Prevalence and associated factors of intra-articular lesions in acute ankle fractures evaluated by arthroscopy and clinical outcomes with minimum 24-month follow-up

Xing-Zuo Chen, Ying Chen, Qian-Zheng Zhu, Li-Qiang Wang, Xiao-Dong Xu, Peng Lin

Department of Orthopedic Surgery, China-Japan Friendship Hospital, Beijing 10029, China.

Abstract

Background: Acute ankle fractures can lead to high rate of concomitant intra-articular lesions which may compromise clinical results. The purpose of this study was to evaluate the Prevalence of concomitant intra-articular lesions in acute ankle fractures with arthroscopy. We also sought to analyze the relationship between intra-articular lesions and the fracture type, as well as the severity of the fracture.

Methods: It was a retrospective cohort study. From April 2014 to December 2015, we have chosen arthroscopy-assisted open reduction and internal fixation (AORIF) for the treatment of unstable acute ankle fractures. All concomitant intra-articular lesions were assessed and documented carefully and prospectively, such as ligament injuries, osteochondral lesions, and tibiofibular syndesmosis injuries. All fractures were classified according to the Lauge-Hansen classification system. The American Orthopedic Foot and Ankle Society's (AOFAS) ankle-hindfoot scale was used to assess post-operative function. Statistical comparisons between the intra-articular lesions, the fracture type, and the severity of the presenting fracture were performed using a Chi-squared analysis.

Results: Data of 36 patients were analyzed in the study, including 23 supination-type fractures and 13 pronation-type fractures. The incidence of tibiofibular syndesmosis injuries, chondral lesions, and loose bodies were 92%, 72%, and 39%, respectively. Avulsion fractures of the anterior tibiofibular syndesmosis were more commonly found in supination-type fractures than pronation-type fracture (45% *vs.* 15%, $\chi^2 = 5.78$, $P = 0.02$), which would cause mechanical blocking in the anterior portion of the ankle. On the contrary, chondral lesions were more commonly found in the more severe fractures than mild fractures (86% *vs.* 53%, $\chi^2 = 4.57$, $P = 0.03$). A mean 41.7 months (range, 33.0–51.0 months) of follow-up was achieved. A mean AOFAS's ankle-hindfoot scale was 96.9, and 97.2% of the patients were satisfied with the procedure.

Conclusions: Acute ankle fractures have a high incidence of concomitant intra-articular lesions. Avulsion fractures of the anterior tibiofibular syndesmosis are more commonly found in supination-type fractures. Chondral lesions are related to the severity of the fractures, but not with the classification of the fractures. AORIF can be one reliable solution in dealing with the associated injuries seen with acute ankle fractures.

Keywords: Ankle fracture; Soft-tissue injuries; Arthroscopy

Introduction

Unstable ankle fractures are generally treated with open reduction and internal fixation (ORIF). However, residual symptoms, such as chronic pain, recurrent swelling, and limited range of motion, continue to occur unpredictably even with anatomical surgical reduction and ideal healing, which can compromise the clinical outcome and patient satisfaction. In severe cases, a second surgery may be required for desirable results.[1-5] Untreated intra-articular lesions caused by acute ankle fractures may be one of the major factors that hinder the recovery after ORIF.[4-6] Arthroscopy-assisted open reduction and internal fixation (AORIF) for acute ankle fractures has been utilized as an adjunct to traditional ORIF, which provides an ideal solution for evaluating and treating concomitant intra-articular lesions.[3,4,6-10] However, the differentiation of what factors in acute ankle fractures that may lead to intra-articular lesions is still unclear. A previous study reported that only 79.3% of the optimally reduced fractures show good to excellent long-term outcomes, and those outcomes did not necessarily correlate to the severity of the fracture.[1]

The purpose of this study was to evaluate the prevalence of the concomitant intra-articular lesions in acute ankle fractures with arthroscopy and to analyze the relationship between the intra-articular lesions and the fracture type, as well as the severity of the fracture. We hypothesized that

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Correspondence to: Dr. Peng Lin, Department of Orthopedic Surgery, China-Japan Friendship Hospital, No. 2, Ying Hua East Street, Chao Yang District, Beijing 10029, China
E-Mail: 13051988292@163.com

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acute ankle fractures would have a high prevalence of concomitant intra-articular lesions, and chondral lesions were related to the severity of the fractures.

