OPERATIVE EXPLORATION AND REDUCTION OF SYNDESMOSIS IN WEBER TYPE C ANKLE INJURY

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ABSTRACT

Objective: To investigate the surgical methods in treating Weber type C ankle injury and estimate the necessity of syndesmosis operative exploration. Methods: Forty three patients of Weber type C ankle injury were treated with open reduction and internal fixation from October 2004 to December 2009. Twenty nine patients were treated with routine procedure by open reduction and internal fixation, syndesmosis exploration and repair were performed in addition in the others. Thirty four patients were followed during an average time of 31.2 months (range 18 to 50 months), amomg them 22 patients were treated with routine procedures and 12 were treated with additional syndesmosis surgical exploration. Results: All the fractures were reunited in an average time of 13.1 weeks (range 10 to 18 weeks) and full weight bearing began. The mean ankle and hindfoot scale of the American Orthopaedic Foot and Ankle Society (AOFAS) score was 79.86(range 65 to 98) in the routine procedures group and 86.67 (range 78 to 100) in the syndesmosis exploration group and Olerud-Molander score was 77.27 (range 55 to 100) and 86.67 (range 75 to 100) respectively. Statistically significant difference was found between the two groups ($P<0.05$). Conclusion: Syndesmosis surgical exploration is an essential treatment in some Weber type C ankle injuries, which make debridement and direct reduction of the syndesmosis possible, providing thus a more stabilized ankle joint. ***Level of Evidence III, Retrospective Comparative Study***

Keywords: Ankle injuries/therapy. Ankle injuries/surgery. Ligaments, articular.

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INTRODUCTION

Ankle fractures are among the most common injuries treated by orthopaedic surgeons. The Weber type C ankle fractures is considered most commonly associated with instability of the syndesmosis and has been recognized as one of the causes of prolonged ankle pain.[1] It has become evident that an anatomic reduction of this type fractures is critical for optimal outcomes and that this is best achieved with open reduction. However, the method of treatment is still controversial. In addition to treating the fracture itself, it is imperative to also assess the integrity of syndesmosis. In older reports distal tibiofibular syndesmosis injuries account for 1% to 11% of all ankle injuries.[2,3] Currently, however, 17% to 74% of ankle injuries among young athletes are distal tibiofibular syndesmosis injuries.[4,5] This apparent increase in the incidence of syndesmosis injuries can be attributed to an increase in knowledge, understanding, and awareness of syndesmosis injuries. Injury to this complex can lead to diastasis of the distal tibiofibular joint and an unstable ankle mortise.[6,7] Several studies have shown poor tolerance of the ankle mortise for talar displacement. Ramsey and Hamilton[8] have shown a 42% decreased joint contact area with only 1 mm of talar displacement. Clinical studies also support accuracy of reduction of the syndesmosis as a critical factor in achieving good clinical results. Syndesmotic injury presents a challenge not only in diagnosis, but also in operative decision-making and reduction. Many authors described different kinds of methods and devices for syndesmosis fixation in the open reduction and internal fixation of the ankle fracture, while few focused on how to perform anatomic syndesmosis reduction accurately during operation besides fluoroscopic evaluation, and none of them reported the direct syndesmosis reduction and compared the outcome with indirect reduction in Weber type C ankle fractures. The purpose of the present retrospective study was to present a method to restore the syndesmosis alignment with direct visualization

All the authors declare that there is no potential conflict of interest referring to this article.

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and test the hypothesis that treatment with direct visualization reduction would have the same or better functional short and medium-term outcomes as treatment with an indirect reduction of syndesmosis in Weber type C ankle fractures.

MATERIALS AND METHODS

A retrospective review of 43 patients with Weber type C ankle injury was performed. All were treated with open reduction and internal fixation in our institute by a group of surgeons from October 2004 to December 2009. They were 25 males and 18 females aged on average 42.5 years old (range 21 to 64 years old). Three of them presented open fractures with wound less than 10 mm at the medial site without bone defect or exposure. All patients were unilaterally injuried. The average time from initial injury was 11.7 days (range 1 to 22 days). According to Lauge-Hansen classification, 14 patients were stage IV pronation-external rotation injury, 21 patients were stage III and 5 were stage III pronation-abduction injury. Three patients could not be identified by this classification. Fourteen patients sustained a posterior malleolar fracture and Chaput fragment was found in 13 patients.

