Techniques for Ankle Arthrodesis

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Background: The goal of ankle arthrodesis is to create a pain-free plantigrade foot for weight bearing. Attention to the position and alignment of the foot in relation to tibia and leg is crucial. Ideal alignment includes neutral ankle flexion, 0-5 of valgus, aand neutral to slight external rotation position. Malalignment of the foot may have adverse effects on the biomechanics of the lower extremity leading to persistent pain following a soild arthrodesis. Many techniques for ankle arthrodesis are described in the literature and can be broadly classified into two groups : arthrodesis in situ and realignment arthrodesis. Various surgical approaches and fixation methods may be considered depending on the status of the soft tissues, degree of deformity and bone quality, and experience of the surgeon.

Keywords: ankle arthrodesis

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Introduction

Many techniques for ankle arthrodesis are described in the literature and can be broadly classified into two groups : arthrodesis in situ and realignment arthrodesis. Various surgical approaches and fixation methods may be considered depending on the status of the soft tissues, degree of deformity and bone quality, and experience of the surgeon.**(1)**

1. Arthrodesis in situ :

Arthrodesis in situ is indicated for cases with minimal or no deformity, and may done with arthroscopy or minimal arthrotomy and percutaneous screw fixation. Surgical exposure is minimized , resulting in decreased wound morbidity and smaller scars. Postoperative pain and duration of inpatient hospital stay are decreases compared with open ankle arthrodesis. Minimal soft tissue stripping my contribute to a high frequency of union (greater than 90 %), **(2)**faster time of fusion, and greater patient satisfaction. The apparently lower morbidity with in situ arthrodesis may be a result of selection bias for less complex cases that do not require correction of major deformity. A disadvantage of in situ arthrodesis is that major deformity or bony deficiency may not be correctible. **(3)**

Techniques :

A. Arthroscopic

Arthroscopic ankle arthrodesis requires specialized equipment, instruments, and arthroscopic experience, and the procedure may be technically more demanding than open arthrodesis. After arthroscopic ankle debridement and excision of articular cartilage through anteromedial and anterolateral portals, fixation is achieved using two or three cannulated screws. **(4)**

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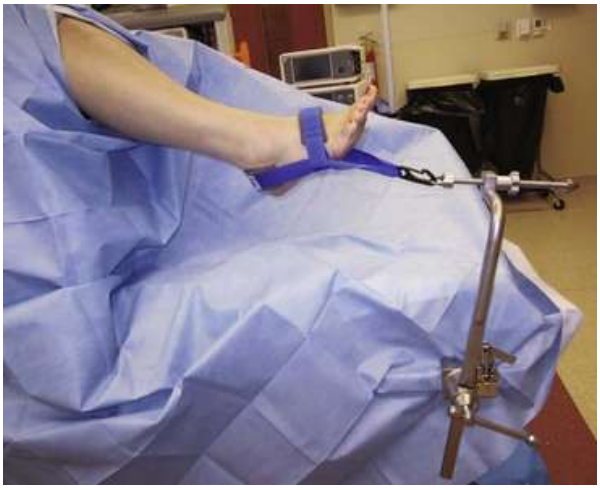

Fig 1 : Ankle arthroscopy using non invasive distraction.

B. Mini open

The minimal arthrotomy technique is done using two smaller anterior (1.5 cm) incisions, one medial to the tibialis anterior tendon and one lateral to peroneus tertius tendon. With the mini arthrotomy technique, one portal serves initially as a distraction portal using a laminar spreader. The other portal serves as a working portal and through this flexible chisels or a low speed irrigated burr are used to prepare half of the joint. The portals are then switched, and the remaining joint prepared by working through the portal that was initially used for distraction. The arthritic tissue and remaining articular cartilage are debrided, and fixation is accomplished with percutaneous tibiotalar screws. **(3,4)**

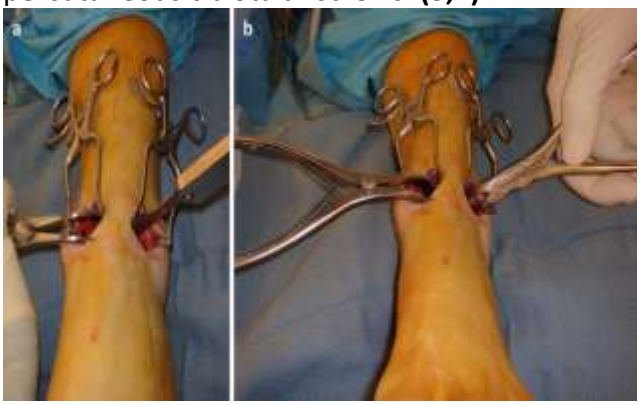

Fig 2 : demonstrating a miniarthrotomy using working portals and anteromedial placement of the laminar spreader to improve visualization.

