Arthroscopic ankle arthrodesis for chronic posttraumatic end-stage ankle arthritis in middle-age adults

Mohamed G. Montaser

Department of Orthopedic Surgery, Faculty of Medicine, Benha University Hospital, Benha, Egypt

Correspondence to Mohamed G. Montaser, MD, Faculty of Medicine, Benha University Hospital, Benha, Qalyubia, Egypt, PO Box 13814. Tel: +20 100 228 2522; e-mail: mgoda71@yahoo.com

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Background
The aim of this prospective study was to assess the clinical results of arthroscopic ankle arthrodesis for end-stage ankle arthritis in middle-aged active adults, as an alternative to open ankle arthrodesis based on the hypothesis that arthroscopic technique yields similar or better results but with less complications and shorter hospital stay.
Patients and methods
Between May 2012 and October 2014, this prospective case study was conducted on 19 middle-aged active patients who met the criteria and were followed for at least 2 years. Clinical grading was done at 6 months postoperatively, and final subjective clinical and radiologic assessment was done at least 2 years postoperatively, dividing the results into four groups (excellent, good, fair, and poor).
Results
After an average of 27.5 months of follow-up, 18/19 (94.7%) patients had their arthrodesis united, and 16 (84.2%) of them were satisfied. Three (15.8%) patients were dissatisfied after arthrodesis. Two (10.5%) of them were dissatisfied because of pain despite fusion occurred.
Conclusion
The results of arthroscopic ankle arthrodesis for end-stage ankle arthritis in middle-aged active adults in selected patients were clinically and radiologically satisfactory and could be used as an alternative to open technique but with fewer hazards and complications.

Keywords:
arthroscopic ankle arthrodesis, end-stage ankle arthritis, posttraumatic

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Introduction

Repetitive or old major ankle trauma is a leading cause of chronic ankle pain, compromising the athlete's performance, and if untreated, it will lead to end-stage ankle arthritis [1]. In a study by Saltzman *et al.* [2] on 639 patients with end-stage ankle arthritis, traumatic causes accounted for 79% of all causes, 12% associated with rheumatoid arthritis, and only 7% primary osteoarthritis [2]. In young individuals with high physical demands, there are limited surgical options for the treatment of symptomatic severe ankle degeneration that is unresponsive to nonoperative treatment. These options include arthroplasty of the ankle and arthrodesis [3,4]. Although it keeps function and range of motion, arthroplasty of the ankle is less rigid when facing high daily physical demands and is generally reserved for older and less active patients [5]. This makes ankle arthrodesis to be the gold standard for the treatment of end-stage ankle arthritis in young active individuals [3,4]. Ankle arthrodesis is a procedure that can produce a pain-free ankle that can withstand heavy daily physical demands [6]. Open ankle arthrodesis has been the standard surgical treatment for end-stage ankle arthritis but with considerable complications, which include nonunion, delayed union, malunion, infection, skin necrosis, subtalar arthritis, neurovascular injury, and reflex sympathetic dystrophy [7]. In 1983, Schneider [8] described the first arthroscopic ankle arthrodesis. Schneider and others counted the advantages of arthroscopic technique compared with open one regarding faster time to union, less blood loss, less morbidity, shorter hospital stays, and more early mobilization [8,9].

Arthroscopic ankle arthrodesis is indicated for the same reasons as for open ankle arthrodesis. The main indication is incapacitating pain owing to advanced joint degeneration associated with instability that cannot be controlled with conservative measures. Extensive scarring favors arthroscopic technique, because scars interfere with incision used in open

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arthrodesis. Significant deformity of more than 15° in varus or valgus ankle is treated by open technique because it needs significant bone resection from the talus or tibia to achieve of neutral ankle position, which is not feasible in arthroscopic technique [7,10].

The current study is focused on posttraumatic arthritis, being the commonest type of arthritis. The study is also focused on the adult active individuals, being the most likely to benefit more from arthrodesis when compared with arthroplasty. Until the preparation of this study and after searching publications, no previous study focused on this group using this technique.

