An Overview about Arthroscopic Ankle Arthrodesis

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Abstract

Presently, tibiotalar fusion remains a valid treatment option in patients affected by end-stage arthritis of the ankle that is unresponsive to other treatments. Over the years, many different surgical techniques have been described to make this kind of surgery less invasive and invalidating. Consequently, the last two decades have seen arthroscopic ankle fusion gain in popularity with many studies aiming to understand its advantages compared with open surgery, indications, and contraindications. The review of literature revealed a lower rate of complication, faster recovery, and shorter time of hospitalization with arthroscopic arthrodesis, in comparison with open surgery. These characteristics, along with a reduction of costs, will probably increase the use of arthroscopic ankle arthrodesis in the near future.

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Introduction:

Currently, tibiotalar fusion is a valid treatment option in young and active patients affected by end-stage arthritis of the ankle that is unresponsive to nonoperative treatment [1–3]. Since the first arthrodeses performed in the early 19th century, technological advancements and a better understanding of the ankle anatomy have brought about less-invasive surgical procedures. Because of these improvements, many different surgical techniques have been described, starting with external fixation and culminating with internal fixation, in order to obtain better outcomes as well as to reduce invasiveness and complications. In order to accomplish this goal, in 1983, Schneider performed the first arthroscopic ankle arthrodesis [4].

In the last two decades, arthroscopic ankle fusion has gained popularity and many studies have been carried out to understand the correct indications and real advantages, or disadvantages, compared with open surgery. Recent studies analyzed the different aspects of an arthroscopic

approach in ankle arthrodesis and revealed a better pain control during the postoperative period [5], less morbidity and a faster return to a normal life after rehabilitation [6], and reduced costs compared with open arthrodesis [7••]. Despite these advantages, some concerns have been expressed regarding arthroscopic ankle fusion, including the ability of correcting significant angular deformities or bone loss with the arthroscopic technique. In addition, it has been shown that both arthroscopic and open ankle arthrodesis lead to early osteoarthritic changes in adjacent joints, mainly the subtalar joint [8, 9].

The goal of this review is to analyze the surgical technique, indications, results, advantages, and disadvantages of arthroscopic tibiotalar fusion in comparison with open arthrodesis.

Indications and contraindications

Arthroscopic arthrodesis is a valuable treatment alternative to total ankle replacement for patients who have symptomatic end-stage ankle arthritis, those who are unresponsive to conservative treatment, and young or active patients.

Tibiotalar arthritis can be primary but more often is due to a post-traumatic condition [2, 10–13]. Recently, Saltzman et al reviewed a group of 639 arthritic ankles and found that 445 (70 %) were post-traumatic, 76 (12 %) were associated with rheumatoid diseases, and only 46 (7 %) were idiopathic (primary osteoarthritis) [14]. This data underlines some peculiar characteristics of the patients affected by ankle arthritis and some problems that the surgeons may encounter during surgery. These difficulties include bone defects, axial deformities, previous open fractures, previous scars, and avascular necrosis of the talus. In addition, tibiotalar arthrodesis can also be indicated in failed total ankle arthroplasty and end-stage tuberculosis [15].

Although arthroscopic ankle fusion generally produces good results, some conditions are widely considered to be contraindications, including: active infection, extensive avascular necrosis of the talus, and large bone defects [2, 16]. Myerson and Quill suggested that bone defects larger than one third of the talar dome surface represented a contraindication for arthroscopic ankle fusion [6]. Zvijac et al reported a case of failed arthroscopic ankle fusion in a patient affected by avascular necrosis involving approximately 50 % of the talus [2]. The surgeon must keep in mind that extensive bone defects could be better treated with an open procedure and bone grafting.

