Effect of Arthroscopic Evaluation of Acute Ankle Fractures on PROMIS Intermediate-Term Functional Outcomes

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Abstract

Background: Following open reduction internal fixation (ORIF) of unstable ankle fractures, some patients have persistent pain and poor outcomes. This may be secondary to intra-articular injuries that occur at the time of fracture, which occur in up to 88% of fractures. Ankle arthroscopy at the time of ORIF has been proposed to address these intra-articular injuries. This study compared patient-reported functional outcomes in patients who underwent ankle ORIF with and without ankle arthroscopy.

Methods: An institutional database was used to retrospectively identify 93 patients who underwent ORIF for an unstable ankle fracture with an intact medial malleolus between 2002 and 2013. Forty-two patients had ankle arthroscopy at the time of ORIF and 51 did not. Functional outcomes between groups were compared using Patient Reported Outcomes Measurement Information System (PROMIS) physical function and pain interference computerized adaptive tests at a minimum follow-up of 1 year. Outcomes were also measured with the visual analog scale (VAS) pain score and the Olerud and Molander ankle fracture outcome scale. Average patient follow-up was 67 months (n = 51).

Results: PROMIS physical function and pain interference scores were not significantly different between groups (physical function, 57.8 vs 54.5, $P = .23$; pain interference, 45.6 vs 46.9, $P = .56$). Operative time was increased in the arthroscopy group (74 minutes vs 59 minutes, $P = .027$). Overall, 60% (25/42) had chondral lesions of the talus, 7% (3/42) had chondral lesions of the tibial plafond, and 21% (9/42) had loose bodies requiring removal. There was no significant difference in complication rates between groups.

Conclusion: At intermediate-term follow-up of patients with unstable ankle fractures and intact medial malleoli, functional outcomes were not significantly improved in patients who underwent ankle arthroscopy. However, there were no increased complications attributable to ankle arthroscopy, and average total operative time was increased by only 15 minutes.

Level of Evidence: Level III, retrospective cohort study.

Keywords: ankle fracture, ankle arthroscopy, articular chondral lesion, patient reported functional outcomes

Introduction

Ankle fractures are common orthopaedic injuries, which occur at a rate of 187 per 100 000 person-years, and are the fourth most common fractures to require operative repair.[4,6] It was initially thought that properly reduced unstable ankle fractures had generally acceptable outcomes, with a reported 81% rate of good to excellent results.[13] However, further investigation and longer term follow-up has shown more mixed and less encouraging results. A 10-year follow-up study showed good to excellent results in only 52% of patients, and other studies report high rates of residual pain and stiffness at 3- to 5-year follow-ups.[5,16,18]

There remains no clear explanation for the subset of patients with poor outcomes following operative treatment and anatomic reduction of ankle fractures. One potential explanation is that occult intra-articular injuries, including intra-articular chondral lesions, occur at the time of the fracture. The reported incidence of chondral lesions ranges from 28% to 88%, though most studies have reported rates of 60% or greater.[1,8,14,22] In traditional open treatment of

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ankle fractures, there is limited capacity to evaluate the articular surface, particularly in the case of an intact medial malleolus. Therefore, an argument has been made for ankle arthroscopy at the time of ankle fracture ORIF, both for prognostication and intervention with assistance in reduction, debridement, loose body removal and possible microfracture or drilling techniques.

Although the use of arthroscopy in the setting of ankle fractures is logical given the incidence of chondral injuries, the evidence to support its use is limited and a review of this topic produced only an indeterminate recommendation.[7] Only 2 studies have directly compared outcomes following ankle fracture fixation with and without concomitant arthroscopy.[20,22] One study included only 19 total patients and both studies had relatively short-term follow-up, while outcomes after chondral injury may change significantly at the intermediate and long-term interval. In addition, no study has evaluated this issue using a validated outcome score. This study sought to determine whether at intermediate-term follow-up, patient-reported functional outcomes following ankle fracture ORIF were improved with the use of ankle arthroscopy.