2. Realignment (open) arthrodesis :

Realignment arthrodesis is indicated for cases with major deformity or bone loss. This may include ankles with severe varus or valgus deformity or talar collapse resulting from trauma, avascular necrosis, or charcot arthropathy. **(5,6)**

Excision of articular cartilage and bony contact are achieved with visualization.

The major advantage of open arthrodesis over the minimal arthrotomy method is that severe deformities of the ankle may be corrected with appropriate bone cuts, and bone deficiency or loss of height may be improved with a bone graft. **(7)**

Disadvantages of open ankle arthrodesis include the wide surgical exposure and soft tissue stripping that may be associated with greater postoperative pain, delayed wound healing, wound infection, dehiscence, nonunion, and neurovascular injury.

Recovery and time to fusion may be more prolonged after open arthrodesis. **(8)**

Surgical approaches

Several surgical approaches to the ankle may be considered for arthrodesis depending on the deformity, fixation technique, condition of the soft tissues, and the surgeon's preference and experience. **(9)**

1. Lateral approach

The lateral approach is a common approach used for ankle fusion. A 10 – 12 cm longitudinal incision is made directly over the distal fibula, with care taken to avoid injury to the sural nerve. The fibula is osteotomized obliquely approximately 6 cm proximal to the distal tip **.** The distal fibula is then removed and may be used as autogenous bone graft. **(10)**

Fig 3 : lateral transfibular approach

2. Medial approach

The medial approach may be used to expose the tibiotalar joint through a longitudinal incision either directly over or anterior to the medial malleolus. The medial malleolus may be excised or retained as a medial buttress. The remaining joint surface is denuded and decorticated. **(11)**

3. Anterior approach

The anterior approach may provide good access to the entire ankle joint, but may place the anterior neurovascular structures at risk. Historically the anterior approach had been used with a transverse incision between the tips of the medial and lateral malleoli, including section of the extensor tendons and neurovascular bundle, however this approach may cause postoperative adhesions between tendons, numbness, swelling, and vascular compromise, and is not recommended. The anterior longitudinal approach involves a slightly curved longitudinal incision, with dissection either between the tibialis anterior and extensor hallucis longus tendons. In both instances, the neurovascular bundle is exposed and protected. The anterior longitudinal approach may be used for realignment arthrodesis of the deformed ankle or when anterior plate fixation is done. **(12)**

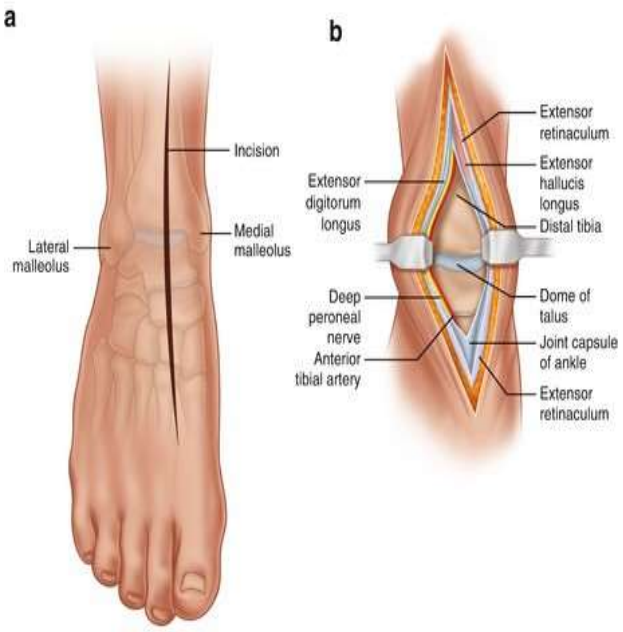

Fig 4 : a. anterior approach b. tibiotalar joint

4. Combined anteromedial and anterolateral approaches

A combined anteromedial and anterolateral longitudinal two incision approach has also been described. The anteromedial incision is made between the tibialis anterior and extensor hallucis longus tendons and the anterolateral incision is is made between extensor digitorum longus or peroneus tertius and the peroneal tendons. However, with this combined approach there is a risk of skin bridge necrosis between the two incisions. **(14)**

5. Posterior approach

Through this approach both the ankle and subtalar joints may be exposed and fused. **(15)**

Fixation methods

❖ **External fixation**

The popularity of external fixation in ankle arthrodesis had declined with improvements in internal fixation instruments and techniques. Besides, the use of external fixators requires more work and effort from the surgeon and the patient intraoperatively and postoperatively. However external fixation remains useful when extensive soft tissue compromise or bone loss precludes internal fixation or casting. **(16)**

The early techniques of compression arthrodesis with external fixation described by charnley and calandruccio provided acceptable fusion rates, but the frames are not as versatile or rigid as current illizarov or equivalent devices.

