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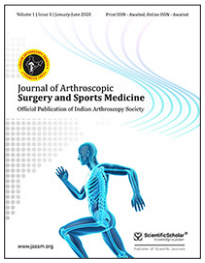

Original Article

Arthroscopic-assisted arthrodesis in the foot and ankle. Subtalar, tibiotalar, tibiocalcaneal, and metatarsophalangeal: 25 years of experience

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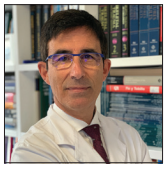

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ABSTRACT

Objectives: Arthritis of the foot and ankle joints provoke pain and restricts function. The arthroscopic assisted arthrodesis (AAA) is a minimally invasive procedure for end stage arthritis to eliminate pain and achieve painless mobilization, with numerous benefits like faster time to union, less blood loss, less morbidity, less infection rate, and less soft tissue complications compared with open surgery. The objective of this paper is to retrospectively evaluate our case series (136 patients) of arthroscopic assisted foot and ankle fusion that includes the subtalar, tibiocalcaneal, tibiotalar and metatarsophalangeal joint in our last 25 years of practice. Level of Evidence: Level IV, retrospective case series.

Materials and Methods: Patients who underwent arthroscopic assisted arthrodesis in the foot and ankle were identified by review of a registry. Minimum follow-up was 24 months. Patient demographics characteristics, time to radiographic union, and preoperative and postoperative American Orthopaedic Foot and Ankle Society score (AOFAS) were obtained.

Results: Subtalar fusion: 43 patients. Radiographic union was seen in 40 patients at a mean time of 10 weeks (8-14) and non union was seen in three patients, of which 1 required open revision surgery. AOFAS score improved from 43 preoperatively (27-57) to 83 (67-93) postoperatively. Tibiotalar fusion: 55 patients. Radiographic union in a mean time of 12 weeks (7-15) in all 55 cases. AOFAS score improved from 50.5 preoperatively (25-60) to 82 (62-94) postoperatively. Tibiotalocalcaneal fusion: 3 patients. 2 patients with radiographic union at 14 and 16 weeks and 1 showed a fibrotic union of the subtalar joint without pain. AOFAS score improved from 43 preoperatively (34-58) to 78 (67-81) postoperatively. Metatarsophalangeal fusion: 35 patients. Radiographic union in 33 patients at a mean time of 8 weeks (6-11). Two patients presented asymptomatic non union. AOFAS score improved from 38 preoperatively (30-60) to 86 (75-93) postoperatively.

Conclusion: Arthroscopic assisted arthrodesis in the foot and ankle is an excellent procedure for end stage degenerated joint.

Keywords: Arthroscopy, Arthrodesis, Foot, Ankle

INTRODUCTION

Advanced arthritis of the subtalar, tibiotalar, and metatarsophalangeal joints provokes pain and restricts function. One of the options for the management of this limiting condition is arthrodesis. The goal of a fusion is to eliminate pain and deformity of the degenerated joint and

obtain a plantigrade foot to achieve painless mobilization.[1,2] Indications to perform this surgical treatment are untreatable pain secondary to rheumatoid arthritis, primary arthritis, and posttraumatic arthritis. Advantage of the arthroscopic technique over the open techniques includes less blood loss, less morbidity, shorter hospitalization, and faster recovery and mobilization.[3,4] Contraindication for this technique involves patients requiring additional surgical procedures, severe ankle deformity, previously failed fusion, joint or soft tissue infections, significant bone loss, and previous surgery in the zone that would modify the normal anatomy of the neurovascular bundle location. Our practice on foot and ankle arthrodesis began in 1991 when we reported our first experience of the arthroscopic ankle arthrodesis technique;[5] then, in 1999, we published the arthroscopic metatarsophalangeal fusion technique and in 2014, our first case series.[6,7] In 2007, we described the arthroscopic subtalar fusion technique in prone position and in 2011, our first case series.[8,9] The purpose of the study is to retrospectively evaluate our case series of foot and ankle fusion that includes the subtalar, tibiotalar, tibiocalcaneal, and metatarsophalangeal joint in our last 25 years of practice.

