Original Article

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Is Additional Medial Plating an Effective Method in Preventing Breakage of Distal Tibial Anterolateral Plate

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Objective: Management of distal tibial fractures remains challenging. Adequate reduction, followed by anterolateral plating using an anterior or anterolateral approach, has been widely used to treat this type of injury. The current study aimed to ascertain the necessity of additional medial buttress plating to prevent breakage of the anterolateral distal tibial plate.

Methods: The study enrolled 94 patients with distal tibial fractures (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association [AO/OTA] 43) who underwent anterolateral plate fixation between January 2011 and July 2022 and had at least one year of postoperative follow-up. Patients were divided into two groups. An additional medial buttress plate was applied to 12 patients who comprised Group I. The remaining 82 patients comprised Group II for comparison. The fracture pattern, soft tissue condition, underlying disease, and occurrence of plate breakage were recorded.

Results: Eleven distal tibial anterolateral plate breakages were noted within one year after surgery. All the breakages occurred in Group II (11/82 = 13.4%). None of the patients in Group I had implant breakage (0/12 = 0%).

Conclusions: Distal tibial anterolateral plate breakages are common. Additional medial buttress plating may be an effective method to prevent this serious complication.

Key words: distal tibia fracture, anterolateral plate, medial buttress plate, implants breakage

Introduction

A distal tibial fracture is defined as a fracture involving the distal tibial metaphyseal area with or without extension into the articular surface. It accounts for 3% – 10% of all tibia fractures, with an incidence ranging from 3 per 10,000 per year to 28 per 10,000 per year depending on sex and age.[1,2] This type of injury is usually caused by rotational and/or axial loads.[3] Concomitant fibula fractures are common and account for 70% – 85% of patients with distal tibia fracture.[3] About 6% of patients may have simultaneous multiple system injuries due to a high energy trauma episode.[3]

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Managing a distal tibial fracture remains challenging, even with advancements in surgical techniques and newly designed implants in recent decades. Some undesired complications such as infection, wound healing problems, and post-traumatic arthritis can occur after operative treatment, leading to unsatisfactory outcomes.[4,5] Adequate reduction through various approaches followed by rigid fixation is still the treatment of choice.[6] Many fixation methods have been introduced for fracture fixation, including external fixation, intramedullary nailing, medial plating, and anterolateral plating.[7-9] Among the implants, using an anterolateral plate through the anterior or anterolateral approach has recently become popular because it is useful for fixation of common fracture patterns. Good clinical outcomes and low wound complication rates have been reported.[10,11]

However, one major concern related to the anterolateral plate is the possibility of implant breakage because the L-shaped design may be unable to withstand varus force. To the best of our knowledge, there are no reports on anterolateral plate breakage. This study aimed to evaluate the efficacy of an additional medial buttress plate in preventing anterolateral plate breakage.

Patients and Methods

Study design and protocol

This study retrospectively reviewed patients' medical records. The inclusion criteria were patients with distal tibial fractures (Arbeitsgemeinschaft für Osteosynthesefragen/ Orthopaedic Trauma Association [AO/OTA] 43) who underwent open reduction and internal fixation surgery with an anterolateral distal tibial plate at our institute. The exclusion criteria were pathological fractures, requirement for early removal of implants due to post-operative infection, and less than one year of post-operative follow-up.

Participants

From January 2011 to July 2022, we performed anterolateral distal tibial plating through an anterior or anterolateral approach in 98 patients with distal tibial fractures at our institute. Four patients were not enrolled in our study because they had less than one year of follow-up. Patient medical records were reviewed retrospectively after obtaining approval from the institutional review board (EMRP-112-139) (Table 1).

All fractures were caused by traumatic episodes, including falls (31) and traffic accidents (63). Anteroposterior and lateral radiographic examinations of each patient's injured ankle were performed preoperatively. Computed tomography (CT) with three-dimensional reconstruction was routinely performed to assess the fracture patterns and joint surface involvement. Definitive treatment was performed after recovery of the surrounding soft

Table 1. Patients' demographic data.

