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Outcomes Following Ankle Fracture Fixation With or Without Ankle Arthroscopy

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Abstract

Background: Ankle fractures are one of the most common orthopedic injuries, and although most patients have a satisfactory outcome following operative fixation, there are patients that have persistent pain despite anatomic reduction. Intra-articular injuries have been suggested as one potential cause of these suboptimal outcomes. Our study assesses the clinical impact of performing an ankle arthroscopy during ankle fracture open reduction and internal fixation (ORIF).

Methods: This was a retrospective chart review of all patients who underwent operative fixation of a bimalleolar or trimalleolar ankle fracture at our institution from 2014 through 2018. We extracted all demographic data, fracture pattern, operative procedures performed, tourniquet times, arthroscopic findings and any arthroscopic interventions. We then conducted a phone and e-mail survey. Our study included 213 total patients (142 traditional ORIF, 71 ORIF plus arthroscopy) with an average age of 40 years. The average follow-up was 32.4 months with a survey follow-up rate of 50.7% (110/213).

Results: The average tourniquet time for the arthroscopy cohort was 10 minutes longer (89 minutes vs 79 minutes). During the arthroscopy, there was a 28% (20/71) rate of full-thickness osteochondral lesions, 33% (24/71) rate of loose bodies, and a 49% (35/71) rate of partial-thickness cartilage injury. The mean Patient Reported Outcome Information System (PROMIS) physical function score among Weber B fibula fractures was 45.8 and 42.3 in the arthroscopy and nonarthroscopy groups, respectively ($P = .012$). In addition, the patient satisfaction rate in Weber B fibula fractures was higher in those patients who underwent arthroscopy compared with ORIF alone (93% vs 75%, $P = .05$). Patients who had a tibiotalar joint dislocation at the time of the ankle fracture had a significantly higher PROMIS physical function score (46.6 vs 40.2, $P = .005$) when their surgery included arthroscopy.

Conclusion: Ankle arthroscopy at the time of ORIF led to statistically significant improvements in patient-reported outcomes for Weber B fibula fractures and ankle dislocations. There was no increase in complication rates and the arthroscopy took 10 minutes longer on average.

Level of Evidence: Level III, retrospective cohort study.

Keywords: ankle arthroscopy, ankle fracture, PROMIS

Introduction

Rotational ankle fractures are among the most commonly treated orthopedic injuries.[4] Open reduction and internal fixation (ORIF) remains the gold standard treatment for unstable injuries, and studies from as early as 1965 and 1985 have shown good to excellent results in a large number of patients.[3,13] However, there is still a subset of patients who do not achieve satisfactory results despite appropriate treatment with anatomic reduction of the fracture. One large

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systematic review including 1822 patients showed that 21% of patients had a fair or poor outcome at an average of 5.1 years postoperation despite optimally reduced fractures.[16] One possible explanation for this group of patients failing to achieve satisfactory results is concomitant intra-articular injury occurring at the time of the ankle fracture. The rate of intra-articular injury associated with a rotational ankle fracture has been reported to be as high as 63% to 79% in some studies.[8,14] However, there is no consensus on what the role of arthroscopy should be in the management of acute ankle fractures.

Several studies have reported on the incidence of chondral lesions seen during arthroscopy at the time of ankle fracture ORIF, but those studies largely report the role of arthroscopy as a diagnostic or predictive tool for patient outcome. Very few studies have discussed the rates of arthroscopic intervention, the procedures performed, and the association of these procedures with patient outcomes. The purpose of this study was to investigate the rate of chondral pathology and other intra-articular injuries in ankle fracture patients and compare the clinical and radiographic outcomes of the patients who underwent arthroscopy at the time of ankle fracture ORIF with those patients who did not. Our hypothesis was that patients who underwent arthroscopy at the time of ankle fracture ORIF would have better patient-reported outcomes scores compared with ORIF without arthroscopy.

Methods

After obtaining Institutional Review Board approval, we performed a retrospective chart review on all patients who underwent open treatment of a rotational ankle fracture in our health system with or without the use of concomitant ankle arthroscopy at our institution since January 1, 2014. We only included Danis-Weber classification B or C fibula fractures. We excluded those patients with other injuries who required operative intervention, patients younger than 18 years, patients with a tibial plafond axial load injury, and patients who were lost to follow-up prior to radiographic union of the fracture. A power analysis was performed using an alpha of 0.05 and a beta of 0.20. Forty-seven and 94 patients would be required in the 2 groups to show a 5-point difference in Patient Reported Outcome Information System (PROMIS) score with an anticipated standard deviation of 10.