MATERIALS AND METHODS

This was a single-center, single-surgeon, and retrospective study. Subjects were identified from an institutional review board-approved foot and ankle registry at the investigators' institution. Eligible patients were contacted by the investigative team for follow-up. The senior author (LPC) performed all the procedures and the minimum follow-up was 24 months. Data pertaining to patient demographics characteristics, time to radiographic union, and pre-operative and post-operative American Orthopaedic Foot and Ankle Society score (AOFAS) were obtained. The study was approved by the Ethics Committee of Hospital Clinica Mompia, Santander, Spain.

Subtalar arthrodesis

Between January 2004 and January 2018, 43 patients, 38 men and 5 women with a mean age of 43 years (range 38–57), were surgical treated in prone position with arthroscopic-assisted subtalar fusion with cannulated screws. Thirty-two were secondary to posttraumatic arthritis after intraarticular calcaneus fracture, 8 primary arthritis, and 3 secondary to rheumatoid arthritis.

Operative technique

The arthroscopic procedure was performed with the patient in the prone position and the technique described by Carro *et al*.[8,9] and a 30°, 4.5-mm optic arthroscope through a posterior 2 portal approach, as described by van Dijk *et al*.[10] After a stab incision is made just lateral to the Achilles tendon at the level of or slightly above the tip of the malleolus, the entry of the arthroscope shaft is prepared. The arthroscope shaft is introduced with a blunt trocar, pointing in the direction of the web space between the first and second toes until it touches bone. Instruments are inserted through the medial portal 5-mm medial to the medial border the Achilles tendon at the same level as the posterolateral portal. By palpating the bone in the sagittal plane, the level of the ankle joint and subtalar joint most often can be distinguished because the prominent posterior talar process can be felt as a posterior prominence between both joints. Better access to the posterior subtalar joint might be obtained by placing the foot in dorsiflexion or by applying manual distraction to the os calcis to open up this area. Inversion and eversion during the procedure can also help to introduce the arthroscope and shaver into the posterior subtalar compartment. First, the shaver is introduced through the posteromedial portal and directed toward the arthroscope shaft. The posterior talar process can be freed of scar tissue, and the flexor hallucis longus tendon should be identified because it is an important landmark to prevent damage to the more medially located neurovascular bundle. After removal of the posterior joint capsule of the subtalar joint, the posterior compartment can be visualized. Both the posteromedial and posterolateral portals are used in an alternating fashion. A third portal may be used if desired and is established approximately 1 cm proximal and 1 cm posterior to the tip of the lateral malleolus. This portal can be used for distraction by inserting a large blunt trocar into the joint. The initial debridement and synovectomy are performed by use of 4-mm and 5-mm shavers. Debridement and decortication are done posterior to the interosseous ligament because only the posterior facet is fused. As debridement moves from posterior to anterior, arthroscopic visualization and instrumentation are easily achieved because the joint space increases. Denudation of the articular surfaces is performed with straight and curved curettes, as well as 4.5- and 5.5-mm burs, to remove 2 mm of subchondral bone [Figure 1]. Once the subchondral plate is removed, small 2-mm spot-weld holes are created on the surfaces of the calcaneus and talus to create vascular channels. During debridement, care should be taken to maintain the normal bone contour of the joint and not to remove too much bone. If a fixed pre-operative varus or valgus deformity is present, additional bone can be removed on either the lateral or medial aspect of the posterior facet. Stabilization of the joint is accomplished with internal fixation through 2 percutaneous cannulated from the non-weight-bearing portion of the calcaneal tuberosity directed to a point 5–10 mm posterior to the anterior margin of the posterior facet. The joint is positioned and held in 5° of hindfoot valgus. No autogenous bone graft or bone substitute is needed for this procedure. The skin incisions are closed