Methods

Ethical approval

The study was approved by the Ethics Committee of the China-Japan Friendship Hospital (No. 2019-84-k55). Informed written consent was obtained from all the patients.

Patient demographics

It was a retrospective cohort study. From April 2014 to December 2015, a total of 37 consecutive patients with acute unstable ankle fractures underwent AORIF. However, one patient had congenital talipes equinovarus and was excluded from the study. Therefore, 36 patients were analyzed in this study, which consisted of 14 male patients and 22 female patients. The average age of the patients at the time of injury was 47 years (range, 20–78 years). A total of 18 fractures were left sided, and 18 were right sided. The mechanism of injury included ankle sprain in 31 patients and traffic accidents in five patients. The average time from injury to surgery was 4.8 days (range, 6 h to 13.0 days).

The inclusion criteria included acute unstable ankle fractures treated with AORIF. The exclusion criteria consisted of the following: chronic ankle fractures, previous trauma history, or deformity of the involved limb, Pilon fractures.

Surgical technique

All patients signed the consent form prior to the surgical procedure. The operative procedure was performed under general or spinal anesthesia. Patients were placed in a supine position without applying a traction system. A pneumatic tourniquet was routinely used. Surface anatomy was carefully outlined in all cases, especially when patients presented with swelling of the ankle.

Standard anteromedial and anterolateral portals were made after fracture fixation. Gravity flow was routinely used. A motorized shaver with suction was carefully used to remove the hematomas, fracture debris, and traumatic synovitis in the joint, to make it easier to observe the intra-articular structures.

Chondral lesions were carefully inspected, and any unstable chondral flaps were removed [Figure 1A]. Size

