Evaluation of arthroscopic ankle fusion for diabetic ankle fractures

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Background

Ankle fractures are a very common orthopedic trauma. One in eight patients undergoing ankle fixation is diabetic. Most of these patients also have additional comorbidities including peripheral arterial disease and diabetic neuropathy. Therefore, on one hand surgical intervention can pose challenges for wound healing and risk of infection, but non-operative management increases the risk for loss of reduction and therefore stresses the condition of the surrounding soft tissue. The aim of this work was to observe the radiological and functional outcome of arthroscopic ankle fusion in diabetic ankle fractures.

Methods

This prospective study was carried out on 20 patients, both sexes, with clinical criteria of displaced ankle fractures in diabetics, adults, closed ankle fractures, isolated trauma, diabetic patients with neuropathy and Adelaide Fracture in the Diabetic Ankle score more than or equal 5.

Results

Fourteen cases had solid bony union at a mean of 27.2 weeks while six cases had stable ankles with stiff fibrous nonunion at the end of the follow up period. Two of which had a breakage of distal locking screws. However, stiff fibrous nonunion of tibio-talar joint with the foot in a stable plantigrade position was considered satisfactory and no further intervention was advised. Our limb salvage rate was 100%. No below knee amputation was done.

Conclusions

Ankle fractures in diabetic patients are increasingly frequently encountered in comorbid patients with suboptimal overlying soft tissue integrity. Arthroscopic assisted ankle fusion can be considered a valid primary definitive treatment option to help reduce the potential perioperative soft tissue insult and associated complications. Utilizing an arthroscopic-assisted approach to this procedure is of added benefit in allowing for articular preparation and thereby reducing the risk of non-union while also minimizing additional extensive soft tissue insult in patients with underlying soft tissue compromise.

Keywords:
Arthroscopic ankle fusion, Diabetes mellitus, Ankle fractures

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Introduction

Ankle fractures are common orthopedic injuries. One in eight patients undergoing ankle fixation is diabetic [1,2]. Diabetic patients have a higher incidence of postoperative complications compared to nondiabetics. After ankle fracture fixation in diabetic patients complications have been shown to be 26–47% versus ∼15% in matched control groups of nondiabetic patients [2]. Compared to other risk factors, Diabetes has shown higher rates of amputation after diabetic ankle fracture fixation compared to other risk factors [3]. That is why in the past many have proposed conservative treatment for ankle fractures as a safer option compared to the burden of fixation in diabetics [4].

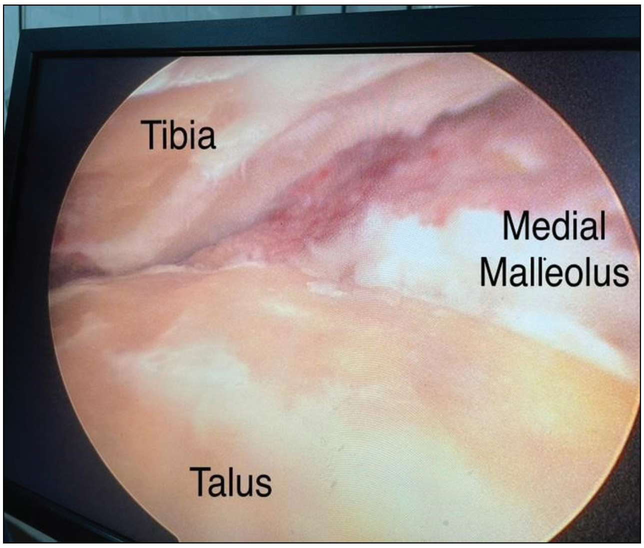
However, "conservative management of unstable ankle fractures in diabetics may have worse and higher complication" [5]. As ankle injury can elicit the process of Charcot neuroarthropathy which causes joint destruction, bone resorption, and different deformities. Therefore, the need for rigid fixation is highly recommended [6].

Ankle fusion may be an acceptable option compared to osteosynthesis in patients with high Adelaide ankle scores [7].