Twenty nine patients were treated with routine procedure (RPG) by open reduction and internal fixation, syndesmosis direct exploration and repair (SPG) was performed in addition in the others. No significant differences were observed between groups with regard to age, sex, mechanism of injury, or follow-up. Patient demographics and fracture classification are summarized in Table 1. Seven patients were lost during followup, leaving 36 patients available for review. The mean follow-up period was 31.2 months (range 18 to 50 months). This investigation was conducted with the approval of the institutional review board of our hospital. The board waived the requirement of informed consent because it was a retrospective study.

Table 1. Demographics.

	RPG (n=29)	SPG (n=14)
Age (mean, range)	40.7 (29-57)	44.9 (21-64)
Gender (Male-Female)	16:11	9:7
Classification		
C1	5	3
C2	14	7
C3	10	4
Chaput fragment	7	6
Medial wound	2	1
Follow-up	35.1 (19-50)	29.4 (18-42)
Weight bearing (week)	14.8 (11-18)	12.7 (10-18)
Syndesmosis screw fixation %	79.31% (23/29)	50.00% (7/14)

Statistical comparisons between both treatment groups were performed with an unpaired Student t-test with statistical significance defined as $p<0.05$. Two-tailed p values are presented.

Operative techniques

The operation was performed with a tourniquet and commenced with the exposure and reconstruction of the lateral structure and syndesmosis. The patients laid laterally with the injured side facing upward initially, then changed to supine position after lateral procedure was completed, in order to facilitate the reduction and fixation of medial structures. Injury to the syndesmosis was determined by surgeon's experience before and during operation. Intraoperative fluoroscopic stress tests were done after fixation of the fibular fracture and before application of the syndesmotic screw to assess the instability, using external rotation and lateral fibular distraction tests. After syndesmotic screw fixation, stress tests were repeated. Diastasis less than 1 mm was our determinant for adequate stabilization. All patients were immobilized with plastic cast for 2 weeks after operation. Twenty nine patients were operated with standard AO techniques, the routine procedure group (RPG). Fourteen patients were underwent direct visualization of syndesmosis reduction beside the routine procedure, which was syndesmosis exploration group (SEG).

Routine procedure group: Open reduction and internal fixation of the fibular fracture was done using standard AO technique. A posterolateral approach to the ankle was used to treat both the posterior malleolar fracture and associated fibular fractures. The fibula fracture was reduced and fixed first via the interval between the peroneus brevis and flexor hallucis longus, then, the posterior part of syndesmosis and posterior malleolar were exposed by elevating the flexor hallucis longus muscle belly from the posterior aspect of the distal tibia. The posterior malleolar fragment was then reduced through visualization. The fragment was typically stabilized with one or two cancellous screws with washer. The syndesmosis was reduced with a closed reduction of the distal tibiofibular joint by plantarflexing and internally rotating the foot while applying a big point clamp across the distal tibia and fibula. Two trans-syndesmotic screws across four cortices were placed under anterior to posterior, mortise, and lateral fluoroscopic control. When present, all medial malleolar fractures were treated with open reduction and internal fixation first with two partially threaded 4.0 mm cancellous screws prior to the closed reduction of the syndesmosis.

Syndesmosis exploration group: In the patients with distal part fibular frcture, beside the routine procedure, the distal tibiofibular articulation was directly exposed anteriorly, utilizing the same posterolateral approach that was used for open reduction and internal fixation of the fibula. In the patients with middle or proximal part fibular fracture, the syndesmosis was approached anteriorly with a small longitudinal incision of 2-3cm length prior to the reduction of fibular and post-malleolar fragments. (Figure 1) Dissection is performed until the disrupted anterior inferior tibiofibular ligament is visualized. The remnant of the anterior inferior tibiofibular ligament

Figure 1. Two incisions were used to reduce the fibular fracture and syndesmosis, the syndesmosis was approached anteriorly with a 2-3cm longitudinal incision.

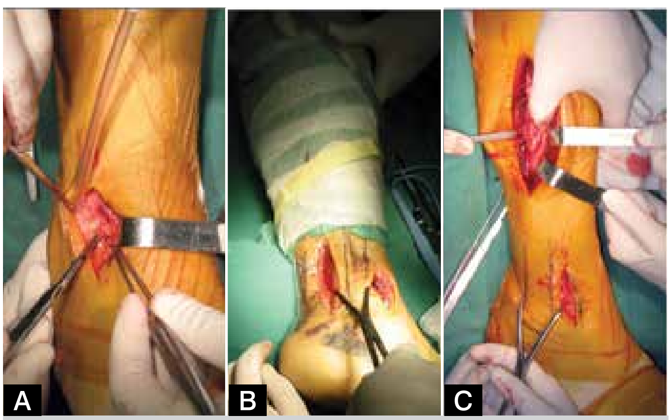

Figure 2. Dissection to visualize the disrupted anterior inferior tibiofibular ligament. The remnant of the anterior inferior tibiofibular ligament is reflected medially, and all fibrous tissue interposed in the distal tibiofibular articulation is excised (A). The distal fragment of the fibula is pulled distally and rotated internally using a small clamp in a high (B) and in a distal fibular fracture (C).