Patients and methods

Between May 2012 and October 2014, this prospective case study was conducted on 19 patients (12 males – seven females) with 19 ankles (11 right, eight left) with chronic end-stage posttraumatic ankle arthritis operated with arthroscopic ankle arthrodesis after exhausting nonoperative measures. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Benha university, Egypt. Mean postoperative follow-up time was 27.5 weeks (range, 24–36), and mean patients' age at the time of arthrodesis was 42.5 years (range, 33–48 years). All patients were complaining of disabling mechanical pain that interfered with occupational demands and was partially improved by rest and medications, as well as night pain that was partially improved by NSAIDs. Previous trauma or fracture had occurred at a mean of 9 years (3–17 years) before arthrodesis.

Preoperative weight-bearing anteroposterior, lateral, and mortise view radiograph were done to both sides to identify extent of arthritis in the ankle, osteopenia, and the degree of varus or valgus deformity associated with osteoarthritis (Fig. 1a, b). Knee and foot radiograph were done to assess the condition of neighbor joints (knee or intertarsal joints), as they will be required to compensate for the lack of motion at the ankle after arthrodesis and should be free of degenerative changes. Computed tomography of the foot was done in some cases to exclude intertarsal or tarsometatarsal arthritis.

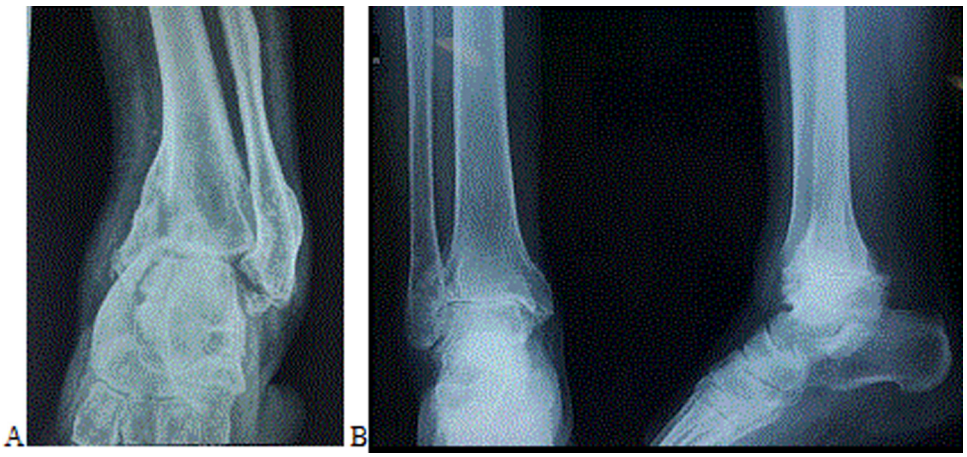
Inclusion criteria were patients with chronic end-stage, nondeformed ankle osteoarthritis, in the age from 20 to 50 years, primarily owing to old traumatic event, ranging from chronic neglected ligamentous ankle instability to failed reconstructive ankle surgery for fractures.

Exclusion criteria were those with advanced arthritic ankle due to rheumatoid arthritis, paralytic or neuropathic conditions, active infections, bone loss more than 30% that specially occurs with avascular necrosis, significant ankle deformity in varus/valgus of more than 15°, previous failed open or arthroscopic ankle arthrodesis, advanced idiopathic osteoarthritis, or concomitant osteoarthritis knee of subtalar, talonavicular, and calcaneocuboid joints.

Operative technique

The patient is positioned supine under general or spinal anesthesia with leg dangled by the side of operative table and foot strap for ankle distraction. Preoperative intravenous antibiotic prophylaxis is given to the patient before thigh tourniquet is elevated to 350 mmHg. Ordinary arthroscopic instruments (lens 4 mm 30° arthroscopy, shaver, burr, and abrader 3.5 and 5 mm.) are used via standard anteromedial and

Figure 1



Preoperative radiograph to assess extent ankle of arthritis, osteopenia, and the degree of varus or valgus deformity associated with osteoarthritis.

anterolateral portals. Remove of about 1 cm of entire articular surface systematically, using shaver, abrader, curettes, is done arthroscopically with the help of intraoperative C-arm control.