	Group I (N = 12)	Group II (N = 82)
Gender		
Male	8	43
Female	4	39
Age-years, median (range)	55 (20 – 87)	46 (31 – 67)
AO classification	A1: 1 C2: 3 C3: 8	A1: 1 A2: 9 A3: 6 C1: 10 C2: 33 C3: 23
Ipsilateral fibular fracture	9	65
Gustilo classification	II: 1 IIIB: 1	I: 4 II: 25 IIIA: 6 IIIB: 3
Underlying disease		
DM	2	15
HTN	1	21
Heart disease	0	7
Renal disease	0	6
Liver disease	0	7

AO: Arbeitsgemeinschaft für Osteosynthesefragen; DM: diabetes mellitus; HTN: hypertension.

tissue. The staged treatment protocol included temporary use of external fixation, which was commonly used in our case series to prevent wound complications.

Postoperative care and follow-up

After the definitive surgery, adequate pain control and regular aseptic wound care were initiated. The condition of the surgical wound and surrounding soft tissue were checked regularly. Antibiotic regimens were prescribed for each patient based on the wound conditions. The patients were encouraged to change their position, sit up, and get out of bed as soon as possible. Weight-bearing was restricted until bone union occurred. The rehabilitation protocol included ambulation training with assistance, which was initiated if the patient could tolerate it. The patients were discharged if their wound conditions were stable. They visited our outpatient clinic for regular follow-up once a week until wound healing, then every month until bone union and every three months thereafter. Radiographic examinations in two views were performed at each visit to define the condition of bone union and identify any undesired complications such as implant breakage or loss of reduction. All patients were followed up in outpatient clinics for at least one year. The endpoint of this study was the completion of one year of postoperative follow-up or the occurrence of anterolateral plate breakage.

Statistical analysis

According to the definition of statistical power, the unequal group sizes and a low plate breakage rate were related to the risk of making a type II error (β), which is the bias of concluding that there is no significant difference between groups when in fact such a difference exists in this study. Given the underpowered nature of this study, we used a descriptive analysis to evaluate the differences in implant breakage rates between patients with and without additional medial buttress plating.

Results

Patients' demographic data

The study population included 51 men and 43 women, with an average age of 54.9 years. The fracture patterns based on the AO/OTA classifications were as follows: 43A1 (2), 43A2 (9), 43A3 (6), 43C1 (10), 43C2 (36), and 43C3 (31). Forty patients had open fractures (42.6%). An additional medial buttress plate was applied in 12 patients who comprised Group I (Fig. 1 & 2). The remaining 82 patients comprised Group II for comparison (Fig. 3 & 4).

Breakage of anterolateral plate

Eleven implant breakages were observed in this case series. The average time from definitive surgery to implant breakage was 28 weeks (range, 5 – 55). All the breakages occurred in Group II (11/82, 13.4%). None of the patients in Group I had implant breakage (0/12 = 0%). The breakage rate was higher in Group II patients, but the difference was not significant ($p = 0.203$). In Group I, one patient (1/12, 8.3%) had a surgical wound infection of the medial ankle. The patient was successfully treated with debridement, removal of the medial plate, and adequate antibiotic administration.

Discussion

In this study, additional medial buttress plating decreased the incidence of distal tibial anterolateral plate breakage. Although no significant difference was observed, this could be an effective method for preventing implant breakage. To the best of our knowledge, this is the first study to suggest the use of additional medial buttress plating.

Conservative therapy for distal tibial fractures is reserved only for selected patients.[12] Surgical methods remain the treatment of choice for most patients. In general, there is still room for improvement in postoperative