Most of the ankle fusion now is done by open approaches [8]. But many studies noted a considerable number of complications. A case series evaluating open ankle fusion using a retrograde nail reported nonunion rates from 0 to 45%, major complications from 5 to 38%, and minor complications from 1 to 56% [9]. The majority of these complications were surgical site infections. Therefore, new operative ankle arthrodesis techniques had to be developed to reduce the number of surgical site infections and complications while achieving bony fusion. One way to reduce the invasiveness of this procedure could be arthroscopic ankle fusion. Many studies have reported better results for isolated arthroscopic compared to open arthrodesis of the ankle joint [10].

This work aimed to observe the radiological and functional outcome of arthroscopy-assisted ankle fusion in diabetic ankle fractures.

Figure 1



Ankle joint arthroscopy.

Patients and methods

This prospective study was carried out on 20 adult patients of both sexes who suffered isolated, closed, and displaced ankle fractures and who are known to have diabetes mellitus. All patients had diabetic neuropathy and an AFDA score of more than or equal to 5.

The study was done from April 2022 to April 2023 after approval from the Ethical Committee of Tanta University Hospitals, Egypt. An informed written consent was obtained from all patients.

Criteria for exclusion: exclusion criteria were non-ambulatory patients, intact sensation in active adults with controlled diabetes, a previously failed ORIF, poly-trauma patients, and open ankle fractures.

All patients were subjected to complete history taking, clinical examination, radiological examination: plain radiograph (anteroposterior, lateral, and mortise views) of the ankle joint and computed tomography of affected ankle to detect articular extension of injury and quality of bone stock, laboratory investigations (complete blood count, international normalized ratio, glycated hemoglobin test, fasting, postprandial blood glucose level, renal function test, liver function test, random blood sugar), echocardiogram, ECG, and vascular investigations to detect limb perfusion like [Doppler ultrasound and ankle-brachial index (0.9–1.30)].

Operative technique

The procedure was performed under epidural anesthesia.

The patient was supine on a radiolucent table, the limb was then exsanguinated by elevation for 3–5 min. A tourniquet was applied, and a bump was placed under the ipsilateral hip, so the knee was straight up.

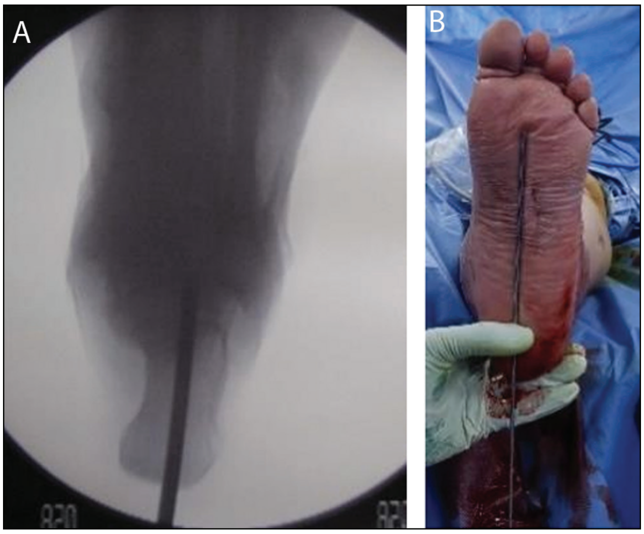
Under the image intensifier, the ankle joint was reduced by the help of an assistant. Arthroscopy was performed with a 2.7 or 4 mm 30° arthroscope. The anteromedial portal, medial to the tibialis anterior tendon, was placed. The anterolateral portal (lateral to the extensor digitorum communis tendon) was established under direct vision. Once the portals were established, debridement of the soft tissues was performed with a shaver in the anterior part of the joint, and the cartilage was removed with an acromioplasty, burr, and curettes.

The medial malleolus articular surface was removed as well (Fig. 1). The tourniquet was deflated to evaluate bleeding from the tibial and talar surface. This ended the arthroscopic part of the surgery, then we proceeded to the planned fixation after the scope was out.

The assistant maintained the position of the ankle in neutral dorsiflexion, 0–5° valgus angulation, and ∼5–10° of external rotation during ankle fixation.