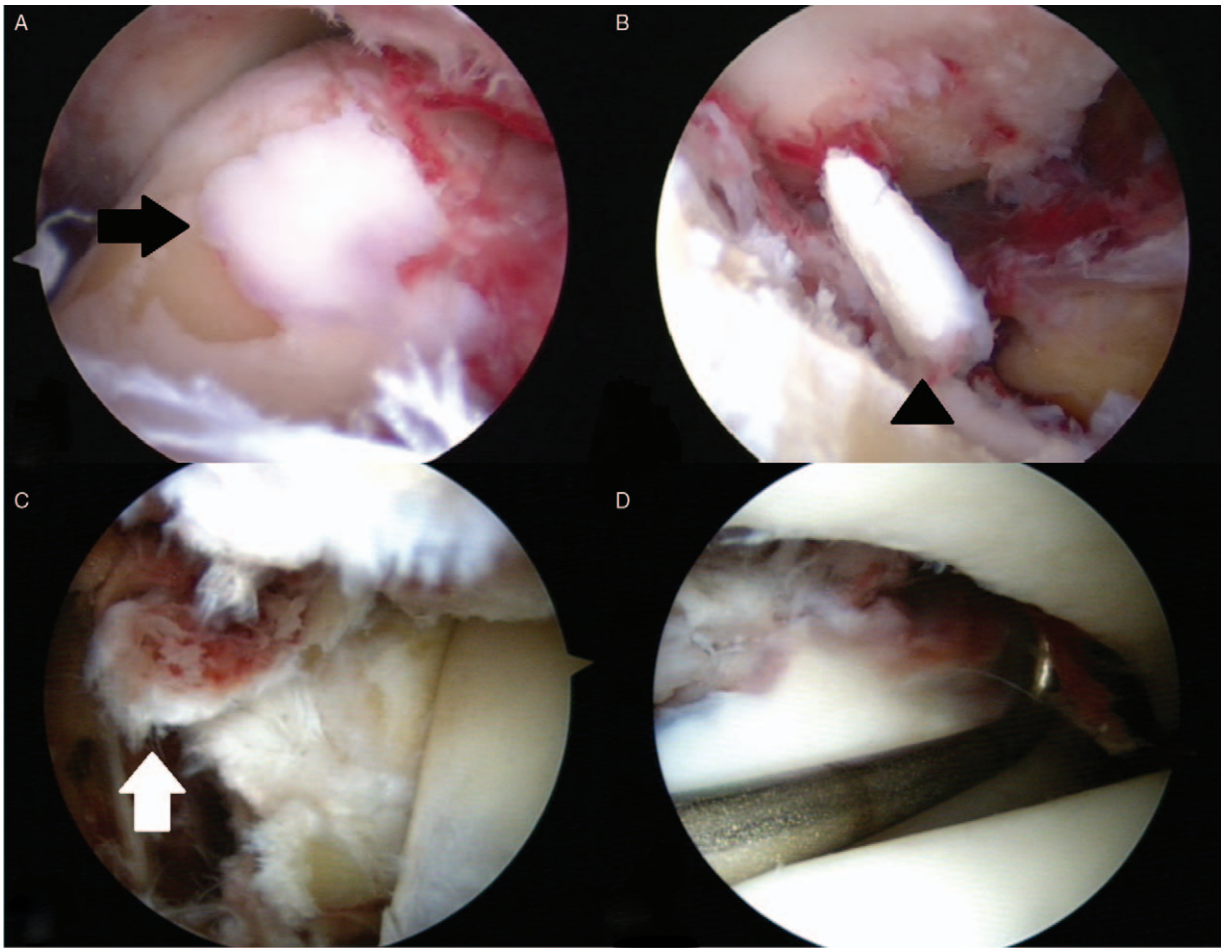

Figure 1: Concomitant intra-articular lesions in acute ankle fractures. (A) Chondral lesion in acute ankle fracture. The chondral lesion from the anterior portion of the talus (black arrow). (B) Loose body in acute ankle fracture. Loose body in an anterior portion of the ankle joint (black arrowhead). (C) Tillaux fracture (white arrow). (D) Unstable tibiofibular syndesmosis injury in acute ankle fracture. Widen of the tibiofibular syndesmosis imply unstable tibiofibular syndesmosis injury.

and position of the chondral lesions, as well as the severity of the damage, was documented according to the Outerbridge classification system (grade 0, normal cartilage; grade I, cartilage with softening and swelling; grade II, a partial-thickness defect with fissures on the surface that do not reach subchondral bone or exceed 1.5 cm in diameter; grade III, fissuring to the level of subchondral bone in an area with a diameter more than 1.5 cm; grade IV, exposed subchondral bone). Shaving, ablation, curetting, and microfracture were performed when appropriate. Anterior ankle impingement was evaluated by flexion and extension of the joint repeatedly, and a motorized bur was used to remove the presence of any bony spur if impingement existed. The severity of the lacerations of the anterior capsule and the presence of loose bodies were documented [Figure 1B].

In the medial aspect, the continuity of the deep layer of the deltoid ligament was assessed. Reduction of the medial malleolus was visualized and checked for any residual displacement in medial malleolus fracture cases.

In the lateral aspect, the anterior inferior tibiofibular ligament (AITFL) was checked for ligamentous injuries or the presence of a bony avulsion fracture [Figure 1C]. The stability of the tibiofibular syndesmosis was examined in the coronal and sagittal planes [Figure 1D]. Cases of unstable syndesmosis were reduced under fluoroscopic and arthroscopic guidance and fixed by one or two cortical screws by purchasing three cortices. In AITFL bony avulsion fracture cases, the stability of the tibiofibular syndesmosis was rechecked after fixation. If it was stable, we then removed the bony fragments; otherwise, a trans-osseous screw was used for fixation in these cases. The anterior talofibular ligament was also evaluated for integrity.