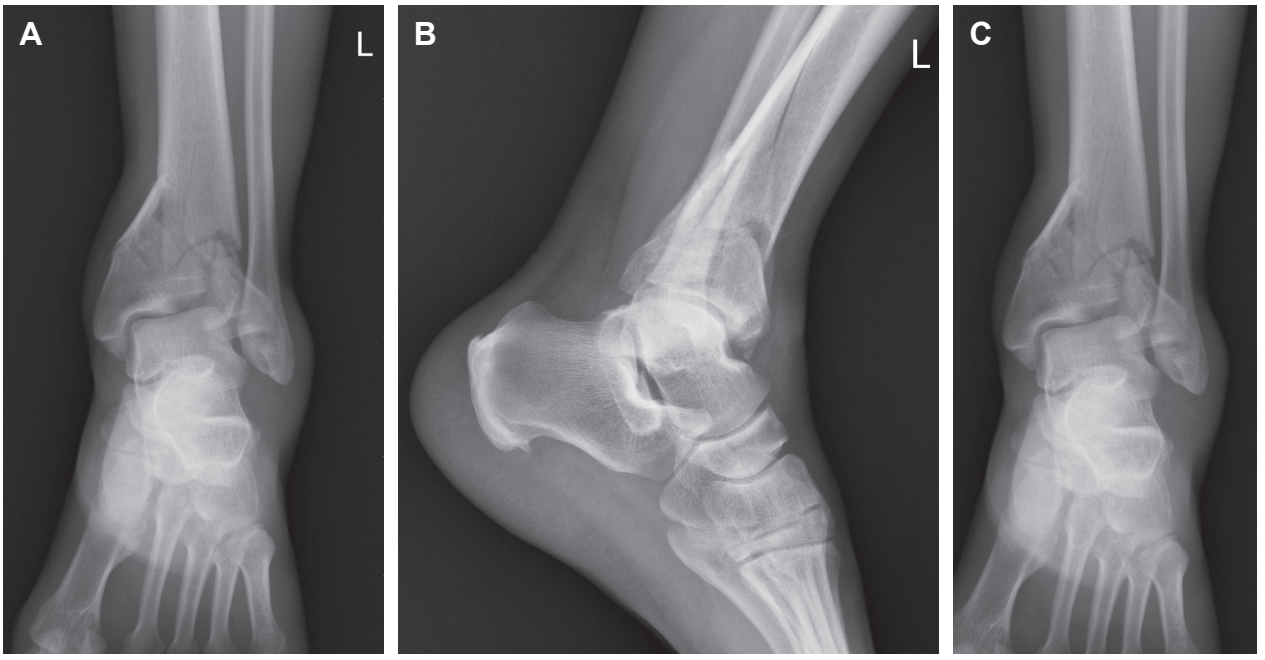

Fig. 1 A 45 year-old male patient suffered from a traffic accident and resulted in left ankle painful deformity. The anterior-posterior (A), lateral (B) radiographs, and 3-dimensional reconstruction CT scan (C) of left ankle revealed an intra-articular distal tibia fracture (AO/OTA 43C3).

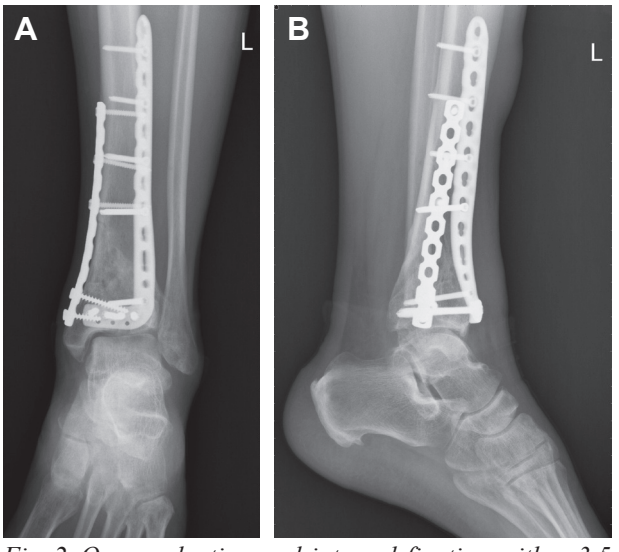

Fig. 2 Open reduction and internal fixation with a 3.5 mm LCP anterolateral distal tibia plate (DePuy Synthes) was performed. Another 3.5 mm reconstruction plate was applied as a medial buttress plate. One year after operation, bone union with a good alignment was noted in the anterior-posterior (A) and lateral (B) radiographs of left ankle.