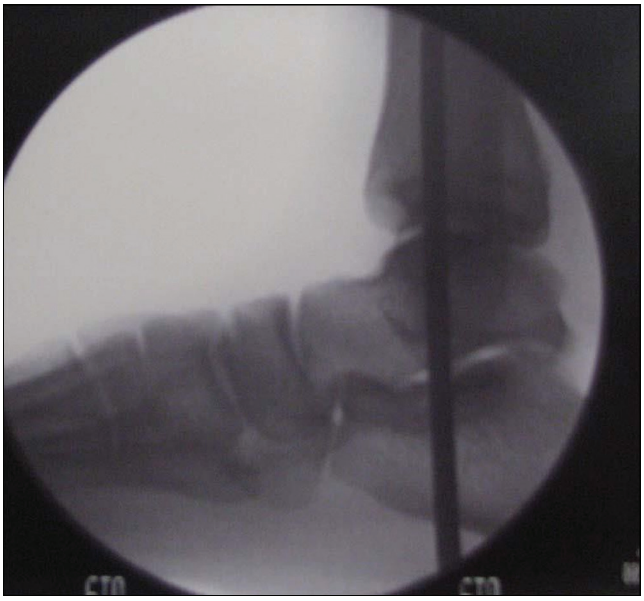
The planter incision for the nail was determined by placing a K-wire on the plantar surface (1/3 lateral) and taking an axial heel view to align it with the longitudinal axis of the calcaneus (Fig. 2). We marked this line on the skin. Next, we placed the K-wire on the lateral side of the ankle aligning the wire along the tibial axis on a lateral fluoroscopic view (Fig. 3). We marked this line on the skin extending the line onto the plantar surface. The starting point for the incision was determined by the intersection of the two lines on the plantar surface.

Figure 2



(a) Using intraoperative c-arm, a calcaneal axial view help to draw a line bisecting the calcaneus. (b) Marking the calcaneal entry on the plantar surface of foot.

Figure 3

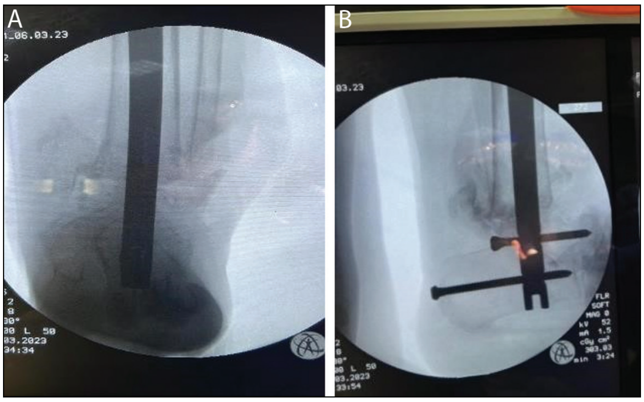


A line was made on the ankle which is consistent with a line that bisects the tibia and goes through the lateral talar process.

A longitudinal incision of ∼2–3 cm was made at this intersection. Careful dissection was then utilized to gain access to the plantar surface of the calcaneus. The entry point was made under lateral and axial heel fluoroscopy control.

Once this position was verified as center/center in the talus, reaming, nail insertion and interlocking screws are then achieved by nail system. The ankle fusion nail used was the retrograde nail femur made by local companies, for example: the international center of orthopedic implants (Fig. 4).

Figure 4



(a) Anteroposterior view of the ankle after TTC nail insertion and (b) lateral view of the ankle after TTC nail insertion.

Postoperative follow up

The patient is instructed not to weight bear and placed in a splint.

And to use crutches for ambulation for 4–6 weeks.

Follow-up radiographs at 6, 12 weeks, 6 months, and 1 year follow-up.

Evaluation of outcome

The AOFAS score was modified, to evaluate our results, by elimination of the points for the sagittal motion (of the ankle joints) and hindfoot motion achieving a maximum of 86 points.