After establishing portals, osteophytes are removed, especially anterior osteophyte, which by its removal facilitates step-by-step anterior to posterior visualization together with extensive debridement of the medial, lateral, anterior, and posterior gutters. Then using burr and curette, the articular surfaces are removed, and healthy bleeding cancellous bones are exposed. Removal of about 5-mm depth of articular surface all through ensures maintenance of contour of the ankle and avoids its squaring, and doing this in a systematic manner protect against leaving islands of articular surface in between (Fig. 2).

Drill guide pins are drilled percutaneously into the medial malleolus and lateral malleolus under direct arthroscopic vision, with controlled pressure on the heel against the tibia and C-arm control. Medial pin is inserted first in the medial malleolus halfway between the anterior and posterior cortex at 30° coronal and 30° sagittal plane. Then lateral pin is inserted on the posterolateral edge of the fibula and angled 30° in the coronal plan and 60° in the sagittal plane. Care is taken to avoid penetration of the subtalar joint, which is checked by C-arm.

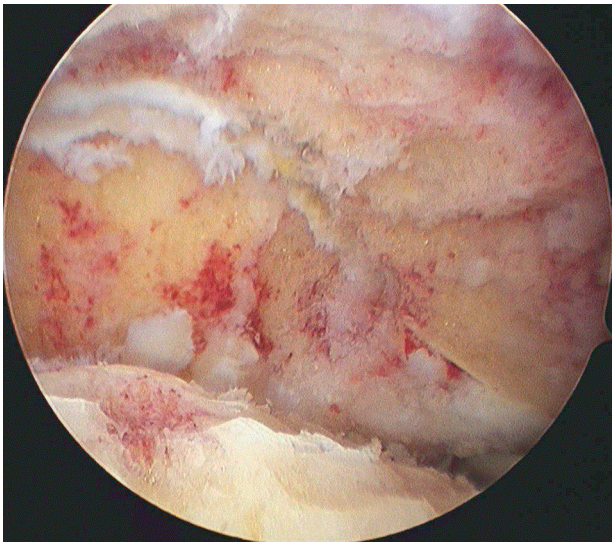
When position is appropriate, self-drilling self-tapping cannulated 6.5 screws are inserted. One or two screws from each side and washers were used according to intraoperative judgment of bone quality and solidity of fixation, and also checked by image intensifier (Fig. 3a, b).

Postoperative anteroposterior and lateral radiographs were used to assess the screws and fusion positions. Short leg cast was done for all patients postoperatively, and the patient is mobilized nonweight bearing for 6 weeks.

Partial weight bearing in a walking cast is started thereafter for 6 weeks at which the patient is examined every 2 weeks clinically and radiologically for union until union is seen on radiograph (Fig. 3). After 12 weeks (or earlier if clinical and radiological union occur earlier), the cast is removed and the patient is allowed full weight bearing without any support. Union was defined as a clinically stable pain-free ankle, on manipulation and weight bearing, with postoperative radiographic evidence union in the form of bridging trabeculae without failure of internal fixation or change in position [11]. When fusion was not evident on radiographs, further protection in a walking boot was required and further radiologic follow-up was arranged every 2 weeks till union occurred (Fig. 4a–c). Then routine follow-up was arranged at 6-month interval till a minimum of 2 years postoperatively.