reflected medially, and all fibrous tissue interposed in the distal tibiofibular articulation was excised. (Figure 2A) The distal fragment of the fibular was pulled distally and rotated internally via a small clamp (Figure 2 B,C) to reduce both the fibular fracture site and the distal tibiofibular articulation by attempting to center the fibula within the tibial incisura, and confirming fluoroscopic reduction of the syndesmosis using standard radiographic parameters and direct visualization. Plate fixation of the fibular fracture was then performed as soon as its length and rotation were corrected. (Figure 3) The ruptured ligament was sutured using non-absorbable 2-0 (Ethibond®, Johnson & Johnson, NJ, USA) sutures. If the ligament was avulsed, it was fixed in the original insertion using screws or K wires. (Figures 4 and 5). The medial malleolar and syndesimosis were fixed by the above described method in routine procedure.

All patients had similar postoperative treatment protocols. The ankles were immobilized in a below-the-knee cast for two weeks. Then, non-weight bearing exercise began. Weight bearing motion was allowed till the radiological evidence of union. The union and weight bearing time were showed in Table 1.

Figure 3. AP and lateral radiograph (A) shows a comminuted mid fibula fracture combined with medial malleolar fracture and syndesmosis avulsion. Syndesmosis exploration and stabilization achieved by small screw, K wire and ATiFL suture (B, C). In these cases, the medial and lateral malleoli are fixed, and the syndesmosis is then tested. Twelve weeks after operation, the fractures were healed (D) and the patient could walk and stand with no discomfort (E).

Figure 4. The avulsed fracture of the lateral distal tibia (Chaput`s fragment) was reduced and fixed temporarily with K wires and the fibular was fixed with plate after anatomical reduction.

RESULTS

Thirty four patients were followed with average time of 31.2 months (range 18 to 71 months), in them, 22 patients were treated with routine procedures and 12 were treated with additional direct syndesmosis operative exploration. All fractures were united at the average time of 13.1 weeks (range 10 to 23 weeks) and full weight bearing began. According to the ankle and hindfoot scale of AOFAS, the mean score was 79.86 (range 65 to 98) in the routine procedures group and 86.67 (range 78 to 100) in the syndesmosis exploration group,

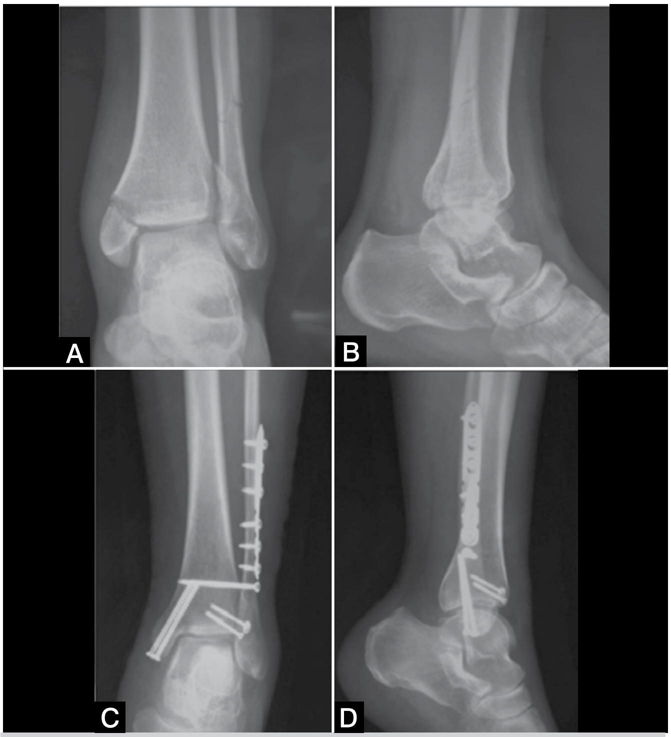

Figure 5. The X rays of the same patient above before (A, B) and after (C, D) operation were showed. The Chaput`s fragment was reduced directly and fixed with 2 screws and the stability of syndesmosis was enhanced by one 3.5 cortical screw with the additional evaluation of intraoperative fluoroscopy.