Lastly, arthroscopic arthrodesis has long been considered inadequate to treat severe deformities [16, 17]. Despite this belief, it is now accepted for arthroscopic fusion involving a deformity up to 15 °, and some have successfully treated patients with angulations of 25 ° degrees or more [18, 19••]. Gougoulas et al described a series of 78 consecutive patients retrospectively reviewed to understand possible applications of arthroscopic arthrodesis in marked deformities. They divided the population into two groups: 1) patients with a minor varus/valgus deformity, and 2) patients with more than 15 ° deformity (maximum 45 °). Time to fusion, complications, and post-operative tibiotalar axis were recorded. A high fusion rate (97 %) and correction of the malalignment were

obtained with the arthroscopic technique in both low and high grade deformities [18]. Similar results were described by Dannawi et al, with no significant differences in terms of fusion rate and patient satisfaction between high and low grade deformity groups. However, time to union was longer (12.7 weeks versus 8.8 weeks, p = 0.001) in cases of greater deformities [19••].

These considerations must be taken into account since most of arthritic ankles are post-traumatic, and the surgeon must often treat axial or torsional deformities deriving from fractures.

Preoperative evaluation

As previously described, pre-operative work-up for ankle arthrodesis should take into account possible axial deformities, bone defects, bone quality, condition of the skin, and underlying infections.

Inspection of the tibiotalar joint usually reveals reduced, sometimes almost abolished, range of motion; pain and swelling are common as well. During physical examination of the arthritic ankle, it is important to evaluate adjacent joints. These joints (knee, subtalar, and tarsal) need to compensate for the lack of motion due to ankle fusion and should be free from degenerative changes [20, 21].

Some authors suggested performing a careful examination of the forefoot, which should be balanced without fixed pronation or supination. If this correction cannot be achieved, an open procedure should be performed in order to extend the arthrodesis to the forefoot joint [17].

Weight-bearing antero-posterior, lateral, and mortise views of both ankles are required. The rearfoot alignment (Cobey/Saltzman) view is essential to evaluate the ankle joint and identify any calcaneal-to-tibial deformities [22]. In the case of diaphyseal deformities, antero-posterior and lateral views of the leg are required. Antero-posterior and lateral weight-bearing long leg x-rays are usually required to assess a malalignment involving the whole limb. In the sagittal plane, the anterior distal tibial angle (ADTA) should be measured. The ADTA is formed by the mechanical axis of the tibia and the joint orientation line of the ankle in the sagittal plane (normal values 80 ° ± 3 °) [23]. An increased ADTA represents a recurvatum deformity. In the coronal plane, the lateral distal tibial angle (LDTA), the tibiotalar angle, and the calcaneal tibial alignment should be measured. The tibiotalar angle is defined by the tibial and talar articular surfaces in the ankle joint. When the tibiotalar angle is >10 °, the joint is defined as incongruent (unstable) [24]. The LDTA is formed by the distal tibial articular surface and the anatomical axis of the tibia (normal values 89 ° ± 3 °) [23]. A decreased LDTA represents a varus deformity. Alternatively, the medial distal tibial angle (MDTA) can be used [25]. The calcaneal-tibial alignment (measured on the Cobey/Saltzman view) is useful to confirm any varus or valgus deformities as well as to assess every talar compensation (inversion and eversion) to an abnormal LDTA [22]. The subtalar joint can compensate 15 ° of eversion and 30 ° of inversion. Evaluation of subtalar joint compensation and range of motion is important because tibial realignment (with osteotomy or TAR) may unmask a

subtalar deformity. If this distal (rearfoot) deformity is not addressed, further symptoms may develop [22]. If an abnormal ADTA or LDTA is present (sagittal or coronal deformity), the center of rotation of angulation (CORA) is measured. The CORA is the intersection of the mid-diaphyseal line and the line starting from the middle of the joint and perpendicular to the abnormal ADTA or LDTA. The CORA can be located at the joint line level (usually due to anatomical joint line malalignment or to ankle degeneration) or proximally (usually due to tibial deformities/fractures). In case of severe deformities with the CORA located proximally, a realignment proximal to the ankle joint line is required prior to fusion.

MRI and CT scans are useful when evaluating bone defects (for example, in case of necrosis of the talus or pilon fractures) and pathologies involving soft tissues.