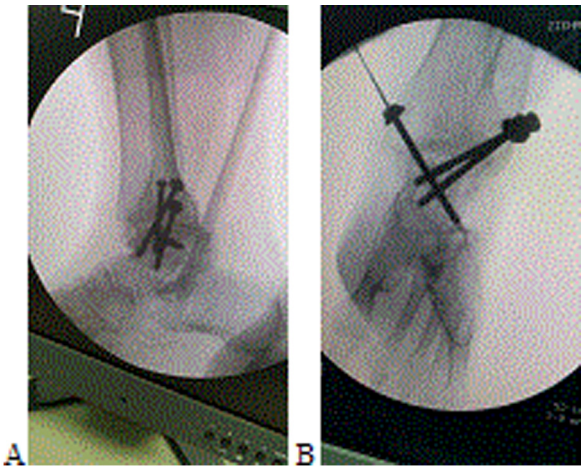
Clinical grading was done at 6 months postoperatively, and final subjective clinical and radiologic assessment is done at least 2 years postoperatively, dividing the results into four groups (excellent, good, fair, and poor) according to four parameters of success of ankle fusion, presence or absence of pain, limp or restriction in activities, and patient satisfaction. Patient satisfaction was graded into three groups: satisfied without reservation, satisfied with

Figure 2



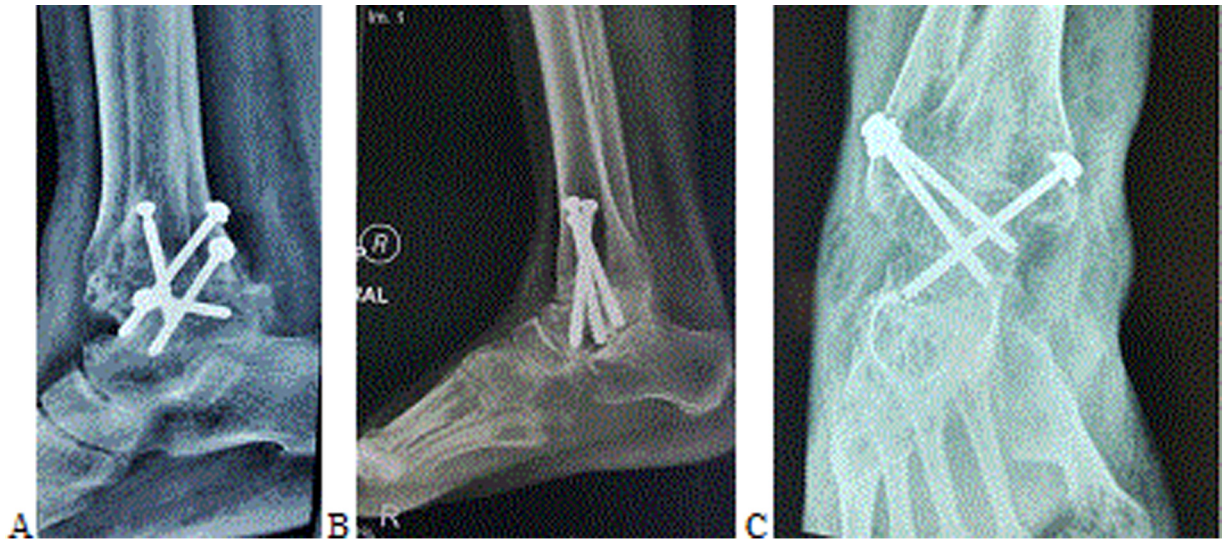
Removing about 5-mm. depth of articular surface, leaving islands of articular surface in between.

Figure 3



Intraoperative check of screw position and length.

Figure 4



(a–c) Postoperative follow-up radiograph with different degrees of union in three patients.

reservation, and dissatisfied. The result is excellent when the ankle is fused, without pain, limp, or restriction in activities. Good results are the same as excellent but with mild controllable pain. When the ankle is fused, with moderate pain, limp, and occupational restriction, the result is fair. Poor results are in nonunion or severe pain.

Results

After follow-up for an average of 27.5 months (range, 24–36), 18 (94.7%) patients had their arthrodesis united and one (5.3%) patient had arthrodesis nonunion. The 18 patients with successful union of arthrodesis had a mean time to union of 12.44 weeks (range, 10–16 weeks).