We recorded each patient's demographic data, the mechanism of injury, the presence or absence of dislocation based on original injury radiographs, and/or documentation in the history and physical office note, significant comminution (more than one butterfly fragment), medial malleolus fracture, and/or posterior malleolus fracture. In addition, we recorded the total tourniquet and anesthesia times. We then recorded all procedures performed, including whether or not an arthroscopy was performed. If arthroscopy was performed, we reported on the presence of intra-articular pathology and any additional arthroscopic or arthroscopically assisted procedures performed. Lastly, we looked at the final follow-up radiographs to determine the Kellgren-Lawrence scale of osteoarthritis and to assess the final outcome of the fracture, labeling them as either nonunion, malunion, or union.[10]

Table 1. Demographic Data.

Characteristic	ORIF with Arthroscopy (n = 71)	ORIF Alone (n = 142)	*P* Value
Age, y, mean	39.9	40	.940
Gender, n (%)			.098
Male	38 (53.5)	59 (41.5)	
Female	33 (46.5)	83 (58.5)	

Abbreviation: ORIF, open reduction internal fixation.

Table 2. Injury Mechanism and Fracture Pattern.

Injury mechanism	n (%)	n (%)	*P* Value[a]
Fall	46 (64.8)	106 (74.6)	.134
Sports	21 (29.6)	31 (21.8)	.214
Motor vehicle	4 (5.6)	5 (3.5)	.469
Fracture pattern			
Weber B	54 (76.1)	104 (73.2)	.677
Weber C	17 (23.9)	38 (26.8)	.677
Medial malleolus	19 (26.8)	59 (43.7)	**.017**
Dislocation	16 (22.5)	32 (22.5)	.927
Syndesmosis injury	40 (47.9)	61 (35.2)	.065

[a]Boldface indicates statistically significant difference.

Our chart review included 213 total patients with a 2:1 ratio between the ORIF alone group and the ORIF plus arthroscopy group. The complete demographic data for the 2 groups can be found in Table 1. The study included 142 traditional ORIF and 71 ORIF plus arthroscopy patients with an average age of 40. The injury mechanism and descriptive data for the fracture patterns can be found in Table 2. The 2 groups were statistically similar for every variable except for percentage of medial malleolus fractures, which was slightly higher in the ORIF alone group. Overall, the fractures were classified as Weber B in 74% (158/213) of patients and Weber C in the other 26% (55/213). The average follow-up was 32.4 months with a survey follow-up rate of 51% (110/213). Overall, 94% (210/213) of patients underwent fibula ORIF (the remaining 6% were proximal Weber C fractures that were treated only with syndesmosis stabilization). Thirty-five percent of patients (75/213) had an ORIF of the medial malleolus, 9% (20/213) underwent ORIF of the posterior malleolus, and 47% (101/213) of patients had stabilization of their syndesmosis. Sixty-two percent (63/101) of the syndesmotic repairs were with a screw construct whereas the other 38% (38/101) used suture button fixation. There were differences between the 2 groups in regard to fixation construct, with the ORIF plus arthroscopy group

having a higher rate of flexible fixation (65% vs 20%, $P < .001$). There were an additional 20 procedures performed on the total group during the initial fracture ORIF. This included 16 patients who had a deltoid repair, 3 patients who had a lateral ligament repair, and 1 patient who underwent a superficial peroneal nerve repair.

We then contacted the study patients via an e-mail or telephonic survey. We first sent an e-mail link to our survey to all patients who had a recorded e-mail address on file. We then sent out a reminder e-mail 1 week later for a total of 2 e-mails per patient. After a 2-week period to collect e-mail survey responses, we began systematically calling patients who had not completed the e-mail survey. We called each patient 3 times and left voicemails for those patients who did not answer. We used the PROMIS Global Health Short Form and the 2 question PASS scale as our selected patient-reported outcome scores.[2,7] In addition, we asked the patients whether they had undergone any additional procedures on the operative ankle, including removal of hardware, ankle arthroscopy with or without "cartilage" procedure, revision fixation of the fracture, and ankle fusion or replacement. We then used a Student *t* test to assess differences between continuous variables and either chi-square test or Fisher exact test to examine the differences between categorical variables.