Methods

Institutional review board approval was obtained prior to the initiation of this study. A hospital database (Enterprise Data Warehouse) was used to identify patients who underwent ORIF of an unstable ankle fracture by a single surgeon over a 10-year period from 2002 to 2013. At a point during this study period, the surgeon started performing ankle arthroscopy on all ankle fractures that had an intact medial malleolus in order to evaluate the articular surface. In the setting of an intact medial malleolus, there is no opportunity to evaluate the articular surface without arthroscopy, and therefore this subset of patients represented the group with the greatest potential benefit from ankle arthroscopy. This was the same subset of patients selected by Thordarson et al in a small, randomized trial that also evaluated ankle arthroscopy for ankle fracture.[22] A chart review was used to select a study group of 98 patients who had an ankle fracture but an intact medial malleolus. Exclusion criteria include skeletally immature individuals, prior ankle surgery, and chronic ankle fractures, defined as those presenting for surgery at greater than 3 weeks post injury. For the comparison of functional outcomes and pain scores, patients were excluded for presence of chronic foot or ankle pathology or prior surgeries involving the foot or ankle.

Additional review of medical records was performed. Patient demographics, operative details, and postoperative follow-up and complications were recorded. The patients were divided into 2 groups depending on whether or not ankle arthroscopy had been performed at the time of ankle ORIF. For the ankle arthroscopy group, operative reports were reviewed and intraoperative findings including presence of chondral lesions or loose bodies were recorded, as well as any interventions that were performed. Preoperative and postoperative radiographs were reviewed, and fractures were classified by the AO/OTA ankle fracture classification system.[15]

Patient Reported Outcomes Measurement Information System (PROMIS) physical function and pain interference computerized adaptive tests are validated outcome scores for foot and ankle conditions, and were selected as the primary outcomes for this study.[9] PROMIS was developed by the NIH and uses computerized adaptive tests based on item-response theory, meaning that a patient's response to a previous question determines the subsequent question that he or she is asked from a larger bank of questions.[3] This methodology allows for increased precision and efficiency in gathering outcomes. The scores generated from these computerized adaptive tests are based on a sampling of the general US population. The mean score is set at 50, with a standard deviation of 10 points. A higher physical function score indicates better function, and a higher pain interference score indicates more pain. Use of these instruments is free and publicly available at www.assessmentcenter.net. Secondary outcomes included the Olerud and Molander ankle fracture scoring system[17] and the pain visual analog scale (VAS). The Olerud and Molander scoring system was developed to compare outcomes after ankle fractures. It is scored on a 100-point scale, with a higher score indicating a better outcome. Patients were contacted by one of the authors and, if consenting, completed the surveys by telephone.

A total of 93 patients were identified who underwent ORIF of an unstable ankle fracture with an intact medial malleolus. Forty-two patients had ankle arthroscopy at the time of ORIF and 51 patients did not. There was no significant difference in patient age, laterality, tobacco use, or number of diabetic patients between the 2 groups. There were significantly more male patients in the arthroscopy group compared to the non-arthroscopy group. There was no significant difference in distribution of fractures by AO/OTA classification or by syndesmotic instability (Table 1). A total of 51 patients were available for follow-up and completed outcome surveys at a minimum of 1 year postoperatively. Twenty-four of 42 patients (57%) in the arthroscopy group and 27 of 51 patients (53%) in the non-arthroscopy group were available for follow-up. Average time to follow-up was 67 months. One patient from each group was excluded for the comparison of functional outcomes and pain scores. In the arthroscopy group, a patient was excluded for preexisting ankle arthritis. In the non-arthroscopy group, a patient was excluded for hindfoot arthritis and bilateral talonavicular arthrodesis.

Statistical analysis was performed using Statistical Analysis System v9.3 (Cary, NC). Linear regression models were applied to evaluate the effects of the use of arthroscopy

Table 1. Demographics.[a]

Characteristic	Arthroscopy (n = 24)	Non-arthroscopy (n = 27)	Significance (P value)[b]
Age, years (mean)	38.3	40.3	.62
Gender			
Male	18 (75)	13 (48)	**.0499**
Female	6 (25)	14 (52)	
Tobacco use	4 (17)	3 (11)	.69
Diabetic	1 (4)	1 (4)	1.0
Laterality			
Right	13 (54)	12 (44)	.49
Left	11 (46)	15 (56)	
AO/OTA			
Type B	16 (67)	17 (63)	.78
Type C	8 (33)	10 (37)	
Syndesmosis			
Unstable	19 (79)	21 (78)	.90
Stable	5 (21)	6 (22)	

[a]Values are n (%) unless otherwise noted.
[b]Boldface indicates statistically significant difference.

on primary and secondary outcome measures, with other factors such as demographics and fracture type controlled. The same type of modeling was used to compare complication rates, duration of surgery, and the correlation of chondral injuries with outcomes. The significance level was set at $\alpha = .05$. PROMIS physical function and pain interference scores have been validated for foot and ankle disorders; however, a minimal clinically important difference has not been established. Therefore, a typical a priori power analysis could not be performed. The cohort of patients for whom we had follow-up was adequate to detect a difference of 8 or more points (scale is 0-100) between groups with 80% power.

