing any pathology. These include eight points in anterior aspect of the ankle, six points in central region and seven points in the posterior region of the ankle. The anterior points include the deltoid ligament, medial gutter, medial talus, central talus, lateral talus, talofibular articulation (trifurcation of the talus, tibia, and fibula), lateral gutter, and anterior gutter. The central region to be examined includes the medial central tibiotalus, middle tibiotalus, lateral tibiotalus, capsular reflection of the FHL tendon, transverse tibiofibular ligament, and posterior inferior tibiofibular ligament. The seven regions to be examined in the posterior aspect of the ankle includes the medial gutter, medial talus, central talus, lateral talus, talofibular articulation, lateral gutter, and posterior gutter.

9) A posterolateral portal can be used as described above to identify and treat disorders in the posterior aspect of the joint.

10) The arthroscopic skin portals are closed with 3-0 vicryl rapide and compression dressing applied.

Figure 13: Arthroscopic appearances of ligament injuries. A: Medial ligament rupture. B: Lateral ligament rupture. C: Syndesmotic ligament injury

Post-operative care

This post-operative course varies with the procedure performed. An air cast walker boot may be used to rest and to allow ankle range of motion and muscle strengthening exercises intermittently out of the boot. The leg is elevated for 3-4 days and appropriate analgesia prescribed. Indications

Indications for ankle arthroscopy:

The indication for ankle arthroscopy have expanded rapidly in the last twenty years. Table 2 summarises the current indications. Each specific indication, relevant literature and arthroscopic appearances as deemed necessary will be discussed.

Ankle impingement:

Impingement can be defined as a chronic pain due to soft tissue or bony pathology mechanically limiting ankle movements. This can either be anteromedial, anterior, anterolateral, posteromedial or posterior impingement. The term "footballer's ankle" or athletes ankle has been replaced by anterior ankle impingement. Patients with soft tissue impingement presents with a history of ankle inversion sprain which was inadequately treated (Figure 9). The chronicity of the injury leads to scarring of the anterior talofibular ligament and causes anterolateral gutter pain. Molloy et al. have described a physical sign in

Table 2: Indications for ankle arthroscopy
• Ankle impingement
○ Soft tissue
○ Bone
• Ankle arthritis
• Osteochondral lesions
○ Subchondral bone microfracture
○ Tissue transplantation
• Acute trauma
• Ankle instability
• Synovial disorders
○ Synovial chondromatosis
○ Pigmented villonodular synovitis
• Septic arthritis

patients with lateral synovial impingement that had a sensitivity of 94.8% and a specificity of 88% [11]. Failed non-operative treatment is an indication for arthroscopic debridement using a 3.5 mm oscillating resector. Brennan et al. reported good or excellent results in 34 procedures out of 41 arthroscopies for soft tissue impingement [12]. Bony impingement is often due to osteophyte in the anterior margin of the tibia due to repetitive microtrauma restricting most commonly dorsiflexion of the ankle (Figure 10). The osteophyte is removed using the 4 mm chisel and/or resector/shaver. Parma et al. have reported the long-term results of arthroscopic treatment of bony impingement in eighty consecutive patients [13]. They have concluded that overall good results with arthroscopy, but the prognostic factors were dependent upon age, history of trauma and associated chondral lesions. Arthroscopic appearances are shown in figure 10.

Ankle arthritis:
The surgical treatment options of ankle arthritis include debridement/arthrolysis, arthroplasty or ankle arthrodesis. Arthrodesis of the ankle can be performed by open methods or using arthroscopy (Figure 11). Jones at al. have published the results of arthroscopic ankle arthrodesis in 116 patients (120 ankles) [14]. They have concluded that 94.6% achieved radiographic ankle fusion. The technique used was a medial and a lateral screw from the posterior metaphysis of the distal tibia and fibula into the talus. Quayle et al. have compared open (in 29 patients) vs. arthroscopic fusion (in 50 patients) [15]. The open method was performed by 3 or 4 large fragment partially threaded solid screws with no plates being used. Arthroscopic fusion was performed by percutaneous cannulated 6.5, 7.3 or 8.0 mm partially threaded compression screws. The have concluded that union occurred in 83% of open group versus 98% in arthroscopic group. Moreover, the open group also had higher rate of complications (31% vs. 8%).

Osteochondral lesions:
Osteochondral lesions are due to injury to articular cartilage or subchondral bone of the talus or the tibial plafond. These are most commonly post-traumatic in origin. The treatment algorithm is based on age, activity level, symptoms and size of lesion. Treatment options include arthroscopic microfracture and drilling, and tissue transplantation.