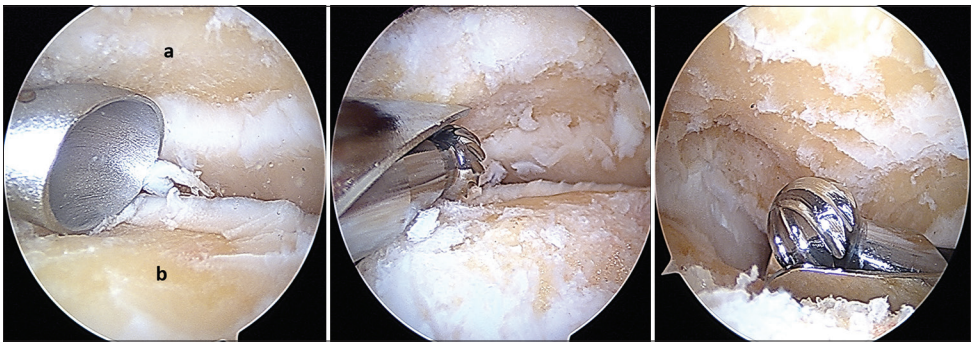

Figure 1: Arthroscopic view showing denudation of the articular surfaces of the subtalar joint performed with straight and curved curettes, as well as 4.5 and 5.5-mm burs, to remove 2-mm of subchondral bone. (a) Talus and (b) Calcaneus.

with nylon suture, and a sterile bulky dressing and posterior splint are applied. Postoperatively, the neurovascular status of the patient is checked and is discharged as an outpatient. After 3 days, the splint is removed, and a short walking cast is applied to the leg if the swelling is minimal. The patient is instructed to use crutches for ambulation and to avoid weight-bearing activities for the first 3 weeks, and then partial weight-bearing is progressed to weight-bearing as tolerated over the next 3–4 weeks. Full weight-bearing with the leg in a walking cast or brace is continued until radiographic union occurs and the patient has no pain with ambulation.

Tibiotalar arthrodesis

Between January 1989 and January 2018, 55 patients, 38 men and 17 women with a mean age of 62 years (range 57–74) were surgical treated with arthroscopic-assisted tibiotalar fusion with cannulated screws. Twenty-five patients were secondary to posttraumatic arthritis after tibial fracture and 30 patients were diagnosed of primary arthritis.

Operative technique

The arthroscopic procedure is performed with the patient in the supine position and no traction. Anterolateral and anteromedial portals are made for this technique debridement and removal of subchondral bone is done with caution and in a similar way described for subtalar arthrodesis. Two-millimeter nest is created with the burr of the distal tibia and proximal talus. Removal of the anterior osteophyte must be made if it is present. Two 6.5-mm AO cannulated screws were used for fixation from the medial to lateral zone in 50 cases and additionally 1 from lateral to medial in 5 cases [Figure 2]. For 2 weeks, the leg was immobilized in a below-knee slab and after stitch removal, below-knee orthosis was applied for 12 weeks. Partial weight-bearing was allowed with the help of axillary crutches at 4 weeks and after 6 weeks full weight until radiographic union occurs and the patient has no pain with ambulation.

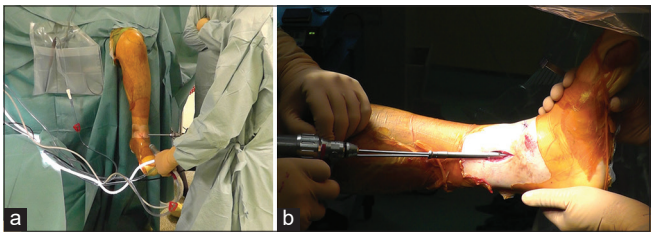

Figure 2: (a) Left foot. External view of the portals for tibiotalar arthrodesis: The scope is in the anterolateral portal and the instrument in the anteromedial portal. (b) Left foot. External view showing the introduction from the medial tibia of cannulated 6.5-mm cancellous screws for fixation of the tibiotalar joint.

Tibiotalocalcaneal arthrodesis

Between January 2004 and January 2018, three women with a mean age of 65 (range 60–70) with tibiotalar and subtalar arthritis were surgical treated with a tibiotalocalcaneal fusion using intramedullary nail with an arthroscopic technique in the prone position. The surgical technique (in the subtalar and tibiotalar) and postoperatively management were similar to subtalar fusion [Figure 3].