Operative Technique

At the start of the procedure, anatomic landmarks and neurovascular structures were identified and marked out. Open reduction and internal fixation (ORIF) of the lateral malleolus fracture was performed first, when appropriate. ORIF was performed before arthroscopy in order to minimize fluid extravasation and also to allow for fluoroscopic and arthroscopic assessment of syndesmotic stability. AO/OTA C3 proximal fibula fractures were treated with syndesmotic fixation only. Next, in cases for which arthroscopy was performed, arthroscopic portals were established. Noninvasive distraction was used and the anteromedial portal was established first after insufflation of the joint, followed by establishment of the anterolateral portal if needed for visualization of structures or for intervention. Chondral and ligament injuries were noted and debrided as necessary (Figure 1). Loose bodies were removed. Full-thickness chondral injuries were

microfractured or drilled. The syndesmosis was stressed using the external rotation stress test and Cotton stress test. The syndesmosis was visualized and assessed for instability via fluoroscopy and arthroscopy, and syndesmotic fixation was performed in cases of instability. The device used for syndesmotic fixation varied. Either screw fixation, a suture fixation device, or a combination of the 2 were used. This decision was dependent on multiple factors, including patient size, degree of syndesmotic instability, and whether there was an accompanying fibula fracture that was stabilized. When screw fixation was used, the syndesmotic screw was not routinely removed. Patients were splinted in a bulky postoperative dressing for the initial 2 weeks followed by transition to a removable boot, with initiation of range of motion exercises and finally initiation of weight-bearing at 6 weeks postoperatively. A series of preoperative and postoperative radiographs of a representative case are shown in Figures 2 and 3, respectively.

Results

The mean PROMIS physical function score for the arthroscopy group was 57.8 compared with 54.5 for the non-arthroscopy group ($P = .23$). There was also no significant difference in PROMIS pain interference scores (45.6 vs 46.9, $P = .56$). Olerud and Molander scores for the arthroscopy group were higher than the non-arthroscopy group (90 vs 84), but the difference was not significantly different ($P = .11$). Likewise, visual analog scale scores were lower in the arthroscopy group, but this was not statistically significant (1.0 vs 2.1, $P = .13$) (Table 2).

Of the patients who had ankle arthroscopy, 62% (26 of 42) had articular surface lesions. Twenty-five patients had a chondral injury of the talus, and 3 patients had a chondral injury on the tibial side. Of the talar articular surface lesions, 14 were medial, 5 central, and 9 lateral (some patients had multiple talar lesions). The majority of lesions required only debridement, but microfracture was performed in 3 patients. Nine patients were found to have loose bodies, all of which were removed. Using the AO/OTA classification, 14 of 26 (54%) type B fractures had chondral lesions, compared to 12 of 16 (75%) type C fractures. This difference in rate of chondral injury did not reach statistical significance ($P = .17$). AO/OTA C3 fractures (proximal fibula or Maissoneuve fractures) were compared to all others. AO/OTA C3 fractures had associated chondral lesions in 6 of 9 (67%) cases, whereas all other fractures had associated chondral lesions in 20 of 33 (61%) cases. The difference was not statistically significant ($P = 1.0$). There was also no statistically significant association between syndesmotic instability and chondral lesions. Twenty-three of 35 patients (65%) with syndesmotic instability had a chondral lesion compared to 3 of 7 patients (43%) without instability ($P = .39$) (Table 3).
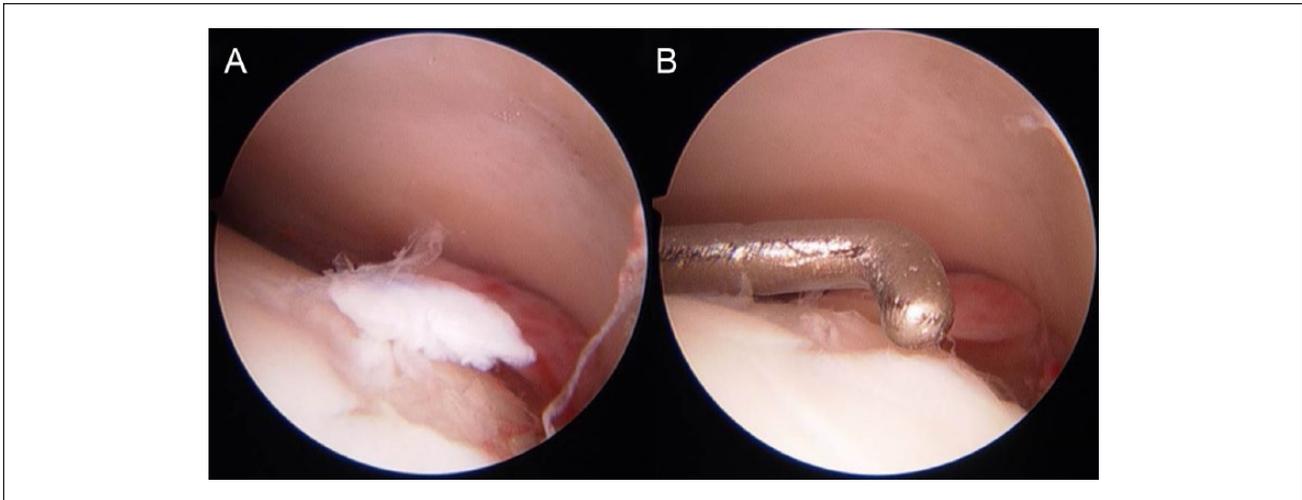
Figure 1. A partial-thickness, medial talus articular surface lesion identified during ankle arthroscopy of a right ankle fracture, imaged (A) before and (B) after debridement.