A total of 16 (84.2%) patients were satisfied at the final assessment, including 11 (57.9%) patients satisfied without reservation (excellent results) and five (26.3%) satisfied with reservations owing to mild pain that did not interfere with their occupational activities (good results); moreover, two (10.5%) patients were dissatisfied despite union of arthrodesis at 12 and 16 weeks (fair results).

Three (15.8%) patients were dissatisfied after arthrodesis. Two of them (10.5%) were dissatisfied despite of union. These two patients experienced moderate ankle pain and foot swelling that increased by physical activities, and partially improved by rest. The first one had union after 12 weeks, but he developed subtalar arthritis that was diagnosed clinically and on radiologic examination after one and a half years postoperatively. Foot orthosis and pain killers were given to him, but pain persisted, and subtalar fusion was done, but the pain persisted till the end of follow-up for 30 months. The other patient had union after 16 weeks despite moderate superficial infection that was diagnosed 2 weeks postoperative. The patient was given antibiotics for 6 weeks according to blood cultures and culture with swap from screw head incision with complete subsidence of infection but with persistent pain. He changed his occupation to less exhausting one, and the pain partially improved.

The third dissatisfied patient (5.3%) had arthrodesis nonunion. He was a 38-year-old male patient, who was a manual laborer and heavy smoker and had early postoperative deep staphylococcus infection at his ankle. Systemic antibiotics according to culture and sensitivity were given to him, but the infection did not subside. After 6 weeks of arthrodesis, ankle debridement, screws removal, and short leg cast was done, after which the infection subsided completely by the sixth months, which was confirmed by clinical examination and laboratory investigations, but still arthrodesis did not unite. Open fusion was done at 6 months postoperatively, and no recurrence of infection occurred. This patient had union after 20 weeks of revision. He continued to have moderate pain and limping despite normal laboratory infection profile; he had to change his work and was graded poor results. Results of the current study are grouped in Table 1.

Regarding complications in the current study, nonunion was seen in one patient, superficial infections occurred in four patients and resolved with

antibiotics, and subtalar arthritis was seen in one patient. Regarding pain, 11 patients had no postoperative pain, five had mild pain, and three had moderate to severe pain. There were no recorded cases of deep vein thrombosis. There were no recorded complications related to the arthroscopic technique, either injury to the neurovascular structures and tendons in the proximity of the portals, nerve palsy due to distraction, or instrument breakage within the joint.

In the current study, 11 were nonsmokers, whereas eight patients smoked, including three who were heavy smokers. In these three heavy smoker patients, fusion time was delayed relative to nonsmokers, indicating strong correlation of heavy smoking with fusion time. The relation between smoking and fusion time is analyzed in Table 2.

There were no statistical differences between male and female in fusion time or healing rate. No statistical difference was noticed from younger to older patients because of narrow age limits (30–50 years) and similar activity level, being originally incorporated in the inclusion criteria.

Discussion

For a very long time, open ankle arthrodesis was the standard technique for end-stage ankle arthritis even after the increasing popularity of total ankle arthroplasty [12]. Since the development of arthroscopic technique for ankle arthrodesis by Schneider [8], with several potential advantages, it still needs experienced surgeon and full equipment, as the surgeon may change the technique to an open fusion if necessary [7].

Proper patient selection is crucial for obtaining good results as young active patients with strenuous activities respond better to arthrodesis than with arthroplasty, and so arthroplasty is better reserved to less-active and less-demanding individuals. In patients with associated arthritis of neighboring joints (such as with rheumatoid arthritis or degenerative arthritis of subtalar or calcaneocuboid joints), isolated arthrodesis of ankle joint will increase loads in these joints, with more pain [3]. These patients are either treated by ankle arthroplasty or arthrodesis of arthritic joints in conjunction with ankle arthrodesis.