Metatarsophalangeal arthrodesis

Between February 1998 and January 2018, 35 fusion, 23 women and 12 men with a mean age of 56 years (range 38–64) were surgical treated. Indication for this procedure was hallux rigidus or arthritis of the metatarsophalangeal joint with mild or none deformity without a significant bone loss that requires fusion *in situ*.

Operative technique

The arthroscopic procedure was performed with the patient in the supine position and the technique described by Carro *et al.*[6,7] The patient was placed in the supine position with 5 kg of traction using a toe-finger trap. Under tourniquet control, an incision was made in the dorsolateral portal and a 2.7-mm 30° oblique arthroscope

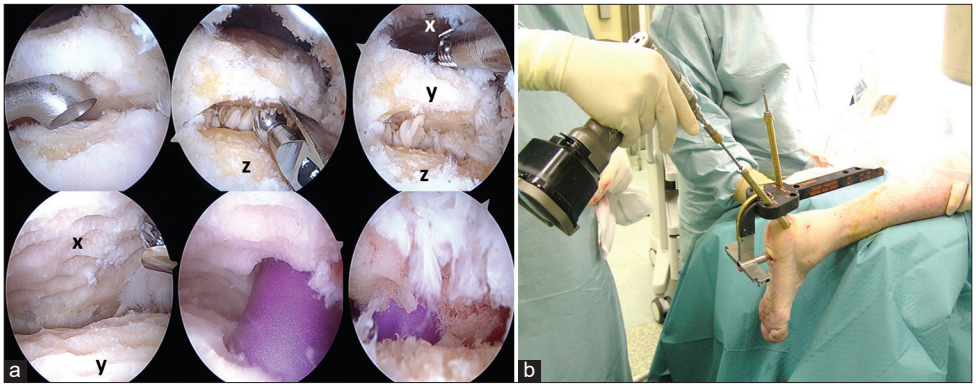

Figure 3: (a) Left foot. Arthroscopic view showing denudation of the articular surfaces of the subtalar and tibiotalar joints for tibiocalcaneal fusion. Posterior approach prone position. (x) Tibia, (y) talus, and (z) calcaneus, (b) Left foot. External view showing a guide device to assist placement of percutaneous intramedullary tibiocalcaneal nail from the nonweight-bearing portion of the calcaneal tuberosity.

was inserted into the joint. Debridement of all hyaline cartilage and underlying avascular subchondral bone was accomplished using a 2-mm full radius and burr through the dorsomedial and medial portal [Figure 4]. During debridement, care was take to maintain the normal bone contour of the joint (phalanx concavity and metatarsal head convexity) and not to remove too much bone. The fusion was positioned aligning in neutral rotation, 15° of valgus and 20° of dorsiflexion. In this position, the fusion was internally fixed with screws under fluoroscopic control. The patient was immobilized in a non-weight bearing cast for 2 weeks, and thereafter full-heel weight-bearing in a wooden shoe is permitted. Weight-bearing on the hallux is allowed when the fusion has healed usually at 6–8 weeks. At that time, use of the wooden shoe is discontinued and the patient is permitted to return to normal activity. Normal shoes are worn after 2–3 months, according to clinical and radiographic findings.

Statistical analysis

Statistical analysis was performed with SPSS Statistics Data Editor (version 22.0; IBM, Chicago, Illinois, USA). All categorical parameters were described with frequencies and percentages. Normality was assessed using the Kolmogorov–Smirnov test and the Wilcoxon signed-rank test was used to compare the amount of improvement of outcomes scores. The mean value of the pre-operative and post-operative scoring scale of each arthrodesis group was compared using a paired *t*-test for related groups. Differences were considered significant for values $P < 0.05$.

RESULTS

Subtalar arthrodesis

6.5-mm AO cannulated screws for woven bone were used in 35 patients and Acutrak Plus headless screws in 8 patients.