outcomes. An unsatisfactory prognosis is associated with poor soft tissue coverage, complex fracture anatomy, and high-energy trauma. A series of complications such as wound dehiscence, infection, nonunion, malunion, and traumatic arthritis can occur. Infection rates of 7% – 32% have been reported.[13] Teeny et al. conducted a retrospective study and revealed a 50% rate of poor results.[14] Some authors even recommended using primary ankle or tibiotalocalcaneal arthrodesis in selected patients.[15,16]

Soft tissue conditions are usually a major concern in the treatment of distal tibial fractures. The blood supply and soft tissue envelope around the ankle region are poor, and appear to be problematic for wound healing. A staged treatment protocol has been proposed and is widely used to decrease the soft tissue complication rate.[17] A definitive operation is usually performed after soft tissue recovery. Among the methods of definitive surgery, anterolateral plating through the anterior or anterolateral approach is one of the most commonly used and has gained popularity in recent years.[18,19] The distal tibial anterolateral plate has some advantages. First, the ankle joint is exposed through an anterior or anterolateral approach to reduce the articular surface. Second, the soft tissue coverage of the plate is better than that of medial plating. Third, it has a good ability to capture pilon fragments. For

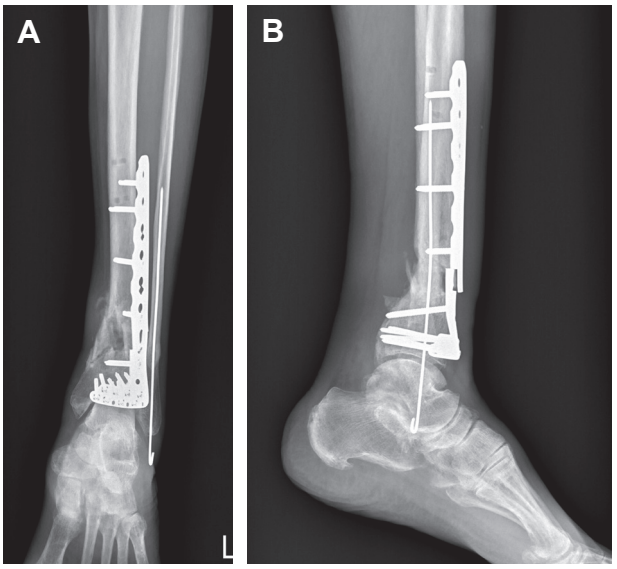

Fig. 3 A 75 year-old female patient received open reduction and internal fixation surgery with a 2.7/3.5 mm VA-LCP Anterolateral Distal Tibia Plate (DePuy Synthes) for left distal tibia fracture (AO/OTA 43C2). Four months after operation, plate breakage was noted in the anterior-posterior (A) and lateral (B) radiographs of left ankle.

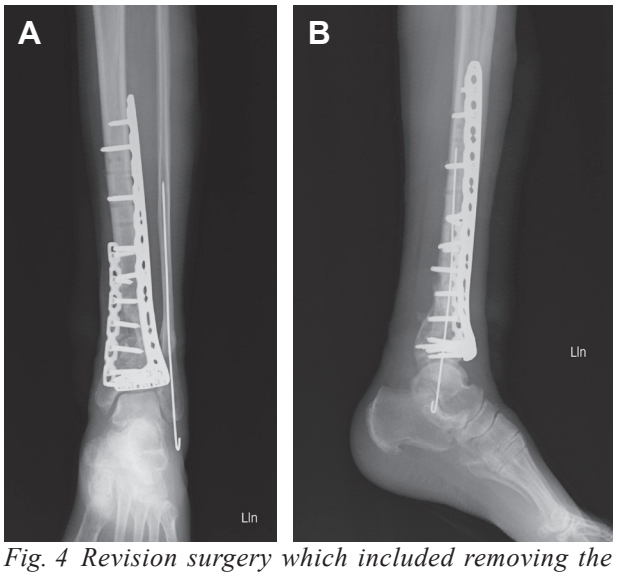

Fig. 4 Revision surgery which included removing the broken plate followed by applying a new one was performed. Another 3.5 mm LCP reconstruction plate was applied as a medial buttress plate (A) (B).