Arthroscopic microfracture and drilling:
This method is used foraccessible symptomatic lesions ≤ 15 mm in diameter. The rationale of this treatment to stimulate the bone marrow by drilling multiple holes into the subchondral bone thereby facilitating migration of pluripotent stem cells into the defect (Figure 12). Fibrocartilage tissue is formed in the defect which has different mechanical and biological properties in comparison to native articular cartilage. Zengerink et al. have reported short-term to mid-term results of this technique with an overall success of around 85% [16]. Murawski et al. have reported that the long-term results of this technique are less satisfactory with fibrillation and fissuring recognized in the fibrocartilage [17]. Arthroscopic appearances are shown in figure 12.

Tissue transplantation:
This technique is preferred if the lesions are > 15 mm in diameter. The preferred options are osteochondral autograft, juvenile allograft or autologous or matrix-induced autologous chondrocyte implantation. These methods rely on superior biomechanical strength of the hyaline cartilage than fibrocartilage.

Acute trauma:
Arthroscopy may be used as an adjunct tool in the management of acute ankle fracture. The benefits include an intra-operative assessment of accuracy of fracture reduction, diagnose associated cartilage and ligament injuries. Chen et al have reported a systematic review of arthroscopy- assisted ankle fracture fixation in a total of 861 patients [18]. Their results indicate an associated chondral lesion in 63.3%, deltoid ligament injuries in 60.9% and tibiofibular syndesmosis injuries in 77.9% of patients.

Ankle instability:
Ankle instability occurs in approximately 20 % of patients with acute ankle sprains despite initial conservative treatment as reported by O'Loughlin PF and colleagues [19]. Arthroscopic appearances of different ligament injuries are shown in figure 13. The gold - standard treatment for chronic lateral ligament deficiency with mechanical lateral ankle instability is modified open modified Broström-Gould procedure. This procedure consists of shortening and reattachment of attenuated anterior talofibular and calcaneofibular ligaments and further augmentation by suturing the inferior extensor retinaculum to the distal fibula. In a systematic review, Brown AJ et al. have reported that arthroscopic treatment for chronic lateral ankle instability has favourable results in short-term [20]. Anchors were used in most of the patients. However, complications were more frequent in arthroscopic technique (11%) in comparison to open modified Broström-Gould procedure (5.4%) emphasizing the technical demands of the procedure.

Synovial disorders:
These may be due to inflammatory disorders such as rheumatoid arthritis or non-inflammatory causes like synovial chondromatosis and pigmented villonodular synovitis. Radical synovectomy can be very effectively performed arthroscopically without the need to expose the joint with its attendant soft tissue problems.

Rheumatoid arthritis:
Synovectomy is an acceptable treatment modality in early-stage rheumatoid arthritis. Choi et al. have reported good or excellent outcomes after ankle arthroscopic synovectomy in eighteen patients at mean follow-up of five years [21].

Synovial chondromatosis:
Synovial chondromatosis is a benign disorder more commonly found in hips, knees and shoulders. There have been reports successful treatment by arthroscopic excision and synovectomy [22, 23].

Pigmented villonodular synovitis:
Pigmented villonodular synovitis is a locally aggressive benign proliferative synovial pathology. Lesions occur more commonly in knee than the ankle joint. The appearance on arthroscope includes a hemosiderin staining of inflamed synovium with papillary formation. Kanatli et al. have reported no recurrence in four patients treated with arthroscopic excision at a mean follow-up of 33 months [24].

Septic arthritis:
Septic arthritis of the ankle can lead to long-term sequela if there is a delay in diagnosis and inadequately treated. The traditional methods involve an open approach for adequate drainage and debridement. Mankovecky et al. have reported short-term results of a protocol driven approach in eight patients [25]. The steps included synovial biopsy, three sets of deep tissue specimens for culture, synovectomy, thorough irrigation and debridement. Eradication of infection was achieved in all eight patients.

Contraindications of ankle arthroscopy include:
- Presence of local soft tissue infection
- Severe restriction of ankle movements which interferes with instrument dexterity
- A limb with a precarious blood supply
- Complex regional pain syndrome
- Lack of operating skill

Complications:
These can be discussed in the following subgroups:

Neurological injuries:

The rates reported in the literature vary from 1.9% to 3.46% for anterior ankle arthroscopy as described by Zengerink M et al. and Deng DF et al [26, 27]. The anterolateral portal causing injury to the superficial peroneal nerve is the most common nerve injury as reported by Ferkel RD et al [28]. The reported rate for posterior and hind foot arthroscopy is 3.7% as reported by Nickisch F et al [29]. The sural nerve is the most common nerve injured in creating the posterolateral portal.