Figure 2. Preoperative, initial injury plain radiograph series of a representative Weber B ankle fracture.

A subgroup analysis was performed of patients who underwent ankle arthroscopy, with comparison of outcomes between patients with and without chondral lesions. For PROMIS physical function scores, patients with chondral lesions had an average score of 57.4 compared to 58.3 in patients without identified lesions ($P = .88$). For PROMIS pain interference scores, patients with chondral lesions had an average score of 46.7 compared to 44.5 in patients without identified lesions ($P = .84$). For the Olerud and Molander scoring system, patients with chondral lesions had significantly lower scores of 87.7 compared to 93.2 in patients without identified lesions ($P = .02$). Visual analog scores

did not show a significant association with presence of chondral injury (0.8 vs 1.0, $P = .42$).

A chart review was performed to compare postoperative complications between the arthroscopy and non-arthroscopy group. There were no cases of nonunion, implant failure or loss of fixation, and there were no cases of late syndesmotic instability in either group. There was 1 patient in the arthroscopy group identified to have a partial nerve injury to the intermediate branch of the superficial peroneal nerve. There were no nerve injuries identified by chart review in the non-arthroscopy group. In the arthroscopy group, there was 1 patient with a wound complication requiring additional

Figure 3. Postoperative, plain radiograph series of a representative Weber B ankle fracture.

Table 2. Outcomes.

Scale	Mean Score		
	Arthroscopy (n = 24)	Non-arthroscopy (n = 27)	Significance (*P* value)
PROMIS physical function	57.8	54.5	.23
PROMIS pain interference	45.6	46.9	.56
Olerud and Molander	90	84	.11
Visual analog scale	1.0	2.1	.13

Table 3. Articular Chondral Lesions.[a]

	Lesion	No Lesion	Significance (*P* value)
AO/OTA			
Type B (n = 26)	14 (54)	12 (46)	.17
Type C (n = 16)	12 (75)	4 (25)	
Syndesmosis			
Unstable (n = 35)	23 (65)	12 (35)	.39
Stable (n = 7)	3 (43)	4 (57)	

[a]Values are n (%).

procedures (hardware removal). In the non-arthroscopy group there were no patients with wound complications requiring additional procedures. There were no cases of compartment syndrome secondary to fluid extravasation in the arthroscopy group. When patients were surveyed for their functional outcomes, they were also asked if they had any residual dorsal foot numbness. Of the arthroscopy patients, 3 out of 24 patients reported residual numbness, compared to 4 out of 27 in the non-arthroscopy group (*P* = .66). On review of the operative records of each patient, there was a significant difference in operative time; the average operative time for the arthroscopy group was 74 minutes, versus 59 minutes for the non-arthroscopy group (*P* = .027).