Operative Technique

The operative technique and postoperative protocol was similar for all patients. Informed consent was obtained prior to all cases. Standard pre-incision antibiotics were administered, and patients were placed under general anesthesia. Whether or not a patient underwent arthroscopy was based solely on surgeon preference. For those patients who underwent ORIF plus arthroscopy, we started with a standard ankle arthroscopy. A thigh tourniquet was used at a pressure of 250 mmHg. A leg holder and ankle joint distractor were used. We started with the anteromedial portal and introduced the 2.7-mm scope into the ankle joint. Next, under direct visualization, and taking care to preserve any branches of the superficial peroneal nerve, we created the anterolateral portal. We then carried out a standard diagnostic ankle arthroscopy taking note of any chondral lesions, loose bodies, or other ligamentous injuries. Small or partial-thickness cartilage lesions underwent a simple debridement or chondroplasty. Larger, full-thickness lesions underwent a microfracture procedure with or without allograft cartilage matrix (BioCartilage; Arthrex, Naples, FL).

The operative procedure for the open reduction and internal fixation was similar among all study patients. Posterior malleolus fractures were addressed when more than 25% of the tibial plafond was affected. The fibula fractures were fixated using either a posterolateral or direct lateral incision. Lag screws were used when the fracture pattern allowed, and all fractures were also treated with a neutralization or antiglide plate depending on the pattern and approach. If a medial malleolus fracture was present, this was addressed via a direct medial incision. These fractures were either fixated with cannulated screws or a plate and screw construct depending on the fracture pattern. Once all bony injuries were stabilized, a Cotton test was performed under live fluoroscopy to determine syndesmosis stability. If warranted, the syndesmosis was stabilized using either fully threaded screws or a suture button fixation.

All patients were then placed in a splint with restricted weight bearing for either 2 or 6 weeks, based on surgeon preference and fracture pattern. Patients were routinely seen in the clinic at 2 weeks, 6 weeks, 3 months and 6 months postoperatively. Radiographs were typically obtained at each of the postoperative visits. Depending on the fracture and the fixation construct, ankle range of motion exercises were either begun at 2 weeks or 6 weeks.

Results

We found a 28% (20/71) rate of full-thickness osteochondral defects (OCDs) during the arthroscopy, with another 49% (35/71) of patients having a small cartilage defect not requiring intervention for a total cartilage injury rate of 77% (55/71). We also found a 33% (24/71) rate of clinically significant loose bodies requiring removal. In total, the arthroscopy portion of the procedure led to 48% (34/71) of patients undergoing an arthroscopic intervention.

The 2 groups had different subspecialist representation. The ORIF plus arthroscopy group was composed of 100% foot and ankle fellowship-trained surgeons whereas the traditional ORIF group had a mixture of 51% (72/142) trauma fellowship–trained surgeons, 31% (44/142) other (including general orthopedics and other subspecialty training), and 18% (26/142) foot and ankle. The mean tourniquet time for the ORIF alone group was 79 minutes, and it was 89 minutes in the ORIF plus arthroscopy group ($P = .065$). Ninety-seven percent (138/142) of the ORIF alone group, and 94% (67/71) of the ORIF plus arthroscopy group had Kellgren-Lawrence scores of 0 or 1 at a mean radiographic follow-up time of 6.1 months and 8.6 months, respectively. In addition, at final radiographic follow-up, the ORIF plus arthroscopy group had one malunion and 2 nonunions. The ORIF alone group had 2 malunions and 2 nonunions. These rates were not statistically significant.

The overall complication rate was 8.0% and was equivalent between the 2 groups. This included 5 patients with deep venous thromboses, 5 patients with loss of reduction or breakage of hardware, 4 patients with infection requiring antibiotics, and one patient each with a lower extremity amputation, an ankle replacement, and severe reflex sympathetic dystrophy. In addition, 3 patients of the 108 who completed the survey reported undergoing an additional procedure on their ankle at a different institution. This represented 2 procedures for removal of hardware and 1 revision ORIF.

Table 3. Subgroup PROMIS Scores.

	Number of Responses	Physical Means	Mental Means	Number of Responses	Physical Means	Mental Means	*P* Value, Physical	*P* Value, Mental
Weber B	49	42.4	45.9	29	45.9	47.8	.01	.12
Weber C	22	43.4	46.9	7	41.0	44.2	.3	.35
Dislocation	17	40.2	45.1	10	46.6	47.9	.01	.31
Syndesmosis	30	42.7	45.3	19	44.3	47.2	.3	.21
Medial malleolus fracture	24	41.9	46.0	11	43.1	47.2	.58	.57

Abbreviation: PROMIS, Patient Reported Outcome Information System.