Infection:

Superficial wound infection which resolved with antibiotic therapy has been reported to occur in around 3% of cases in a study by Deng et al [27].

Articular cartilage injury:

Ankle arthroscopy requires the skill to work in a small joint and has a high risk of iatrogenic cartilage injury. This specific complication has been reported only in one study and was found to be around 31%. Severe damage to articular cartilage occurred in 6.7% of ankle arthroscopies as reported by Vega et al [30].

Other complications:

The other reported rare complications include compartment syndrome due to fluid extravasation, breakage of instruments, sinus tract creation, pseudoaneurysm of anterior tibial artery/dorsalis pedis artery, deep vein thrombosis and complex regional pain syndrome.

Conclusion

Ankle arthroscopy has advanced rapidly with extended indications. The benefits of shorter hospital stay and earlier rehabilitation will benefit patients to achieve an optimum functional recovery. It is a surgical technique with a steep learning curve. It is necessary to practice this skill in a video-recorded cadaver simulation course to gain confidence prior to performing on patients. Koehler et al. have developed the Arthroscopic Surgical Skill Evaluation Tool (ASSET) to assess competency for diagnostic arthroscopy of cadaveric knee specimens [31]. This tool measures eight domains including: safety, field of view, camera dexterity, instrument dexterity, bimanual dexterity, flow of procedure, quality of procedure and autonomy. This tool has also been employed to assess competency in diagnostic ankle arthroscopy in orthopaedic surgical trainees as described by Martin and colleagues [32]. It is imperative for an aspiring orthopaedic surgeon to achieve the required competent skills to ensure greater patient safety.