Statistical analysis

Statistical analysis was done by SPSS, v26 (IBM Inc., Chicago, Illinois, USA). Quantitative variables were presented as mean and SD and compared between the three groups utilizing the analysis of variance (F) test with post-hoc test (Tukey). Quantitative nonparametric data were presented as the median and interquartile range (IQR). Qualitative variables were presented as frequency and percentage and were analyzed utilizing the χ^2 test. A two-tailed P value less than 0.05 was considered statistically significant.

Results

Age ranged from 44 to 75 years with a mean value (±SD) of 62.45 ± 10.35 years. Two (10%) were males and 18 (90%) were females. Two (10%) were smokers. Two (10%) were office workers and 18 (90%) were housewife. The mode of trauma was a twisting injury

Table 1 Preoperative data of the studied patients

	N=20
Age (years)	62.5 ± 10.35
Sex	
Male	2 (10)
Female	18 (90)
BMI (kg/m^2)	33.7 ± 2.8
Smoking	2 (10)
Occupation	
Office work	2 (10)
Housewife	18 (90)
Characters of fracture	
Mode of trauma	
Twist	20 (100)
Side of fracture	
Right side	13 (65)
Left side	7 (35)
Associated comorbidities other than diabetes	
Hypertension	6 (30)
Hypertension and nephropathy	7 (35)
Nephropathy and cardiac dysfunction	3 (15)
Hypertension and nephropathy and cardiac dysfunction	2 (10)

Data are presented as mean±SD or *n* (%).

in all patients. The side of fracture was right in 13 (65%) patients and left in seven (35%) patients. Associated comorbidities were hypertension in six (30%) patients, hypertension, and nephropathy in seven (35%) patients, nephropathy and cardiac in three (15%) patients, and hypertension and nephropathy and cardiac in two (10%) patients (Table 1).

The AFDA score was with median (IQR) of 7 (58). The lag time to surgery ranged from 2 to 21 days with a mean value (±SD) of 5.6 ± 4.12 days. The AOFAS score was with median (IQR) of 71 (71–80). The duration of surgery ranged from 75 to 100 min with a mean value (±SD) of 91.6 ± 7.71 min. The postoperative hospital stay ranged from 1 to 4 days with a mean value (±SD) of 1.5 ± 0.83 days. The time for fusion ranged from 12 to 21 weeks with a mean value (±SD) of 16.86 ± 3.25 weeks. The time of weight bearing ranged from 7 to 14 weeks with a mean value (±SD) of 10.1 ± 2.63 weeks. Solid bony union was achieved in 14 cases in a mean of 27.27 ± 3.71weeks. Six cases had stable ankle with stiff fibrous nonunion at the end of the follow up period. Two of which had a breakage of distal locking screw. Six cases had stable ankles with stiff fibrous union at the end of the follow up period. Two of which had a breakage of distal locking screw (Table 2).

Table 2 AFDA score, lag time, AOFAS score, duration of surgery, postoperative hospital stays, fusion, weight bearing, and complications of the studied patients

	N=20
AFDA score	7 (5–8)
Lag time before operation (days)	5.6 ± 4.12
AOFAS score	71 (71–80)
Duration of surgery (min)	91.6 ± 7.71
Postoperative hospital stays (days)	1.5 ± 0.83
Time for fusion and weight bearing	
Time of nonweight bearing (weeks)	10.1 ± 2.63
Solid bony union (cases)	14 (70)
Stiff fibrous union (cases)	6 (30)
Time for fusion (weeks)	27.27 ± 3.71
Complications	
Preoperative complications	
Blisters	2 (10)
Local swelling and erythema	2 (10)
Operative complications	0
Postoperative complications	
Breakage of distal locking screws	2 (10)
No union	6 (30)

AFDA, Adelaide Fracture in the Diabetic Ankle, American; AOFAS, American Orthopedic Foot and Ankle Society.
Data are presented as mean±SD and *n* (%) or median (interquartile range).