The mean PROMIS global health physical function score was 42.7 and 44.9 in the ORIF alone and ORIF plus arthroscopy groups, respectively ($P = .064$). The mean PROMIS global health mental health score was 46.2 and 47.1, respectively. Eighty-nine percent of the ORIF alone group considered their surgery a success compared with 97% of the ORIF plus arthroscopy group. Seventy-eight percent of the ORIF group were satisfied with the function of their ankle compared with 89% satisfaction in the ORIF plus arthroscopy group. Although these satisfaction rates trended toward statistical significance, neither reached a *P* value less than .05.

Subgroup analysis revealed several statistically significant findings (Table 3). When looking only at the Weber B fibula fractures, the patient satisfaction rate among those who underwent arthroscopy was significantly higher than those who underwent ORIF alone (93% vs 75%, $P = .05$). These patients also had a higher PROMIS physical function score (45.9 vs 42.4, $P = .012$). In addition, when looking at patients who had a tibiotalar joint dislocation at the time of the ankle fracture, those patients who underwent arthroscopy had a significantly higher PROMIS physical function score (46.6 vs 40.2, $P = .005$), and these patients trended toward a higher overall satisfaction (90% vs 56%) with a *P* value of .098. Interestingly, those patients who underwent an intervention because of the arthroscopic portion of the procedure had a significantly higher PROMIS physical function score compared with those patients who underwent ORIF alone (46.5 vs 42.7, $P = .009$). Lastly, those patients treated by a foot and ankle fellowship-trained surgeon had a higher satisfaction rate as compared to those patients treated by all other subspecialists (98% vs 87%, $P = .038$).

When comparing arthroscopic findings among the various injury patterns, we did not find any predictors for which patients were more likely to have a cartilage injury or loose body. In addition, we were unable to link any preoperative factors to a higher likelihood of having an arthroscopic intervention. The only significant finding was that Weber C fibula fractures were less likely to have a loose body noted on arthroscopy (6% vs 43%, $P = .005$).

Discussion

Despite the growing amount of literature that demonstrates a high rate of intra-articular pathology associated with an acute ankle fracture, there is no consensus on how best to treat these patients. The majority of patients treated with ankle fracture ORIF have good to excellent outcomes, but clinicians do not currently have a way to predict those patients who are more likely to have poorer outcomes.[3,13] This study is the largest study to date that compares patient-reported outcomes in patients who underwent an ankle fracture ORIF with or without concomitant arthroscopy. We demonstrated a high incidence of intra-articular pathology and that in a subgroup of these patients, arthroscopy was associated with better clinical outcomes and higher satisfaction.

Prior studies have reported intra-articular pathology rates between 63% and 79%.[8,13] Our results mirror these earlier studies with an articular cartilage injury rate of 77.5%. Where our study is different is in reporting the rate and specific procedures associated with the arthroscopy. Many of the previous studies only report the arthroscopic findings without mention of any intervention. Of the 71 patients who underwent arthroscopy at the time of the ankle fracture ORIF, 34 (47.9%) had an arthroscopic intervention beyond the standard debridement of synovitis and fracture hematoma. This included 24 loose body removals, 7 microfracture procedure of talus OCDs, 2 allograft cartilage implantations, and 1 arthroscopic bone spur removal. Interestingly, despite having pathology that required this arthroscopic intervention, these patients had a significantly higher PROMIS physical function score compared to those patients who underwent traditional ORIF alone (46.5 vs 42.7, $P = .009$).

There have been few prior studies that have directly compared patient-reported outcomes after ankle fracture ORIF treated with or without arthroscopy. Thordarson et al performed a randomized controlled trial in 2001 whereby patients were randomized to undergo either standard ORIF treatment of their ankle fracture or ORIF plus an ankle arthroscopy.[18] They found no difference in SF-36 scores or Musculoskeletal Outcomes Data Evaluation and Management Systems (MODEMs) score at a mean follow-up of 21 months. However, the entire study included only 19 patients, and with this small a sample size it is difficult to make any conclusions about the findings. In contrast, Takao et al completed another randomized controlled trial in 2004 of a total of 72 patients.[17] They found a significant improvement in AOFAS scores at a mean of 40.5 months

postoperatively in those patients who underwent arthroscopy at the time of the ankle fracture ORIF. Fuchs et al performed a retrospective chart review on 93 patients treated for ankle fracture ORIF, 42 of whom had undergone concomitant ankle arthroscopy.[5] They compared the PROMIS scores of those patients against the 51 patients who underwent standard ORIF alone. They found no difference in PROMIS scores or Olerud and Molander scores at an average of 67 months. However, this study only had 24 patients in the arthroscopy group available for follow-up and thus may have been underpowered to show a difference in patient-reported outcomes if indeed one existed.