Surgical technique

The patient is placed supine under general or spinal anesthesia. Preoperative intravenous antibiotic prophylaxis is performed (usually a second generation cephalosporin). A tourniquet is positioned around the thigh and inflated (about 300 mmHg). A bump is positioned under the thigh. Fluoroscopy must be ready to use. In most cases, a slight noninvasive traction can be applied to the foot for a better visualization of the joint. Kats et al described a double external distraction device placed medially (through the talus and tibia) and laterally (through the calcaneus and tibia) that can be made using two AO distractors, allowing for a controlled and parallel distraction of the joint. When the surfaces of tibia and talus are ready to be fused, the distraction is released and the device can be used for compression [26]. Otherwise, no distraction or noninvasive distraction can be used. During surgery, these techniques allow for joint motion (when possible), which can help increase the anterior joint space and remove the cartilage from the posterior aspect of the talus.

Arthroscopy is performed with a 2.7 or 4 mm 30 ° arthroscope. Before the two standard portals (antero-medial and antero-lateral) are established, the joint is injected with 20 ml of saline solution in order to expand the joint space. The antero-medial portal, medial to the tibialis anterior tendon, is placed first. The antero-lateral portal (lateral to the extensor digitorum communis tendon) is established under direct vision. When creating the anterolateral portal, attention should be paid not to damage the superficial peroneal nerve. In skinnier patients, this can be appreciated in the subcutaneous tissue pre-operatively (with the foot inverted and the toes flexed) and marked with a surgical pen. However, both portals are performed with a skin incision and a blunt dissection of the subcutaneous tissue with a mosquito clamp or a trocar. Once the portals have been established, debridement of the soft tissues is performed with a shaver in the anterior part of the joint, and the cartilage is removed with an acromioplasty burr and curettes. In some cases, resection of anterior tibiotalar osteophytes is required to access the joint better. The medial malleolus articular surface is removed as well. Some authors prefer not to extend the fusion to the talofibular aspect of the joint and perform a simple shaving of the lateral gutter in order to allow apposition of the tibiotalar

surfaces [17]. The tourniquet can be let down in order to evaluate bleeding from the tibial and talar surface.

Once an accurate preparation is completed and adequate bleeding obtained, the traction is released and the ankle is realigned. Allogeneic bone paste can be inserted though an arthroscopic cannula to increase the healing potential. Fixation is achieved with internal fixation. Two or three cannulated, interfragmental compression percutaneous screws (diameter 6.5 mm) are placed under image intensifier control. Position of the screws may vary according to the surgeon's preference. The foot and ankle are held in neutral dorsiflexion, with 0 ° to 5 ° hindfoot valgus and external rotation equal to the opposite side. If the opposite side is abnormal, then the operated ankle is positioned in 5 ° to 10 ° of external rotation [2, 17]. Crossed transverse configuration, as well as a parallel—almost longitudinal—positioning of the screws, must lead to a satisfactory primary stability (Fig. 1) [2, 17]. The incisions are then closed with simple sutures.

Fig 1: X-ray, 30 days after surgery

Post-operative care

The patient can be discharged and sent home the day of surgery or the day after. After surgery, a complete below-knee cast is applied, and the patient is kept non-weight-bearing for 6–7 weeks. Then, a removable boot is applied, and the patient is allowed full weight-bearing for a final 4 week period. At 12 weeks after surgery, if clinical and radiological signs of fusion are present, the patient can return to full daily activities [7••, 17, 27].

Results

The rate of fusion should be considered the main parameter to evaluate when reviewing the results of ankle arthrodesis. Union can be defined as a clinically stable ankle, painless at palpation and weight-bearing, with radiographic evidence of bridging trabeculae without failure of internal fixation or loss of correction [28]. The literature reported a mean time to union of 12 weeks after surgery (ranging from 6 to 40) [17, 29, 30], with a union rate ranging from 85 % to 97 % [17, 18, 19••, 29–31]. Although a shorter time to union is usually described in the literature for arthroscopic ankle arthrodesis compared with open surgery [6, 17, 31, 32], Peterson et al reported no significant differences in time to union between the two procedures [7••].