There was a significant relation between AOFAS score and age (*P*=0.034), age was significantly lower with excellent AOFAS score than good AOFAS score (*P*=0.029) while age was insignificantly different between fair and (good and excellent AOFAS score). Excellent AOFAS score was higher with 51–60 years than 40–50 years and more than 61 years (*P*=0.032 and *P*<0.001, respectively) while AOFAS score was insignificantly different between age of 40–50 years and more than 61 years. There was no relation between AOFAS score and sex, smoking, occupation, BMI, AFDA score, preoperative complications, post operative complications, time for fusion and time of weight bearing. There was no relation between AOFAS score and (sex, smoking, occupation, BMI, AFDA score, preoperative, postoperative complications, time for fusion, and time of weight bearing) (Table 3).

Case 1

Female patient 65 years old presented to the emergency hospital with closed bimalleolar ankle fracture. The patient has been diabetic on insulin therapy for more than 30 years. Local examination showed varus deformity of ankle with intact peripheral pulsation. Neurological examination showed absent deep sensation. The patient is diabetic with glycated hemoglobin 8, BMI 36.7. No other associated comorbidities. According to Adelaide score, the patient score is 7 which is an indication for ankle fusion. AOFAS of the patient after 1 year of follow up is 80 (Fig. 5).

Table 3 Relation between AOFAS score and (age, sex, smoking, occupation, BMI, AFDA score, preoperative, postoperative complications, time for fusion, and time of weight bearing) of the studied patients

	AOFAS score Poor (N=0)	Fair (N=4)	Good (N=12)	Excellent (N=4)	P value
Age (years)					
Mean±SD	–	64±13.74	65.8±8.56	51±0	0.034* P1=0.939 P2=0.131 P3=0.029*
40–50 years (N=3)	0	1 (33.3)	2 (66.7)	0	<0.001* P1=0.032* P2=0.711 P3<0.001*
51–60 years (N=4)	0	0	0	4 (100)	
>61 years (N=13)	0	3 (23.1)	10 (76.9)	0	
Sex					
Male	0	0	2 (10)	0	0.476
Female	0	4 (20)	10 (50)	4 (20)	
Smoking	0	0	2 (10)	0	0.476
Occupation					
Office work	0	0	2 (10)	0.476	0.476
Housewife	0	4 (20)	10 (50)	4 (20)	
BMI					
Mean±SD	–	33.8±4.15	34.1±2.78	32.1±0	0.475
Obese (BMI >30) kg/m² (N=20)	0	4 (20)	12 (60)	4 (20)	–
AFDA score	–	9±2.45	6.6±2.19	7±0	0.151
AFDA score					
5–10 (N=19)	0	3 (15.7)	12 (63.1)	4 (21.1)	0.121
>10 (N=1)	0	1 (100)	0	0	
Preoperative complications	0	2 (10)	2 (10)	0	0.188
Postoperative complications					
Nonunion and breakage of distal locking screws	0	1 (25)	1 (8.3)	0	
Fibrous nonunion	0	2 (50)	2 (16.6)	0	0.199
No postoperative complications	0	1 (25)	9 (18.3)	4 (100)	
Time for fusion (weeks)					
< or equal 26 week (N=8)	0	0	4 (33.3)	4 (100)	0.124
>26 week (N=6)	0	1 (25)	5 (41.6)	0	
Time of weight bearing (weeks)					
Mean±SD	–	10.3±2.36	10.8±2.9	8±0	0.199
≤10 weeks (N=13)	0	2 (15.4)	7 (53.8)	4 (30.7)	0.248
>10 weeks (N=7)	0	2 (15.4)	5 (71.4)	0	

Data are presented as *n* (%).
*Significant as *P* value less than 0.05.

Discussion

We used The AFDA management algorithm and score to assist in the optimal decision-making for managing diabetic ankle fractures between ORIF or primary rigid fixation/arthrodesis [7].

In this study, we performed arthroscopic ankle fusion using tibio-talo-calcaneal nails in patients with AFDA scores more than or equal to five. The use of an arthroscope for preparing the ankle joint was recommended by many authors who have reported their experience, showing the favorable outcome of arthroscopic technique including a high fusion rate and a shorter time to union and decreasing the risk of complications [11].