Although there are few individual studies comparing ankle fracture ORIF with and without arthroscopy, there has been one meta-analysis and one systematic review of the literature. Lee et al performed a meta-analysis that included 4 studies and a total of 188 patients.[12] They found a pooled effect size of 0.546 in favor of arthroscopically assisted ORIF. In contrast, Gonzalez et al completed a systematic review of the literature and included 18 studies with a total of 465 patients treated with ORIF alone and 176 treated with ORIF plus arthroscopy.[6] Although they did conclude there was fair-quality (grade B) evidence that traditional ORIF alone can deliver good to excellent outcomes and that ankle arthroscopy can successfully identify and treat intra-articular injuries associated with acute ankle fractures, they found insufficient evidence (grade I) that this approach portends any improvement in functional outcomes compared with traditional methods.

Our 2 groups did have different rates of syndesmotic injury, although this difference did not reach statistical significance. In addition to this difference, the ORIF plus arthroscopy group has a much higher rate of suture button fixation over screw fixation of the syndesmosis vs the ORIF alone group (65% vs 20%, $P < .001$). Although there are a few high-quality studies that have shown a statistically significant improvement in patient-reported outcomes with flexible fixation, when looking at our data, the type of syndesmosis fixation does not explain the outcomes differences we found in the arthroscopy group.[1,11] In fact, in our study, the patients who received screw fixation of their syndesmosis trended toward higher patient satisfaction although this did not reach statistical significance (89% success rate vs 83% in the flexible fixation group, 82% satisfaction vs 78% in the flexible fixation group; P value .49 and .70, respectively). Thus, despite this difference in syndesmosis fixation and the literature that supports improved outcomes with flexible fixation, this difference alone does not explain the patient-reported outcomes differences seen between our groups.

Some of the concerns regarding adding an arthroscopy to ankle fracture ORIF include increased operative time and increased complication rate. In our study, the arthroscopy added only 10 additional minutes of tourniquet time (89 vs 79 minutes), and this difference was not statistically significant. This is similar to prior studies that showed a 15- to 20-minute increase with arthroscopy when added to ORIF.[5,19] Regarding the complication rate, we did not see any increase when arthroscopy was added to the ORIF. This is consistent with many of the other studies on this topic, which did not report any difference in complication rates.[8,15,18] Despite the lack of increase in overall complication rate, there are specific complications unique to the ankle arthroscopy. A 2018 systematic review of 55 studies found a complication rate between 3.4% and 9% of ankle arthroscopy, the majority of which are superficial peroneal nerve injuries due to portal placement.[20] In addition, there is a case report of an arthroscopically assisted reduction of a Maisonneuve fracture leading to a compartment syndrome requiring urgent fasciotomy.[9]

Our study has several limitations. The retrospective nature of the study introduces potential bias. Although the 51% survey response rate is relatively high compared to many retrospective studies on trauma, it still means that about half the total patients in the present study are not represented in the final comparison of patient-reported outcomes. In addition, despite this being the largest study to date to compare these 2 operative interventions, the patient numbers in several of the subgroups were relatively small, making the study likely underpowered for certain subgroup analyses. Lastly, it is routine in our institution to discontinue radiographic follow-up once the fracture is healed, and thus it is difficult to assess the rate of radiographic post-traumatic arthrosis with the available images.

Conclusions

We found that patients treated with ankle arthroscopy in addition to ORIF for a rotational ankle fracture had a statistically significant improvement in patient reported outcomes in patients with Danis-Weber classification B fibula fractures and ankle joint dislocations. These improvements were small and may not reach minimal clinically important differences (MCID) as this is not well defined for the chosen metrics. In addition, we found that 77% of patients undergoing arthroscopy as part of ankle fracture treatment had evidence of chondral or osteochondral injury, and most of these underwent a concomitant procedure to address the cartilage injury. Ankle arthroscopy was a useful adjunct to traditional ORIF and may improve outcomes without a significant increase in operative time and no change in complication rate.

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