Dannawi et al reported good to excellent post-operative results (using Mazur's grading system) with the arthroscopic technique in over 80 % of the patients [19••]. Kats et al obtained 100 % excellent or good results according to the Morgan score [26]. Similar results were described by Gougoulias et al, Ferkel and Hewitt, and Winson et al [17, 18, 30]. Other studies also reported good to excellent results in 86–95 % of the patients treated arthroscopically [5, 6]. Haddad et al carried out a systematic review of the literature about long-term outcomes of open ankle arthrodesis [3]. They identified 39 primary studies that evaluated ankle fusion in a total of 1262 patients. The mean AOFAS (American Orthopaedic Foot and Ankle Society) Ankle-Hindfoot score was 75.6 points. The meta-analytic mean results were excellent in 31 % of the patients, good in 37 %, fair in 13 %, and poor in 24 %. Even if there is no evidence of superiority of one technique over another, the review of the literature seems to indicate better outcomes with arthroscopic fusion.

In addition, arthroscopic ankle fusion seems to have a lower rate of complications.

Since union is the first goal of ankle fusion, non-union should be considered the main undesirable complication. Up-to-date arthroscopic fusion reported a nonunion rate ranging from 3 % to 15 % [17, 18, 19••, 29–31] compared with 7.4 % to 12.1 of the open procedure [3]. Commonly reported risk factors for non-union are poor bone quality, massive bone defect, and inherent positional ankle deformity [2, 31]. Controversies exist regarding body mass index and cigarette smoke as risk factors. No association between age, diabetes mellitus, peripheral neuropathy, and nonunion has been found [17, 31, 33, 34]. No advantages were shown by the addition of demineralized bone matrix or platelet rich plasma [31].

Other complications that may occur after arthroscopic ankle fusion are prominence of screws that requires hardware removal (18.6–31 %), deep infection (0.85 %), superficial infection (2.5 %), deep venous thrombosis, and revision surgery due to malalignment (0.85 %) [17, 30].

With regard to early onset of osteoarthritis in adjacent joints, subtalar degenerative changes are often described in patients with ankle fusion [1, 8, 9, 17, 18]. Although some authors described a 6.8 % incidence of subsequent subtalar or talonavicular fusion [1, 17], most of the patients seem to be satisfied with ankle fusion without the need for further surgeries [8, 9].

Cost benefits with regards to arthroscopic ankle arthrodesis have been proven to be less expensive with the open procedure [7••, 35]. There is in fact a statistically significant difference between an outpatient procedure that requires shorter hospital stay (0–1 day for arthroscopic fusion) and an inpatient procedure (mean 3.5 days for open fusion) [5, 7••].

It should also be mentioned that, with the improvement of total ankle arthroplasty, the controversy between fusion and replacement in young patients is still debated, but this was not one of the goals of the present review.

Conclusions

With correct indications and accurate surgical techniques, arthroscopic ankle arthrodesis yields satisfactory results. The possibility to treat ankles with marked deformity successfully, along with a slightly shorter time to union, reduced complication rates, and clear cost benefits compared with open surgery, makes arthroscopic ankle fusion a safe and reliable technique. Arthroscopic ankle arthrodesis is still not widely performed due to the excellent results of the open technique. However, in the last two decades, the popularity of this technique has been increasing due to the previously-mentioned advantages.

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References:

1. SooHoo NF, Zingmond DS, Ko CY. Comparison of reoperation rates following ankle arthrodesis and total ankle arthroplasty. J Bone Joint Surg Am. 2007;89:2143–2149. doi: 10.2106/JBJS.F.01611. [PubMed] [CrossRef] [Google Scholar]
2. Zvijac JE, Lemark L, Schurhoff MR, et al. Analysis of arthroscopically assisted ankle arthrodesis. Arthroscopy. 2002;18(1):70–75. doi: 10.1053/jars.2002.29923. [PubMed] [CrossRef] [Google Scholar]
3. Haddad SL, Coetzee JC, Estok R, et al. Intermediate and long-term outcomes of total ankle arthroplasty and ankle arthrodesis. A systematic review of the literature. J Bone Joint Surg Am. 2007;89:1899–1905. doi: 10.2106/JBJS.F.01149. [PubMed] [CrossRef] [Google Scholar]
4. Schneider D. Arthroscopic ankle fusion. Arthroscopic Video J. 1983, 3.
5. Zvijac JE, Lemak L, Schurhoff MR, et al. Analysis of arthroscopically assisted ankle arthrodesis. Arthroscopy. 2002;18(1):70–75. doi: 10.1053/jars.2002.29923. [PubMed] [CrossRef] [Google Scholar]
6. Myerson MS, Quill G. Ankle arthrodesis. A comparison of an arthroscopic and an open method of treatment. Clin Orthop Relat Res. 1991;268:84–95. [PubMed] [Google Scholar]
7. Peterson KS, Lee MS, Buddecke DE. Arthroscopic versus open ankle arthrodesis: a retrospective cost analysis. J Foot Ankle Surg. 2010;49(3):242–247. doi: 10.1053/j.jfas.2010.02.019. [PubMed] [CrossRef] [Google Scholar]