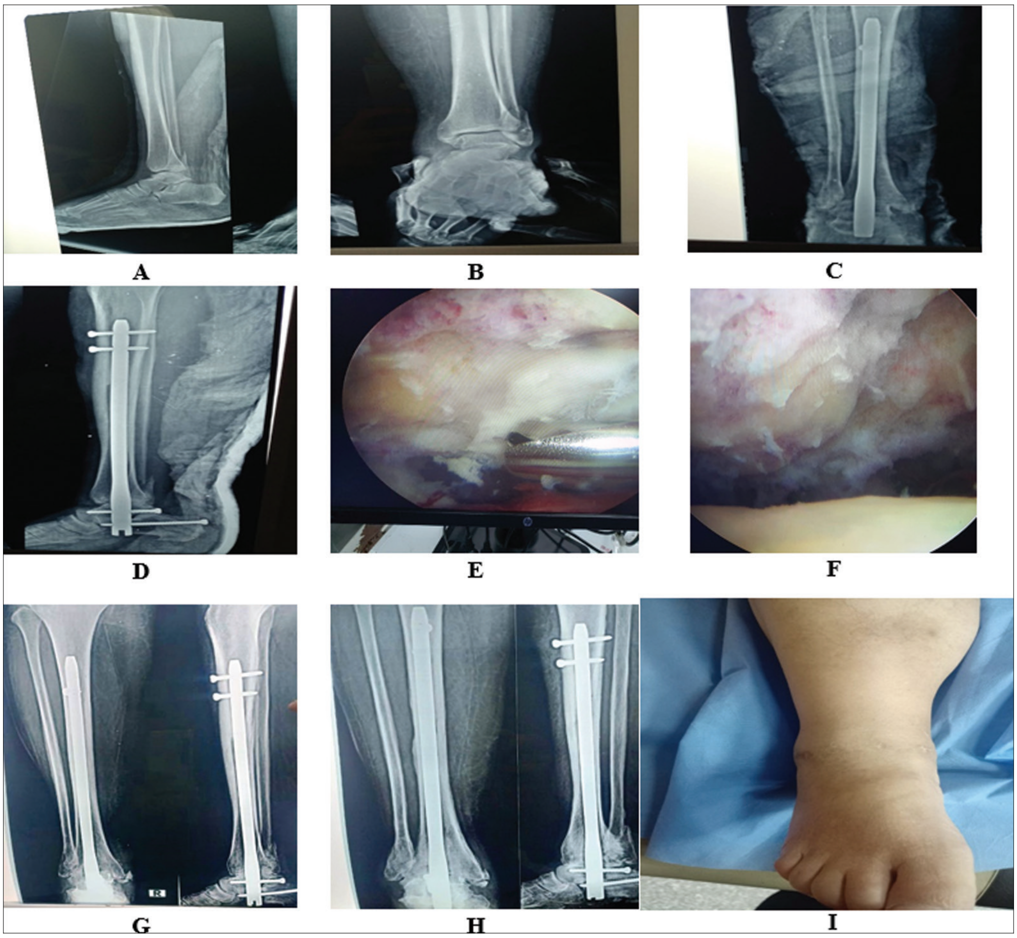
In this study, ages ranged from 44 to 75 years with a mean value of 62.45. Grote *et al.* [12] performed primary ankle arthrodesis in diabetic ankle fractures in 13 patients. The average age of patients was 67.1 years. Ebaugh *et al.* [13] discussed the outcomes of primary tibio-talo-calcaneal nailing for complicated diabetic ankle fractures without formal joint preparation in 27 patients, the mean age was 66 years.

Based on the AFDA score, we only included patients with a score 5 or more. With an average score of 7 which is close to Grote *et al.* [12] of average 6.4.

In this study the mean BMI was 33.7 which correlates with Grote's average BMI of 35.8 and Ebaugh's average BMI 38 [12,13]. In this study, we only included closed ankle fractures unlike Grote who had 40% of his patients with open ankle fractures, and Ebaugh who had 22% open ankle fractures [12,13].