In the current prospective study, 19 young active patients with mean age 42.5 years were included, who were followed for an average of 27.5 months. The overall fusion rate of 94.7% was obtained at an average time of 12.44 weeks, with 84.2% satisfactory clinical results. This matched with the results of a retrospective study of Zvijac *et al*. [13] on 21 patients, with a mean age of 52.7 years who underwent arthroscopic ankle fusion and followed for 34 months, at which time point, the fusion occurred in 20 of 21 patients. Concerning pain, in the current study, 11 (57.9%) patients had no postoperative pain, and eight had mild or moderate pain. Compared with the study by Zvijac *et al*. [13], nine (42.9%) patients had no pain, and 11 had mild postoperative pain.

Several studies compared arthroscopic ankle arthrodesis to an open technique [14,15] and found that advantages of arthroscopic arthrodesis include

Table 1 Study results merging arthrodesis union with patient satisfaction

Satisfaction level	Final assessment	Number of patients	Percent	Time to union (weeks) (mean, 12.44 weeks)
Satisfied 16 patients (84.2%)	Excellent (satisfied without reservations)	11	57.9	10 (2 patients) 12 (5 patients) 14 (3 patients) 16 (1 patients)
	Good (satisfied with reservations)	5	26.3	10 (2 patients) 12 (2 patients) 14 (one patient)
Dissatisfied 3 patients (15.8%)	Fair (united but dissatisfied)	2	10.5	12 (one patient) 16 (one patient)
	Poor	1	5.3	Nonunion

Table 2 The relation between smoking and fusion time and rate

Smoker/ nonsmoker	Smoking index	Number of patients	Time to union
Smoker 8 patients	Heavy smoker	3	2 patients 16 weeks One patient nonunion
	Moderate or low smoking index	5	2 patients 12 weeks 3 patients 14 weeks
Nonsmoker	Nonsmoker	11	4 patients 10 weeks 6 patients 12 weeks One patient 14 weeks

decreased postoperative pain, decreased blood loss, less soft tissue damage, minimal loss of limb length, better cosmesis, and shorter hospitalization time. Disadvantages are difficult learning curve, need for expensive arthroscopic equipment, and inability to correct significant rigid varus/valgus or rotational problems.

Arthroscopic arthrodesis fusion rate in the current study was 94.7%, which matched with the published fusion rates for arthroscopic ankle arthrodesis, ranging from 85 to 97% [16–19].

In this study, the average arthrodesis mean time to union was 12.44 weeks (range, 10–16). This accelerated time to union may be explained by the fact that the joint capsule is still intact in arthroscopic technique, which avoids postoperative bleeding from the exposed bones after the release of tourniquet inside the joint, which accelerates fusion, and also may be owing to preserved blood supply and local circulation, as there is no need for periosteal stripping as in open technique [9]. Another factor is that in the current study weight bearing is postponed for 1 month and gradually increased till union occurred, relying on previous results of Winson *et al.* [4] who connected the time to union with the period of postoperative immobilization. This matched with the fusion time of several published studies [4,17].

Smoking affected both fusion rate and time, as shown in Table 2. The heavy smoker patients either fused late (two patients) or not united (one patient). This could be explained by the decreased immunity, negative effect of smoking on the microcirculation, and tissue perfusion, especially in a vulnerable area like the ankle [20,21].

In the current study, arthroscopic ankle arthrodesis with no or only minimal deformity (upper limit of 10–15°) could be corrected, and patients with greater deformities were excluded. This matched with the inclusion criteria of other studies [7,17], except Gougoulias *et al.* [9], who achieved successful results on ankle deformities of 15–45° varus or valgus based on the preoperative ability to place the forefoot square to the ground, and greater surgeon experience.

The limitations of this study are the small number of patients (because of the strict exclusion criteria) and the short follow-up period (mean, 27.5 months), at which degeneration of the adjacent joints may be still too early to occur.

Conclusion

This study strengthens the concept of using arthroscopy as a valid alternative option to open ankle arthrodesis with several advantages for young and active patients when equipment is available and surgeon is experienced with ankle arthroscopy.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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