Discussion

Chondral injuries of the talus and/or tibial plafond occur in up to 88% of unstable malleolar ankle fractures.[22] However, the role and utility of ankle arthroscopy at the time of ORIF remains undefined because of a lack of evidence demonstrating an association with improved outcomes.[7] In this study, we found no significant difference in intermediate-term patient-reported outcomes using PROMIS physical function and pain interference, which are validated outcome scores. These findings are consistent with one prior similar investigation that reported an 88% rate of articular surface injuries using ankle arthroscopy, but had a low rate of intervention and did not find improved outcomes compared to ORIF without arthroscopy.[22] Conversely, one other study found that AOFAS outcome scores were significantly higher (91.0 versus 87.6) in patients who underwent ankle arthroscopy at the time of ORIF, at an average follow-up of 3 years.[20] However, this result may have been confounded by other variables; in particular an assessment of syndesmotic stability and subsequent stabilization (if indicated) was performed only in the arthroscopy group.

Our overall rate of articular surface injuries was 62%, which is similar to previous investigations including that by Loren et al which reported an overall rate of 63%.[14] For

AO/OTA B ankle fractures, the rate of articular surface injuries was 54%, whereas the rate was 75% for AO/OTA C fractures. This difference however was not statistically significant. Hintermann et al reported a significantly higher rate of chondral lesions in AO/OTA C fractures than AO/OTA B.[8] Leontaritis et al retrospectively reviewed operative reports of 283 unstable ankle fractures that underwent ORIF and ankle arthroscopy and evaluated the correlation of articular surface lesions with fracture severity according to the Lauge-Hansen classification system.[12] They found that more severe ankle fractures (supination external rotation IV and pronation external rotation IV) were associated with a higher rate of articular surface lesions. Our study found that articular surface lesions were identified in 65% of ankle fractures with syndesmotic instability, and only 43% of fractures with a stable syndesmosis. This difference did not reach statistical significance, though previous studies have shown significant associations between cartilage lesions and syndesmotic injury.[14]

In a subgroup analysis within the ankle arthroscopy group, there were worse outcomes for patients found to have chondral lesions during ankle arthroscopy, only according to the Olerud and Molander scoring system. No significant difference was found in either the PROMIS physical function or pain interference scores. It must be noted that this finding was not the primary objective of this study, and there may not have been an adequate number of patients who underwent ankle arthroscopy to detect a statistically significant difference that may exist. Lantz et al reported poorer outcomes in patients with concomitant talar articular cartilage injuries in the setting of acute ankle fracture.[11] Long-term follow-up of a large cohort of ankle fracture patients who had undergone arthroscopy at time of ORIF showed that poor clinical outcomes and radiographic evidence of osteoarthritis were associated with anterior and lateral talus lesion as well as medial malleolus lesions.[19] Conversely, another study did not find a difference in pain or function outcomes in ankle fracture patients found by preoperative MRI to have articular surface injuries, despite that these chondral lesions were not intervened upon in any manner.[2] In a study of patients with chronic, persistent pain following ankle fractures, arthroscopy revealed a 90% rate of articular surface injuries.[21]

Although our results do not support the use of ankle arthroscopy to improve functional outcomes, they do demonstrate that it is a safe adjunctive procedure in the setting of ankle fracture. We did not find that the addition of arthroscopy resulted in significantly increased wound or nerve complications according to chart review. There were no incidences of compartment syndrome secondary to fluid extravasation from arthroscopy, which is a recognized complication in the setting of acute injury.[10] We also did not find an association between use of ankle arthroscopy and patient-reported residual dorsal foot numbness. Lastly, we found that the addition

of arthroscopy added only minimal operative time (15 minutes) to the operative treatment of ankle fractures.

Limitations of this study include its retrospective design and the biases that accompany this type of study. As this was a retrospective study, we were unable to obtain preoperative functional scores to help determine whether our 2 groups were comparable at baseline. Additionally, our follow-up rate was 55% and the number of patients lost to follow-up may have introduced additional selection bias into our results. This study was adequately powered to detect an 8 point difference in PROMIS physical function and pain interference. The minimal clinically significant difference has not been established for PROMIS and if a less than 8-point difference was determined to be clinically significant, this study would be underpowered to detect such a difference. Lastly, we did not have long-term radiographic or clinical examination follow-up to correlate to our patient-reported functional outcomes. It is not our practice for patients to continue to follow-up after fracture union, and as a result most patients did not have radiographs or physical examinations beyond 6 months postoperatively.

Conclusion

At intermediate-term follow-up of patients with unstable ankle fractures and intact medial malleoli, functional outcomes were not significantly improved in patients who underwent ankle arthroscopy. There were no increased complications associated with ankle arthroscopy, and total operative time was increased by an average of only 15 minutes. Ankle arthroscopy was a safe adjunctive procedure to open reduction internal fixation but cannot be recommended to improve functional outcomes based on the findings of this study.

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