8. Coester LM, Saltzman CL, Leupold J, et al. Long term results following ankle arthrodesis for post-traumatic arthritis. J Bone Joint Surg (Am) 2001;83-A:219–228. [PubMed] [Google Scholar]
9. Fuchs S, Sandmann C, Skwara A, et al. Quality of life 20 years after arthrodesis of the ankle: a study of adjacent joints. J Bone Joint Surg Br. 2003;85-B:994–998. doi: 10.1302/0301-620X.85B7.13984. [PubMed] [CrossRef] [Google Scholar]
10. Demetriades L, Strauss E, Gallina J. Osteoarthritis of the ankle joint. Clin Orthop. 1998;349:28–42. doi: 10.1097/00003086-199804000-00005. [PubMed] [CrossRef] [Google Scholar]
11. Wyss C, Zollinger H. The causes of subsequent arthrodesis of the ankle joint. Acta Orthop Belg. 1991;57(suppl 1):22–27. [PubMed] [Google Scholar]
12. Taga I, Shino K, Inoue M, et al. Articular cartilage lesions in ankles with lateral ligament injury: an arthroscopic study. Am J Sports Med. 1993;21:120–126. doi: 10.1177/036354659302100120. [PubMed] [CrossRef] [Google Scholar]
13. Inokuchi S, Ogawa K, Usami N, et al. Long-term follow up of talus fractures. Orthopaedics. 1996;19:477–481. [PubMed] [Google Scholar]
14. Saltzman CL, Salamon ML, Blanchard GM, et al. Epidemiology of ankle arthritis. Report of a consecutive series of 639 patients from a tertiary orthopaedic center. Iowa Orthop J. 2005;25:44–46. [PMC free article] [PubMed] [Google Scholar]
15. Tang K, Li Q, Chen G, et al. Arthroscopically assisted ankle fusion in patients with end stage tuberculosis. Arthroscopy. 2007;23(9):919–922. doi: 10.1016/j.arthro.2007.04.004. [PubMed] [CrossRef] [Google Scholar]
16. Rippstein P, Kumar B, Muller M. Ankle arthrodesis using the arthroscopic technique. Oper Orthop Traumatol. 2005;17(4–5):442–456. doi: 10.1007/s00064-005-1138-6. [PubMed] [CrossRef] [Google Scholar]
17. Winson IG, Robinson DE, Allen PE. Arthroscopic ankle arthrodesis. J Bone Joint Surg Br. 2005;87-B(3):343–347. doi: 10.1302/0301-620X.87B3.15756. [PubMed] [CrossRef] [Google Scholar]
18. Gougoulias NE, Agathangelidis FG, Parsons SW. Arthroscopic ankle arthrodesis. Foot Ankle Int. 2007;28(6):695–706. doi: 10.3113/FAI.2007.0695. [PubMed] [CrossRef] [Google Scholar]
19. Dannawi Z, Nawabi DH, Patel A, et al. Arthroscopic ankle arthrodesis: are results reproducible irrespective of pre-operative deformity? Foot Ankle Surg. 2011;17(4):294–299. doi: 10.1016/j.fas.2010.12.004. [PubMed] [CrossRef] [Google Scholar]
20. Mazur JM, Schwartz E, Simon SR. Ankle arthrodesis: long-term follow-up with gait analysis. J Bone Joint Surg Am. 1979;61:964–975. [PubMed] [Google Scholar]
21. Lynch AF, Bourne RB, Rorabeck CH. The long-term results of ankle arthrodesis. J Bone Joint Surg Br. 1988;70:113–116. [PubMed] [Google Scholar]