Compression arthrodesis as accomplished by Charnley used one talar pin and one tibial pin and done compression between them. Pin is placed anterior in the talus so the posterior pull of the Achilles tendon will maintain the arthrodesis compressed. This provides stability in only one plane. Calandruccio compression device provides three points fixation with stability in all planes of movements by its triangular configuration **(17)**

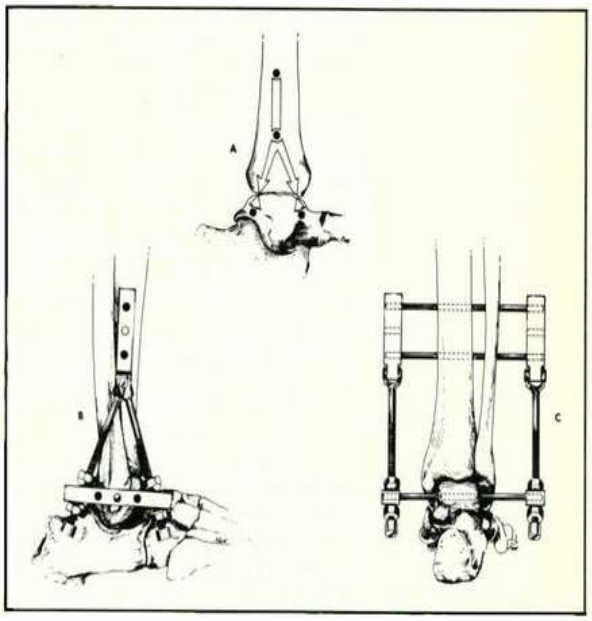

Fig 5 : calandruccio triangular frame

Other external fixators may be used for ankle arthrodesis such as the Hoffmann external fixator with anterior sliding tibial bone graft for arthrosis associated with severe posttraumatic equinus deformity. And the triangular external fixator with a metatarsal pin. **(18)**

Ankle arthrodesis with the illizarov ring external fixator has been used for treatment of nonunion, ongoing sepsis including infected nonunion, malunion, and the limb length discrepancy; this may result in solid union with a clinically satisfactory, plantigrade foot, providing an alternative to amputation in some cases. **(19)**

Complications rates of greater than 50% with circular wire fixators have been reported, presumably because of the complexity of the underlying pathology of ankles for which this method was indicated.

❖ Internal fixation

Various methods of internal fixation have been described including screws, angled blade plate, T plate, Wolf blade plate, Intramedullary nail, and compression blade plate. All of these fixation methods can be used effectively for ankle arthrodesis.

The choice of implant depends on many factors which can be summarized into two groups :

General factors :

- Patient general medical condition.
- History of long standing diabetes.
- Availability of implant.
- Surgeon experience.

Local factors :

- The current ankle pathology (osteonecrosis of the talus, or charcot arthropathy.
- Bone quality and bone stock.
- Degree of deformity.
- Soft tissue condition including previous scars, skin flaps and sepsis.
- Vascularity of the limb.
- Arthrosis of other joints.

Preoperative planning is important for proper selection of surgical approach and fixation method to achieve a painless, plantigrade foot for walking. In some cases, ankle arthrodesis is combined with triple arthrodesis (planter fusion) for limb salvage as an alternative to amputation. Retrograde intramedullary nail technique may be useful in fusion in charcot deformities, rheumatoid patients, and fixed equinus deformity. Anterior sliding graft with rigid internal fixation is another option for treatment of pseudoarthrosis, arthritis after infection, or talar osteonecrosis, but has a complication rate of 33%.**(20)**

Role of bone graft in ankle arthrodesis

Bone graft may be an important component of an ankle arthrodesis if potential for union may be compromised by factors such as infection, osteonecrosis of the talus, bone defects, and previous nonunion. However, a bone graft is not

routinely required in primary ankle arthrodesis in the absence of these complicating factors. In Charnley's primary compression ankle arthrodesis, bone graft was not used. Open transfibular ankle arthrodesis with internal screw fixation may achieve union in greater than 90% of cases without bone graft. **(21)**

Arthroscopic ankle arthrodesis usually does not require a bone graft because of the extensive cancellous surface exposed with minimal soft tissue disruption. **(22)**

Potential sources of autogenous bone graft for ankle arthrodesis may vary depending on the type and the amount of graft required. Available bone stock may depend on previous trauma or surgery. The iliac crest is a reliable source of cancellous and cortical bone but is associated with donor site morbidity. Local bone graft may be used from the distal fibula or tibia. Arthrodesis with an anterior tibial sliding bone graft may avoid the morbidity of iliac crest bone graft. **(22)**