Olerud and Molander score was 77 (range 55 to 100) and 86.67 (range 75 to 100) respectively. Statistcally difference was found between the two groups ($P<0.05$) by Student t-test analysis. Screw break was found in two patients. One of the two was unsatisfied with the broken screws but no other symptom or ankle restriction presents. Syndesmosis diastasis re-occurred in another one who complained of sustained swelling and pain after syndemosis screws removal and a reversion arthrodesis of the syndesmosis was done to relieve the symptom. All the three patients were in the routine procedure group. Wound complication such as numbness, infection or skin necrosis was not found in all patients. (Table 2)

Table 2. OMS, AOFAS score and complication of the two groups.

	RP (n=22)	SP (n=12)	*P*
OMS	77.27 (55-100)	86.67 (75-100)	0.038
AOFAS (mean, range)	79.86 (65-98)	88.33 (78-100)	0.011
Screws breakage	2	0	
Diastasis after screws removal	1	0	
Reversion operation	1	0	
Wound complication	0	0	

OMS: Olerud and Molander score; AOFAS: American Orthopaedic Foot & Ankle Society.

DISCUSSION

Ankle joint is subject to enormous forces across a relatively small surface area of contact, decreased surface contact area of the ankle joint leads to an abnormal distribution of joint stresses, which presumably leads to post-traumatic arthritis.[8] The ankle fractures are among the most common of all fractures which represent a spectrum of injury patterns from simple to complex and Weber type C ankle fractures are considerablly associated with syndesmotic injuries.[1] Many authors have stated that instability of the ankle is caused by the lateral shift of the talus secondary to fibular or syndesmosis injury.[9] Inadequate reduction of the fibula leads to an unstable mortise and valgus tilting of the talus. Stabile reduction of the fibula in its anatomic position is the key for the stability of the talus.

Recently, the recommended and accepted treatment of Weber type C ankle injuries is open reduction and internal fixation, but, despite appropriate initial fracture reduction, painful osteoarthrosis and untable joint still develop in some patients. One of the most acceptable factors is the inaccurate reduction of the syndesmosis.[9,10] Several studies have demonstrated that failure to reduce and stabilize a disruption of the syndesmosis that occurs in association with some rotational ankle fractures is associated with poor outcomes. Inadequate initial reduction of the syndesmosis in patients with bimalleolar or trimalleolar fractures can present a negative effect on the subjective and objective measures of outcome and correlated with the presence of late instability and arthritis of the ankle. The authors concluded that anatomic reduction of the syndesmosis leads to good clinical results. Weening and Bhandari[7] also noted that anatomic reduction of the syndesmosis was significantly associated with better functional outcomes. Similarly, Thordarson et al.[11] showed that 2 mm of shortening or lateral shift of the fibula, or external rotation greater than or equal to 5 degrees, increases contact forces in the ankle joint, which may predispose to ankle arthritis. To our experience, the inadequate reduction of the fibular result largely from the disturbance of distal tibiofibular articulation with the distal fibular fragment rotating laterally and shifting proximally. With the assistant of improved technique or additional procedure, the anatomical reduction and alignment of the lateral structures of the ankle can be achieved.

Syndesmotic injury is particularly problematic because of the challenge it presents in diagnosis, operative decision-making, and reduction. It has become evident that an anatomic reduction is critical for optimal outcomes.[12] However, the method of treatment is still controversial. Many debates concentrated on the identification of instability and developed several methods based on fluoroscopy before and during operation, while some reports have demonstrated that standard radiographic measurements used to evaluate the integrity of the syndesmosis are inaccurate.[13,14] In present study, the clinical outcome was different significantly with SEG better than RPG, in spite of the intraoperative X-ray was used in both groups and the stability of syndesmosis was tested with the same method. It meant some kind of malreduction was ignored or misled without direct visualization detection of the injured structures. The proper length of the fibular can be achieved by a lamina spreader at the fracture site while rotation cannot be corrected by X-ray inspection alone. A recent study of human cadaver specimens also showed that in a Weber C ankle fracture model with syndesmotic disruption, fixing the fibula in up to 30 degrees of external rotation may go undetected using fluoroscopy alone relying on the accepted radiographic indices for syndesmosis widening.[13] These findings suggest that no optimal radiographic measurement exists to assess syndesmotic integrity, and that repeated radiographs of the ankle are of little value because of the inability to reproduce ankle positioning even under optimal laboratory conditions. Thus, it is urgent to develop other means of visualization of the syndesmosis in order to assure correct rotational reduction of the fibula within the tibial incisura. There are some options available to the surgeon such as formal intraoperative X-rays, intraoperative CT and open reduction of the syndesmosis. When the questions of accuracy of reduction, influence on patient outcome, applicability, and cost-effectiveness of these options were considered, direct visualization with intraoperative fluoroscopy assistant for syndesmosis reduction may be the best choice available.