22. Bonasia DE, Dettoni F, Femino JE, et al. Total ankle replacement: why, when and how? Iowa Orthop J. 2010;30:119–130. [PMC free article] [PubMed] [Google Scholar]
23. Mendicino RW, Catanzariti AR, Reeves CL. Percutaneous supramalleolar osteotomy for distal tibial (near articular) ankle deformities. J Am Podiatr Med Assoc. 2005;95(1):72–84. [PubMed] [Google Scholar]
24. Haskell A, Mann RA. Ankle arthroplasty with preoperative coronal plane deformity: short-term results. Clin Orthop Relat Res. 2004;424:98–103. doi: 10.1097/01.blo.0000132248.64290.52. [PubMed] [CrossRef] [Google Scholar]
25. Stufkens SA, Barg A, Bolliger L, et al. Measurement of the medial distal tibial angle. Foot Ankle Int. 2011;32(3):288–293. doi: 10.3113/FAI.2011.0288. [PubMed] [CrossRef] [Google Scholar]
26. Kats J, Kampen A, Waal-Malefijt MC. Improvement in technique for arthroscopic ankle fusion: results in 15 patients. Knee Surg, Sports Traumatol, Arthrosc. 2003;11:46–49. [PubMed] [Google Scholar]
27. Lee MS, Millward DM. Arthroscopic ankle arthrodesis. Clin Podiatr Med Surg. 2009;26:273–282. doi: 10.1016/j.cpm.2009.03.002. [PubMed] [CrossRef] [Google Scholar]
28. Monroe MT, Beals TC, Manoli A., 2nd Clinical outcome of arthrodesis of the ankle using rigid internal fixation with cancellous screws. Foot Ankle Int. 1999;20:227–231. [PubMed] [Google Scholar]
29. Pierre A, Hulet C, Locker B, et al. Arthroscopic tibio-talar arthrodesis: limitations and indications in 20 patients. Rev Chir Orthop Reparatrice Appar Mot. 2003;89(2):144–151. [PubMed] [Google Scholar]
30. Ferkel RD, Hewitt M. Long term results of arthroscopic ankle arthrodesis. Foot Ankle Int. 2005;26(4):275–280. [PubMed] [Google Scholar]
31. Collman DR, Kaas MH, Schuberth JM. Arthroscopic ankle arthrodesis: factors influencing union in 39 consecutive patients. Foot Ankle Int. 2006;27(12):1079–1085. [PubMed] [Google Scholar]
32. Mann RA, Manen JW, Wapner K, et al. Ankle fusion. Clin Orthop Relat Res. 1991;268:49–55. [PubMed] [Google Scholar]
33. Frey C, Halikus NM, Vu-Rose T, et al. A review of ankle arthrodesis: predisposing factors to nonunion. Foot Ankle Int. 1994;15(11):581–584. [PubMed] [Google Scholar]
34. Cobb TK, Gabrielsen TA, Campbell DC, 2nd, et al. Cigarette smoking and nonunion after ankle arthrodesis. Foot Ankle. 1994;15:74–77. [PubMed] [Google Scholar]
35. Nielsen KK, Linde F, Jensen NC. The outcome of arthroscopic and open surgery ankle arthrodesis: a comparative retrospective study on 107 patients. Foot Ankle Surgery. 2008;14(3):153–157. doi: 10.1016/j.fas.2008.01.003. [PubMed] [CrossRef] [Google Scholar].

36. Cottino, U., Collo, G., Morino, L., Cosentino, A., Gallina, V., Deregibus, M., & Tellini, A. (2012). Arthroscopic ankle arthrodesis: a review. Current reviews in musculoskeletal medicine, 5(2), 151–155.