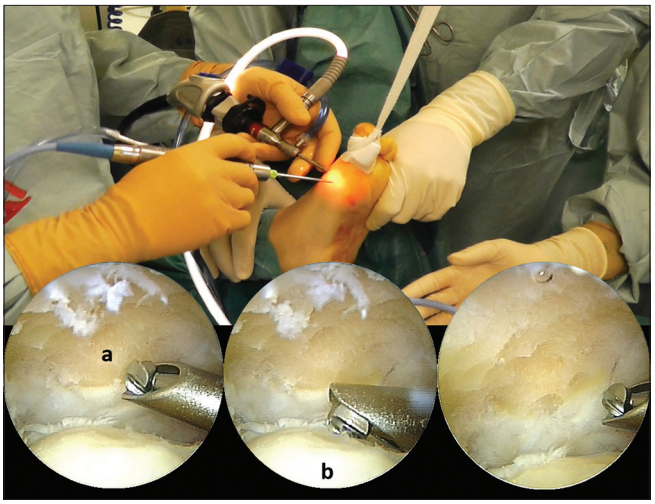

Figure 4: Above: Left foot. External view of the portals for metatarsophalangeal assisted arthrodesis. The scope is in the dorsolateral portal and the instrument in the dorsomedial portal. Below: Arthroscopic view showing denudation of the articular surfaces of the metatarsophalangeal joint (a) base of the proximal phalanx and (b) metatarsal head.

Radiographic union was evident in 40 patients at a mean time of 10 weeks (range 8–14). Nonunion (1 in the Acutrak group and 2 in the AO group) was seen in three patients, of which 1 required open revision surgery to complement with iliac crest bone graft for final fusion. The other two patients did not present symptoms. No other complications were found and no patient has required removal of the screws. The AOFAS score improved from 43 preoperatively (27–57) to 83 (67–93) [Figure 5].

Tibiotalar arthrodesis

6.5-mm AO cannulated screws for woven bone were used in all patients. Radiographic union was succeeded in a mean time of 12 weeks (7–15) in all the cases. No difference

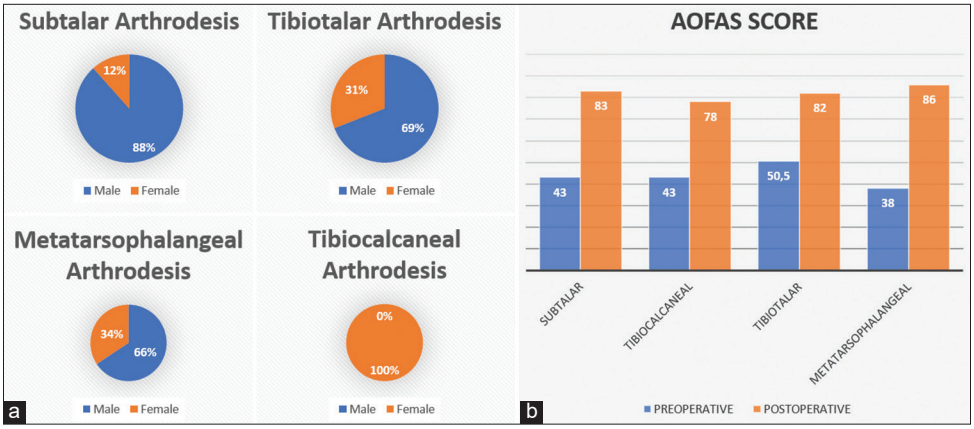

Figure 5: (a) Demographic data of patients who underwent arthroscopic-assisted arthrodesis in the foot and ankle. (b) Graft showing the pre- and post-operative results (AOFAS Score). AOFAS: American Orthopaedic Foot and Ankle Society Score.

in the form of fusion and outcome in both groups (screws from medial only or medial and lateral). No complications occurred during the procedure or follow-up. The AOFAS score improved from 50.5 preoperatively (25–60) to 82 (62–94) postoperatively [Figure 5].

Tibiotalocalcaneal arthrodesis

Tibiotalocalcaneal fusion nail (Smith-Nephew®) was used in all patients. Two patients proved radiographic union at 14 and 16 weeks and 1 showed a fibrotic union of the subtalar joint without pain. No complications were documented during the procedure or follow-up. The AOFAS score improved from 43 preoperatively (34–58) to 78 (67–81) postoperatively [Figure 5].