Clinical evaluation

Fractures were classified according to the Lauge-Hansen classification system. All intra-articular lesions were well documented, including deltoid ligament injuries, anterior capsule lacerations, syndesmosis injury and stability, the presence of a loose body or bony avulsion fractures, and chondral lesions. We defined supination-external rotation (SER) type IV, pronation-external rotation (PER) type IV, and pronation-abduction type II as severe fractures, while others were classified as mild fractures.

The American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale was used to assess postoperative function. All the patients were asked whether they were very satisfied/satisfied/disappointed/very disappointed with the procedure at the last follow-up evaluation. All the data were collected retrospectively.

Statistical analysis

Statistical comparisons between the intra-articular lesions, the fracture type, and the severity of the fracture were performed using Chi-squared analysis. The level of clinical significance was set at $P = 0.05$. All statistical analyses were performed using SPSS 24.0 (SPSS Inc., Chicago, IL, USA).

Results

Data of 36 patients were analyzed in this study. According to the Lauge-Hansen classification, 23 fractures were supination type, and 13 fractures were pronation type. For the 23 supination-type fractures, three were SER type II, five SER type III, and 15 SER type IV. For the 13 pronation-type fractures, two were PER type II, three PER type III, four PER type IV, two pronation-abduction type II, and two were Maisonneuve fractures. Therefore, 21 fractures were classified as severe fracture, and 15 fractures were mild fracture. Debridement was performed in all cases. No severe complications were detected. The single notable occurrence was that one patient suffered from temporary superficial peroneal nerve irritation, which resolved within 7 days spontaneously.

Chondral lesions were noted in 26 of 36 patients. The most commonly affected place was the talar dome. Twenty of 26 ankles had outerbridge grades III to IV chondral lesions. Ten of 26 ankles had two or more sites of chondral lesions. The size of the chondral lesions that were larger than 0.5 cm × 0.5 cm was found in 17 of 26 ankles studied.

Unstable tibiofibular syndesmosis injuries were diagnosed in 15 of 36 patients, and most cases were pronation-type fractures (12/15). All of the 15 patients received a trans-osseous screw fixation. AITFL injuries were found in 33 of 36 patients, which were the most common associated intra-articular lesions. Among the 33 patients, 22 were with ligamentous injury, and 11 were with bony avulsion fractures (Tillaux fracture or Wagstaffe fracture). No anterior talofibular ligament injuries were detected in all cases.

Loose bodies were identified to be present in 14 of 36 patients, including 11 patients with AITFL bony avulsion fractures. Those were removed from the ankle joint after the tibiofibular syndesmosis was confirmed as stable. Seven ankles had extensive anterior capsule laceration, including one patient who experienced a severely lacerated anteromedial capsule entrapped between the medial malleolus and the talus, which was removed from the medial clear space with a blunt probe.

Compared with supination-type fractures, pronation-type fractures were found more commonly combined with unstable tibiofibular syndesmosis injuries ($\chi^2 = 21.47$, $P \leq 0.001$), and the type of AITFL injuries was different between groups [Table 1]. Eleven of 13 patients presented with ligamentous injuries in pronation-type fractures. However, nine of 20 patients presented with bony avulsion fractures in supination-type fractures, including seven patients presenting with Wagstaffe fractures ($\chi^2 = 5.78$, $P = 0.02$). Therefore, supination-type fractures were more commonly combined with a loose body in the ankle joint.

Chondral lesions were more commonly found in severe fractures ($\chi^2 = 4.57$, $P = 0.03$), and there was no statistical difference for the others between the two groups noted [Table 2].

All the patients were reviewed with a mean follow-up of 41.7 months (range, 33–51 months). All the patients returned to active normal daily lives. No severe compli-

Table 1: Comparison of concomitant intra-articular lesions between fracture types in acute ankle fractures.