these reasons, anterolateral plating is usually indicated in our daily practice for patients with poor soft tissue conditions over the medial ankle region and intra-articular fractures that require reduction using the anterior approach. Good clinical outcomes after anterolateral plating for distal tibial fractures have been reported in the literature.[11,18]

Although the distal tibia anterolateral plate seems to be a reasonable choice, it has some drawbacks compared with other implants. First, it is technically more demanding because of the proximity of the critical neurovascular structure at the route of the approach. Second, medial malleolar fragments cannot be identified. Third, it cannot function in the anti-glide mode at the medial ankle, and its stability may not be sufficient to prevent varus force. Pirolo et al. conducted a biomechanical study and revealed that anterolateral plates showed inferior performance to medial plates in varus fracture pattern.[9] Stapleton et al. recommended that anterolateral plating should not be used for varus failure of the tibia.[19]

Implant breakage is a severe osteosynthesis complication. The anterolateral distal tibial plate is designed in an L-shape. The distal arm is horizontal to the joint surface, whereas the proximal arm is parallel to the tibial diaphysis. This unique design increases the varus force of the lever arm during standing or walking. This may increase the load on the implants and the incidence of plate breakage. In this study, implant failure was observed in 11 patients, all in Group II, with an incidence of 13.4%.

Additional medial buttress plating could provide better stability against the varus force. We performed this procedure in 12 patients and observed no implant breakage. A major concern with this technique is the possibility of medial ankle wound complications. To reduce this undesired complication, we meticulously handled the soft tissue. This technique was never used if there was soft tissue compromise over the medial ankle or a 5-cm skin bridge could not be achieved.[20] In our case series, the incidence of wound infection was acceptable (1/12 = 8.3%).

Our study has several limitations. First, Group I comprised only 12 patients; consequently, the sample size was too small to prove

the feasibility and efficacy of this method. Second, this study was conducted through a retrospective review of patients' medical records. It was impossible to enroll patients who underwent different treatments for subsequent comparisons. Hence, randomization was lacking owing to the study design. Third, we enrolled a diverse group of patients including those with open fractures, intra- or extra-articular involvement, ipsilateral fibular fractures, and other concomitant injuries. The broad inclusion criteria may have affected the analysis. Fourth, the quality of the bone is unknown because bone mineral density was not examined for each patient. Fifth, some patients had comorbidities, such as hypertension, diabetes mellitus, heart disease, or renal disease. However, we did not consider these comorbidities, which may have influenced our analysis. Sixth, the inequality in the size of the two groups and a low plate breakage rate limit the power of this study to detect a significant difference. Therefore, we analyzed all data using descriptive statistics. Seventh, we did not select the same anterolateral or medial plate for each patient. Therefore, differences in implant design and materials may influence the outcomes. Finally, we only recorded the presence or absence of plate breakage within one year after surgery and did not consider healing time or nonunion. Therefore, further prospective randomized studies with larger numbers of cases are required to prove the efficacy of this technique.

Conclusions

To the best of our knowledge, distal tibial anterolateral plate breakage has not been thoroughly discussed in the literature. Although the current study included a small sample size, the patients required additional surgical procedures for medial buttress plating. We believe that additional medial buttress plating could be an efficient method for preventing distal tibial anterolateral plate breakage, and should be applied to each patient if the soft tissue condition of the medial ankle is acceptable.

Author Contributions

Yen-Chun Chiu was the major contributor in writing the manuscript. Shih-Chieh Yang designed the study and analysed the data. Ching-Hou Ma collected the patient's data. Yuan-Kun Tu supervised the study. Chin-Hsien Wu contributed data analysis and substantially revised the manuscript. All authors read and approved the final manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of E-Da Hospital (protocol code: EMRP-112-139 and date of approval: 2023/10/15).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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