Metatarsophalangeal arthrodesis

In 15 cases, two 4-mm percutaneous oblique AO cortical screws were used for fixation. In 15 cases, an isolated standard Acutrak screw (Acumed®) was used, and in 5 cases, the Barouk type screw was used. Radiographic union was succeeded in 33 patients at a mean time of 8 weeks (6–11). Two patients (one patient of the Acutrak group and one patient of the AO cortical screws) presented nonunion but did not require revision surgery because they were asymptomatic. The AOFAS score improved from 38 preoperatively (30–60) to 86 (75–93) postoperatively [Figure 5].

DISCUSSION

Arthroscopic techniques for fusion of the foot and ankle have been reported to generate excellent results. In 2007, Carro *et al.*[8] described the technique for a new alternative method for performing arthroscopically assisted subtalar arthrodesis: The posterior portal approach with the patient in the prone position. Albert *et al.*[11] reported 10 patients treated by subtalar fusion with two screws with the posterior arthroscopic approach. The mean follow-up time was 21.5 months, the fusion rate was up to 100%, the fusion time was 6.8 weeks (6–9 weeks), and the mean AOFAS score pre-operative was 43 and increased to 78 points. Glanzmann and Sanhueza-Hernandez[12] reported 41 arthroscopic subtalar fusions in 37 consecutive symptomatic patients without hindfoot deformity. The average modified AOFAS score improved from 53 (22–69) points preoperatively to 84 (41–94) points at final follow-up (average 55 months, range 24–89 months). Union was achieved in all cases. Our case series[9] demonstrated similar results. In 1983, Schneider[13] performed the first arthroscopic ankle arthrodesis and since then arthroscopic tibiotalar arthrodesis has been widely described in the literature. A systematic review made by Park *et al.*[14] comparing open versus arthroscopic fusion showed that the hospital stay was shorter and intraoperative blood loss was significantly less in the arthroscopic group. The union rate was similar in the open (70–100%) and arthroscopic (76.2–100%) groups and the complication rate was higher in the open technique group (6.7–47.1%) than in the arthroscopic group (0–23.8%). Usually, the reported mean time to union is 12 weeks after surgery (range 6–40)[15,16] with a union rate ranging from 85% to 97%. Furthermore, ankle scores reported in the literature are good to excellent results in 86–95% of the patients treated with arthroscopic technique.[17,18] In our case series, there was no complication, the fusion rate was 100%, and the meantime to fusion and score results also demonstrated very good results.

Few studies in the literature have described arthroscopic tibiocalcaneal fusion. Arriaza and Leyes[19] reported a case of extensive talus necrosis with severe hindfoot deformity treated by means of an arthroscopic tibiocalcaneal arthrodesis. Twenty months after surgery, the patient was pain-free and walked without crutches

using a 10-mm insert to compensate for the residual 19-mm limb length discrepancy. In our case series, the 3 patients were asymptomatic after an average of 16 weeks. Metatarsophalangeal arthrodesis usually is open or percutaneous surgery. Both achieve excellent results in fusion rate, with more 90% of patients satisfied.[20,21] The open technique requires a large approach with the risk of prolonged pain, swelling, and wound healing difficulties.[22] The percutaneous technique has the benefit of a minimal invasive procedure, the bone resection is made by a burr on the metatarsophalangeal joint guided with fluoroscopy, but experience is needed for percutaneous surgery to avoid any mistakes in bone cuts.[23] The arthroscopic-assisted metatarsophalangeal fusion technique described by Carro *et al*.[6,7] has the advantage to see directly the exact quantity of resected bone in the joint for an adequate positioning of the arthrodesis. The excellent clinical scores of our study are comparable to the reported in the literature.[20,21,24,25] In our series, no cases of Charcot joints or avascular necrosis cases were done.

CONCLUSION

This study shows that arthroscopic-assisted technique for foot and ankle arthrodesis is an excellent procedure for end-stage degenerated joint in the foot and ankle. The arthroscopic fusion of the subtalar and tibiotalar joints in prone position is a technique that offers advantages over the traditional lateral approach. The arthroscopic fusion of the tibiocalcaneal joint gives an important advantage over the open technique. Arthroscopic metatarsophalangeal fusion shows similar results to open surgery with lower morbidity. All these techniques have passed the test of time, creating safe and reproducible procedures.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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