If non-structural bone graft is required, the excised distal fibula or medial malleolus may be ground in a bone mill to increase the bony surface area for promotion of union. The distal tibia is an excellent source of cancellous bone graft for procedures in the foot. But this site is usually unavailable for ankle arthrodesis because of proximity to the arthrodesis. The proximal tibia may provide adequate cancellous graft for ankle arthrodesis and avoid iliac crest morbidity. Demineralized bone matrix has been used for ankle arthrodesis, with union rates comparable to autogenous bone graft. **(23)**

REFERENCES

1. Thomas RH, Daniels TR. Ankle arthritis. JBJS. 2003;85(5):923-36.
2. Katcherian DA. Treatment of ankle arthrosis. Clinical orthopaedics and related research. l 998;349:48-57.
3. Gilzad-Kohan J\.11-I, Jamali F. Glucosamine and adjuvant arthritis: a pharmacokinetic and pharmacodynamic study. European Journal of Pharmaceutical Sciences. 2012;47(2):387-93.
4. Buchanan PA, Ulrich BD. The Feldenkrais Method®: A dynamic approach to changing motor behavior. Research Quarterly for Exercise and Sport. 2001;72(4):315-23.
5. Jain S, Janssen K, DeCelle S. Alexander technique and Feldenkrais method: a critical overview. Physical Medicine and Rehabilitation Clinics. 2004;15(4):811- 25.
6. Marijnissen AC, Van Roermund PM, Van Melkebeek J, Schenk W, Verbout AJ, Bijlsma JW, et al. Clinical benefit of joint distraction in the treatment of severe osteoarthritis of the ankle: proof of concept in an open prospective study and in a randomized controlled study. Arthritis & Rheumatology. 2002;46(11):2893-902.
7. Giannini S, Leardini A, O'Connor J. Total ankle replacement: review of the designs and of the current status. Foot and ankle surgery. 2000;6(2):77-88.
8. Leardini A, O'Connor JJ, Catani F, Giannini S. Mobility of the human ankle and the design of total ankle replacement. Clinical orthopaedics and related research. 2004;424:39-46.
9. Saltzman C. Perspective on total ankle replacement. Foot and ankle clinics. 2000;5(4):761-75.
10. Ahmad J, Raikin SM. Ankle arthrodesis: the simple and the complex. Foot and ankle clinics. 2008;13(3):381-400.
11. Nihal A, Gellman RE, Embil JM, Trepman E. Ankle arthrodesis. Foot and Ankle Surgery. 2008;14(1):1-10.
12. Charnley J. Compression arthrodesis of the ankle and shoulder. Bone & Joint Journal. 1951;33(2):180-91.
13. van Dijk NC, van Bergen CJ. Advancements in ankle arthroscopy. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2008;16(11):635-46.
14. van Dijk CN. Arthroscopic Ankle Arthrodesis. Ankle Arthroscopy: Springer; 2014. p. 217-20.

15. Zvijac JE, Lemak L, Schurhoff MR, Hechtman KS, Uribe JW. Analysis of arthroscopically assisted ankle arthrodesis. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2002;18(1):70-5.
16. Cottino, U., Collo, G., Morino, L., Cosentino, A., Gallina, V, Deregibus, M., & Tellini, A. Arthroscopic ankle arthrodesis: a review. Current reviews in musculoskeletal medicine. 2012; 5(2), 151-155.
17. Peterson KS, Lee MS, Buddecke DE. Arthroscopic versus open ankle arthrodesis: a retrospective cost analysis. The Journal of Foot and Ankle Surgery. 2010;49(3):242-7.
18. Coester LM, Saltzman CL, Leupold J, Pontarelli W. Long-term results following ankle arthrodesis for post-traumatic arthritis. JBJS. 2001;83(2):219.
19. Fuchs S, Sandmann C, Skwara A, Chylarecki C. Quality of life 20 years after arthrodesis of the ankle: a study of adjacent joints. Bone & Joint Journal. 2003;85(7):994-8.
20. Mason RJ, Morgan CD. Gross and arthroscopic anatomy of the ankle. Foot and ankle arthroscopy: Springer; 2004. p. 19-37.
21. Kelikian AS, Sarrafian SK. Sarrafian's anatomy of the foot and ankle: descriptive, topographic, functional: Lippincott Williams & Wilkins; 2011.
22. Castro MD. Ankle biomechanics. Foot and ankle clinics. 2002;7(4):679-93.
23. Thordarson DB. Foot and ankle: Lippincott Williams & Wilkins; 2004.