The close reduction and percutaneous fixation of syndesmosis in Maisonneuve-type ankle fracture have been abandoned by some authors.[15] The ability of radiographic measurements to assess the syndesmosis postoperatively is unknown.[16] The difficulty in relying on radiographic measurements for evaluation of the syndesmosis is mostly due to their dependence on rotation and the resulting inability to obtain standardized images in an acute situation. Teramoto et al.[17] also showed that multidirectional instabilities occurred in the ankle after the tibiofibular syndesmosis was cut and a load applied in a 3-D analyses study. Despite these limitations radiographs are commonly used, because they are frequently available in the outpatient setting, allow a general impression of the bony relationships, and are relatively inexpensive.

It is essential to restore the disrupted distal tibiofibular syndesmosis anatomically. Because nonoperative treatment cannot effectively stabilize the distal tibiofibular syndesmosis during healing, operative fixation often is recommended. Numerous operative techniques have been described for stabilizing the distal tibiofibular syndesmosis. In addition to conventional syndesmotic screw fixation, stabilization techniques include the use of bioabsorbable screws, syndesmotic staples, circular wire external fixators, Kirschner wires, flexible implants, syndesmotic hooks, as well as syndesmotic bolts and cerclage wires. But, fewer concentrated on the reduction techniques which is always the more important step prior to fixation. In this study, the authors exposed the syndesmosis to visually assess rotational alignment and fibular length, also secure the fibula in the fibular notch intraoperatively rather than relying on intraoperative fluoroscopy alone. If the fibular fracture site and ruptured syndesmosis were both under direct visualization, the rotation and shortening of the fibular could be corrected by "two windows" inspection (fibular fracture site and syndesmosis). This made fibular reduction more convenient and accurate with pulling the fibular fragment distally and rotating internally via a small clamp. (Figure 2 B,C) The anterior edge of the fibular could also be visualized in its proper location in the incisura. Aided by the intraoperative fluoroscopy, the anatomic reduction of the syndesmosis and fibular fractures were achieved at its most possible. In addition, with direct visualization of the anterior part of the injured syndesmosis, the ruptured ATiFL could be detected and debrided which made repair or reconstruction of the ligament be possible.

The outcome of this aggressive incisure reconstruction and direct visualization protocol was compared to the routine procedure patients who were treated with technique of AO principles. Besides the incision at fibular and medial malleolar site, in seven patients of SEG in our study, the third incision was approached to expose the syndesmosis anteriorly. No wound complication such as numbness, infection or flap necrosis was found in both groups. The open approach does add morbidity to the procedure with another surgical site and the exposure and debridement of the syndesmosis are safe and feasible.[15,18]

The need for syndesmosis transfixation as part of fracture management still remains a matter of debate. In most ankle fractures involving a posterior fragment, the posterior inferior tibiofibular ligament (PITFL) can be repaired by reduction and fixation of a posterolateral avulsion fracture of the distal tibia, thus providing fixation of the syndesmosis, and eliminating the need for syndesmosis transfixation.[19] Gardner et al.[20] asserted that when the posterior malleolar is fractured, failure of the bone suggests that the integrity of the PITFL has been preserved. For the same reason, the AITFL can be reconstructed when Chaput`s fragment presents. In our study, the percentage of patients using syndesmosis screws fixation was lower in SEG than that in RPG, which was 50% (7 among 14) and 79.31% (23 among 29) respectively. The reconstruction of the syndesmosis ligaments enhanced the stability of ankle mortis and eliminated the need for syndesmosis transfixation which might be associated with higher morbidity.

We are aware of several limitations of this study. This series was a retrospective analysis with a small sample size that lacked long-term follow-up and nine (20.93%) patients were lost to follow-up, which could have imparted some bias. Radiologic measurement results especially CT scans comparisons between the two groups and to the contralateral leg could not be made, which also impaired the sufficiency of the evidence. We also did not take into account potential confounding factors, such as chondral damage, that may have affected the clinical results. Future prospective studies using larger sample sizes with clinical correlations need to be undertaken.

CONCLUSION

Beside the treatment of fractures in Weber type C ankle injuries, anatomical reduction and stable fixation of the syndesmosis lead to favorable clinical outcome. We believe that limited open reduction of the syndesmosis will likely lead to a more accurate reduction of any rotatory or shortening deformities than the indirect fluoroscopically-based procedure. Direct visualization, debridement and open reduction and reconstruction of the syndesmosis is indicated in some Weber type C ankle injuries to ensure a stable ankle joint.

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