Parameters	Pronation fracture ($n = 13$)	Supination fracture ($n = 23$)	χ^2	*P*
Chondral lesion	8	18	1.16	0.28
Grade III or grade IV	7	13	0.73	0.39
>0.5 cm × 0.5 cm	5	12	0.04	0.84
Multiple position	3	7	0.01	0.95
Unstable syndesmosis injury	12	3	21.47	<0.001
Anterior tibiofibular syndesmosis injury	13	20	1.85	0.17
Ligamentous rupture	11	11	3.11	0.08
Tillaux fracture	2	2	0.27	0.61
Wagstaffe fracture	0	7	5.78	0.02
Loose body	3	11	2.14	0.14
Deltoid ligament injury	4	7	0	0.98

Data were presented as *n*. Grade III: Fissuring to the level of subchondral bone in an area with a diameter more than 1.5 cm; Grade IV: Exposed subchondral bone.

Table 2: Comparison of concomitant intra-articular lesions between fracture severity in acute ankle fractures.

Parameters	Severe fracture ($n = 21$)	Mild fracture ($n = 15$)	χ^2	*P*
Chondral lesion	18	8	4.57	0.03
Grade III or grade IV	14	6	0.02	0.88
>0.5 cm × 0.5 cm	10	7	2.50	0.11
Multiple position	8	2	0.89	0.35
Unstable syndesmosis injury	8	7	0.26	0.61
Anterior tibiofibular syndesmosis injury	19	14	1.44	0.23
Ligamentous rupture	13	9	0.06	0.80
Tillaux fracture	2	2	0.11	0.74
Wagstaffe fracture	4	3	0	0.98
Loose body	8	6	0.01	0.91
Deltoid ligament injury	9	2	3.59	0.06

Data were presented as *n*. Severe fractures were defined supination-external rotation type IV, pronation-external rotation type IV, and pronation-abduction type II, while others were classified as mild fractures. Grade III: Fissuring to the level of subchondral bone in an area with a diameter more than 1.5 cm; Grade IV: Exposed subchondral bone.

cations were reported. A mean AOFAS's ankle-hindfoot scale was 96.9 (range, 85–100) at the last follow-up, and 97.2% of the patients were satisfied with the procedure. Only one patient complained about occasional ankle pain whose ankle was swollen after 3 km hiking, and the patient was disappointed with the surgery.

Discussion

Acute ankle fractures that are treated with traditional ORIF do not always achieve ideal clinical results. Stufkens *et al*[1] reported 1822 ankle fracture patients who underwent traditional ORIF for a mean follow-up time of 5.1 years in their review. They found that only 79.3% of the optimally reduced fractures show good to excellent long-term outcomes, and those outcomes did not necessarily correlate to the severity of the fracture. Brown *et al*[11] found that 31% of patients had lateral ankle pain after ORIF of ankle fracture in their series. Even after the hardware removal, half of the patients still complained of no relief from the recurrent pain. Intra-articular lesions might be one of the leading reasons that caused this post-operative ankle pain.

Chondral lesions are one of the most common concomitant injuries in acute ankle fractures, and most of these are related to acute injuries.[12] It has been proven that chondral lesions would cause an unfavorable surgical outcome.[2,13] A recent published systematic review[14] showed that the incidence of chondral lesions in acute ankle fractures ranged from 20% to 88%. It was 72% (26/36) in our series. For the patients who had chondral lesions, 77% (20/26) were Outerbridge grade III or IV, 65% were larger than 0.5 cm × 0.5 cm, and 38% (10/26) had two or more sites of chondral lesions.

In this study, chondral lesions presented more commonly in severe fractures than in the cases of mild fractures, which is similar to what Hintermann *et al*[3] and Leontaritis *et al*[4] found. Although it might seem like common sense, however, Aktas *et al*[7] reported that the incidence of chondral lesions was significantly higher in single distal fibula fractures than bimalleolar and trimalleolar fractures in their research. They explained that with less bone damage, the energy of trauma might be directly transmitted from bone to the cartilage which produced more chondral damage. Thomas *et al*[15] performed ankle arthroscopy on patients who suffered from post-operative chronic ankle pain. They also suggested that chondral lesions had no relationship with the severity of the previous fracture. Further studies may be required to solve the discrepancy.