At the end of our 12 months follow-up, our limb salvage rate was 100%. No below-knee amputation was done. Ebaugh *et al.*'s [13] study had a limb salvage rate of 96% when excluding the patient who

Figure 5



(a) Lateral, (b) anteroposterior view of ankle, (c) postoperative anteroposterior, (d) lateral views of ankle after arthroscopic ankle fusion by tibio-talo-calcaneal nail, (e) before preparation of articular surface, (f) after preparation of articular surface, (g) 5 months follow up of arthroscopic ankle fusion, (h) 1 year follow up of arthroscopic ankle fusion, and (i) incisions of entry of ankle arthroscopy.

underwent amputation for an unrelated proximal vascular lesion.

Grote *et al.* [12] who attempted open tibio-talo-calcaneal arthrodesis had an amputation rate of 23.1 all due to unresolved deep infection.

In Ayoub's [14] cohort of open tibio-talar arthrodesis, three patients had below-knee amputation 17%. They developed avascular necrosis of the talus had grossly unstable ankles and were severely handicapped. They later developed ulceration of the lateral hindfoot.

In this study, six (30%) patients failed to achieve solid bony fusion after 12 months of follow-up. However, the stiff fibrous union of the tibio-talar joint with the foot in a stable plantigrade position was considered satisfactory and no further intervention was advised.

Grote *et al.* [12] had a high rate of nonunion of 77.8%. The overall high complication with primary arthrodesis in his study made him suggest that arthrodesis in patients with diabetic ankle fractures should be done on a limited scale. He also suggested the use of TTC hindfoot nails fixation without attempted fusion.

Ebaugh *et al.* [13] used TTC hindfoot nails without attempted fusion and had similar nonunion rates of 12.5% (three out of 24).

In Ayoub's [14] cohort of open tibio-talar arthrodesis using crossing screws a large percentage of nonunion was found about 47%. The fibrous nonunion was stable and painless in five (29%) patients, but unstable with associated avascular necrosis of the talus in three (18%).

No deep infection or wound-related complication was noticed in our study, unlike other studies that attempted open joint preparation.

Ayoub [14] reported four (23.5%) cases with superficial wound infection.

Grote *et al.* [12] reported having five (38%) patients who required repeat operations, all for infection. Three patients required below-the-knee amputation, all for uncontrollable deep infection. Wound complications were common and occurred in 53% of patients.

As for open reduction and internal fixation using the traditional techniques, Costigan *et al.* [15] reported 12 of the 84 patients developed postoperative complications. Ten patients developed infections (eight deep and two superficial).

In this cohort, the average time for union ranged from 21 to 32 weeks with a mean time of 27.27 weeks.

Unlike Ebaugh *et al.* [13] who had similar union rates but a lot shorter time for union with an average time for union 18 weeks although there was no formal joint preparation. Ayoub [14] had a lower fusion rate of 53% but nearly the same duration for union compared to our study of average 5.8 months (range: 5–8 months).

The time of nonweight bearing ranged from 7 to 14 weeks with a mean value of 10.1 weeks in this study. Ebaugh *et al.* [13] reported an average of 6 weeks (1–17) for full weight bearing which is a lot shorter than our study.

At the end of this study, the modified AOFAS score (0–86) was with a median (IQR) of 71 (7180). In our study, no poor results were detected (0–50). Only four (20%) patients had excellent results (81–86). Good results were found in 12 (60%) patients.

These results are remarkable compared to cohorts that performed open ankle arthrodesis in diabetic ankle fractures like Ayoub [14] with assessment scores of excellent (82 points) in one (6%) patient, good in eight (47%), fair in five (29%), and poor in three (18%) patients.

Our thoughts were to decrease the risk of surgical site infection in these high-risk patients by single surgery and help these high-risk patients to start weight bearing as soon as possible.

Open surgeries in these patients may result in catastrophic complications up to amputation. Minimizing this risk by preparation of tibio-talar joint using ankle arthroscope to increase the chance of bony union without open and larger incisions can dramatically decrease the risk of surgical site infection in these high-risk patients.

Conclusion

Arthroscopic ankle fusion/arthrodesis is an alternative primary definitive treatment option in high-risk patients to reduce postoperative complications in these high-risk patients. Utilizing an arthroscopic-assisted approach allows articular preparation to reduce the risk of nonunion.

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Nil.

Conflicts of interest

None declared.

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