References

1. Burman MS: Arthroscopy or the direct visualization of joints: An experimental cadaver study. J Bone Joint Surg Am 1931; 13:669-695.
2. Watanabe M: Sefloc-Arthroscope (Watanabe no. 24 arthroscope): Monograph. Tokyo, Japan: Teishin Hospital, 1972.
3. Chen YC: Clinical and cadaver studies on the ankle joint arthroscopy. J Jpn Orthop Assoc 1976; 50: pp. 631-651.
4. Kim et al. Reliability and Validity of Magnetic Resonance Imaging for the Evaluation of the Anterior Talofibular Ligament in Patients Undergoing Ankle Arthroscopy. Arthroscopy. 2015 Aug; 31(8):1540-7.
5. Accuracy of MRI scan in the diagnosis of ligamentous and chondral pathology in the ankle. Joshy S, Abdulkadir U, Chaganti S, Sullivan B, Hariharan K. Foot Ankle Surg. 2010 Jun;16(2):78-80.
6. Dowdy PA, Watson BV, Amendola A, and Brown JD: Noninvasive ankle distraction: relationship between force, magnitude of distraction, and nerve conduction abnormalities. Arthroscopy 1996; 12: pp. 64-69
7. van Dijk CN, Scholte D. Arthroscopy of the ankle joint. Arthroscopy. 1997 Feb; 13(1):90-6.
8. Gulihar A, Bryson DJ, Taylor GJ. Effect of different irrigation fluids on human articular cartilage: an in vitro study. Arthroscopy 2013; 29:251–6.
9. Ferkel, Richard D.; Dierckman, Brian D.; Phisitkul, Phinit. Mann's Surgery of the Foot and Ankle. 9 th ed. Philadelphia, PA: Saunders, an imprint of Elsevier Inc; 2014. p.1723-1827.
10. Stetson WB, and Ferkel RD: Ankle arthroscopy: I. Technique and complications. J Am Acad Orthop Surg 1996; 4: pp. 17-23
11. Molloy S, Solan MC, Bendall SP. Synovial impingement in the ankle. A new physical sign. J Bone Joint Surg Br. 2003 Apr;85(3):330-3.
12. Brennan SA, Rahim F, Dowling J, Kearns SR. Arthroscopic debridement for soft tissue ankle impingement. Ir J Med Sci 2012; 181(2):253–6.
13. Parma A, Buda R, Vannini F, Ruffilli A, Cavallo M, Ferruzzi A, et al. Arthroscopic treatment of ankle anterior bony impingement: the long-term clinical outcome. Foot Ankle Int 2014; 35(2):148–55.
14. Jones CR, Wong E, Applegate GR, Ferkel RD. Arthroscopic Ankle Arthrodesis: A 2-15 Year Follow-up Study. Arthroscopy. 2018 May; 34(5):1641-1649.
15. Quayle J, Shafafy R, Khan MA, Ghosh K, Sakellariou A, Gougoulias N. Arthroscopic versus open ankle arthrodesis. Foot Ankle Surg. 2018 Apr; 24(2):137-142.
16. Zengerink M, Struijs PA, Tol JL, van Dijk CN. Treatment of osteochondral lesions of the talus: a systematic review [Review]. Knee Surg Sports Traumatol Arthrosc. 2010; 18(2):238-46.
17. Murawski CD, Duke GL, Deyer TW, Kennedy JG. Bone marrow aspirate concentrate (BMAC) as a biological adjunct to the surgical treatment of osteochondral lesions of the talus. Tech Foot Ankle Surg. 2011; 10:18-27.
18. Chen XZ, Chen Y, Liu CG, Yang H, Xu XD, Lin P.Arthroscopy-Assisted Surgery for Acute Ankle Fractures: A Systematic Review. Arthroscopy. 2015 Nov; 31(11):2224-31.
19. O'Loughlin PF, Murawski CD, Egan C, Kennedy JG. Ankle instability in sports [review]. Phys Sportsmed 2009; 37:93-103.
20. Brown AJ, Shimozono Y, Hurley ET, Kennedy JG. Arthroscopic Repair of Lateral Ankle Ligament for Chronic Lateral Ankle Instability: A Systematic Review. Arthroscopy. 2018 May 2. pii: S0749-8063(18)30185-3.
21. Choi WJ, Choi GW, Lee JW. Arthroscopic synovectomy of the ankle in rheumatoid arthritis. Arthroscopy. 2013 Jan; 29(1):133-40.
22. Kunzler DR, Shazadeh Safavi P, Warren BJ, Janney CF, Panchbhavi V. Arthroscopic Treatment of Synovial Chondromatosis in the Ankle Joint. Cureus. 2017 Dec 23; 9(12):e1983.
23. Saxena A, St Louis M. Synovial Chondromatosis of the Ankle: Report of Two Cases With 23 and 126 Loose Bodies. J Foot Ankle Surg. 2017 Jan - Feb; 56(1):182-186. doi: 10.1053/j.jfas.2016.02.009. Epub 2016 Apr 5. Review.
24. Kanatli U, Ataoğlu MB, Özer M, Yildirim A, Cetinkaya M. Arthroscopic treatment of intra-articularly localised pigmented villonodular synovitis of the ankle: 4 cases with long-term follow-up. Foot Ankle Surg. 2017 Dec; 23(4):e14-e19.
25. Mankovecky MR, Roukis TS. Arthroscopic synovectomy, irrigation, and debridement for treatment of septic ankle arthrosis: a systematic review and case series. J Foot Ankle Surg. 2014 Sep-Oct; 53(5):615-9.
26. Zengerink M, van Dijk CN. Complications in ankle arthroscopy. Knee Surg Sports Traumatol Arthrosc. 2012 Aug; 20(8):1420-31. Epub 2012 Jun 5.
27. Deng DF, Hamilton GA, Lee M, Rush S, Ford LA, Patel S. Complications associated with foot and ankle arthroscopy. J Foot Ankle Surg. 2012 May-Jun; 51 (3):281-4. Epub 2011 Dec 20.
28. Ferkel RD, Heath DD, Guhl JF. Neurological complications of ankle arthroscopy. Arthroscopy. 1996 Apr; 12(2):200-8.
29. Nickisch F, Barg A, Saltzman CL, Beals TC, Bonasia DE, Phisitkul P, Femino JE, Amendola A. Postoperative complications of posterior ankle and hindfoot arthroscopy. J Bone Joint Surg Am. 2012 Mar 7; 94(5):439-46.
30. Vega J, Golan´o P, Peña F. Iatrogenic articular cartilage injuries during ankle arthroscopy. Knee Surg Sports Traumatol Arthrosc. 2016 Apr; 24(4):1304-10. Epub 2014 Aug 24.
31. Koehler RJ, Amsdell S, Arendt EA, Bisson LJ, Braman JP, Butler A, Cosgarea AJ, Harner CD, Garrett WE, Olson T, Warme WJ, Nicandri GT. The Arthroscopic Surgical Skill Evaluation Tool (ASSET). Am J Sports Med. 2013 Jun; 41(6):1229-37. Epub 2013 Apr 2
32. Martin KD, Patterson D, Phisitkul P, Cameron KL, Femino J, Amendola A. Ankle Arthroscopy Simulation Improves Basic Skills, Anatomic Recognition, and Proficiency During Diagnostic Examination of Residents in Training. Foot Ankle Int. 2015 Jul; 36(7):827-35.

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