Loren and Ferkel[8] and Thomas *et al*[15] reported that pronation fractures had a higher occurrence rate of chondral lesions than supination fractures. However, there was no statistical difference between chondral lesions and fracture type in the present study. Theoretically, chondral lesions can be caused by indirect torsion force or by direct collision force. Regardless of the difference, pronation or supination fractures are generated from those two kinds of forces that can lead to chondral lesions. Therefore, we believe there should be no difference between the chondral lesion and fracture type.

Ankle arthroscopy is the most sensitive method for diagnosis of tibiofibular syndesmosis injuries which can also aid analysis of different patterns of syndesmosis diastasis and guide anatomic reduction of the syndesmosis. In this study, the incidence of tibiofibular syndesmosis injury was as high as 92% (33/36); however, for unstable tibiofibular syndesmosis injury, it was only 42% (15/36). It is important for us not to over-treat tibiofibular syndesmosis injuries. Only unstable tibiofibular syndesmosis injuries need surgical intervention.

Interestingly, AITFL injuries were not quite the same between pronation and supination fractures. The majority of AITFL among pronation injuries were ligamentous in nature (85%, 11/13), whereas a high proportion (45%, 9/20) was avulsion fractures among supination fractures. Therefore, supination-type fractures had a greater presence of bony fragment at the anterior compartment of the ankle joint. In all of our cases, the stability of the tibiofibular syndesmosis was rechecked after fixation and no unstable cases were found. Therefore, all bony fragments were removed from the joint in case of joint locking or bony impingement. If there was still instability after the fixation, a cortical screw was highly recommended. Based on our findings, we suggest if traditional ORIF is chosen for the treatment of acute ankle fractures, a routine anterior ankle joint exploration should be performed especially in supination fractures.

The biggest advantage of AORIF is an accurate evaluation and proper treatment of the intra-articular lesions without formal arthrotomy. Lavage and debridement of the ankle joint are also considered to be helpful for the recovery of post-operative range of motion. However, whether AORIF would improve the clinical results is still being debated.[14,16] Takao *et al*[9] compared 41 cases of acute ankle fracture treated with AORIF with 31 cases treated with traditional ORIF. At a mean follow-up time more than 3 years, AORIF group showed better clinical results compared with ORIF group. They suggested that precisely diagnosing and treating the combined intra-articular disorders were important for gaining satisfactory clinical results. Turhan *et al*[17] also advocated that AORIF was valuable in the improvement of the clinical outcomes over traditional ORIF. On the contrary, Fuchs *et al*[10] reported that the functional outcomes were not significantly improved in acute ankle fracture patients who underwent ankle arthroscopy. However, they still recommended AORIF for the treatment of acute ankle fracture because no further complications were attributable to arthroscopy and operative time was increased by only 15 min. Our research showed that with arthroscopic debridement of the intra-articular lesions, especially the avulsion fractures, a very good AOFAS score was managed to achieve and that was kept to 41 months.

The main limitation of the present study was we only detected the anterior and the middle portion of the ankle due to the surgical method. Although most of the intra-articular lesions could be evaluated, the structures in the posterior portion of the ankle, such as the posterior inferior tibiofibular ligament, could not be fully evaluated.

In conclusion, acute ankle fractures had an incidence rate of intra-articular lesions equal to 92%. Avulsion fractures of the anterior tibiofibular syndesmosis were more commonly found in supination-type fractures, and inappropriate treatment might influence the clinical outcome. Chondral lesions, which were mostly detected on the talar dome in 72% of the patients, were related to the severity of the fractures, but not with the classification of the fractures. AORIF can be one reliable solution in dealing with the associated injuries seen with acute ankle fractures.

Conflicts of interest

None.

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