Combined Posteromedial and Posterolateral Approaches for 2-Part Posterior Malleolar Fracture Fixation

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Abstract

Background: This study investigated the clinical efficacy of combined posteromedial and posterolateral approaches for repair of 2-part posterior malleolar fractures associated with medial and lateral malleolar fractures.

Methods: This case series report included 27 Weber B with Haraguchi type II patients with medial and lateral malleolar fractures combined with 2-part posterior malleolar fractures. Patients were treated with open reduction and internal fixation through a combination of posteromedial and posterolateral approaches from January 2015 to January 2018. There were 11 males and 16 females, with an average age of 61.5 years (range, 53-67 years). The procedures were performed on prone patients under spinal anesthesia. The medial, lateral, and posterior malleolar fractures were exposed through posteromedial and posterolateral approaches performed at the same time. The lateral malleolar fracture was fixed using a plate, the medial malleolar fracture was fixed using screws, and the posterior malleolar fracture was fixed using a plate or cannulated screws according to the size of the fragments. We performed follow-up on 22 patients for an average of 30 months (range, 18-48 months).

Results: Primary healing of the incisions was achieved in all cases, and no infection was found. The mean time of bone union was 12.5 weeks (range, 10-15 weeks). The mean time from the operation to full weightbearing was 13 weeks (range, 11-16 weeks). We used the American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot Scale to score patient outcomes; the mean score was 85.4 (range, 80-92) at the final follow-up. No significant pain was found at the final follow-up.

Conclusion: This study showed that satisfactory outcomes were achieved with combined posteromedial and posterolateral approaches. Therefore, we believe this approach was a good alternative strategy to repair 2-part posterior malleolar fractures associated with medial and lateral malleolar fractures.

Level of Evidence: Level IV, retrospective case series.

Keywords: ankle joint, fracture, posterior malleolus, operational treatment

Introduction

Posterior malleolar fractures account for approximately 14% to 44% of ankle fractures.14 Boggs concluded that the injury was caused by axial load during plantar flexion of the ankle joint.5 However, most posterior malleolar fractures are associated with other fractures of the ankle joint. Subsequently, Haraguchi et al,11 Bartoníček et al,4 and Mason et al16 grouped the posterior malleolar fracture according to their characteristics on computed tomography (CT) scanning.

The classic Lauge-Hansen classification of ankle fractures was based on the injury mechanism but does not explain the 2-part fracture of the posterior malleolus. Mason et al16 believed that this kind of fracture was caused by the talus rotating in the ankle mortise and impacting the posterior ankle when the foot was in plantarflexion. The posterolateral fragment was formed first. When the stress
continued to be transmitted inward, the posteromedial fragment appeared at a 45-degree angle to the first fragment. Excessive plantarflexion ankle fractures occur when forward force in the sagittal plane with supination of the foot causes the foot to undergo excessive plantarflexion, thereby displacing the talus backward or upward-backward and impacting the posterior malleolus. Vertical shear fractures are caused by axial component forces, which can cause posterior subluxation of the ankle joint.

Traditionally, patients presenting with an articular surface fracture exceeding 25% to 33% were considered to be candidates for posterior malleolus fracture fixation. The current consensus is that the size of the fragment is not the only factor that determines the surgical plan. Full consideration must be given to restoring joint alignment, correcting joint compression and collapse, correcting talar displacement, and restoring the lower tibiofibular joint stability. Therefore, the surgeon should be familiar with the posterior medial and posterolateral approach and direct and indirect reduction of the fragments.8,12

The prognosis is worse when medial and lateral malleolus fractures are accompanied by posterior malleolus fractures. Clinicians and researchers have come to acknowledge that the anatomical features of the posterior malleolus are important for ankle stability.17,23 For common trimalleolar fractures, the most common method is to fix medial malleolus fractures through the medial approach and fix lateral and posterior malleolus fractures through a posterolateral approach. Biomechanical studies have confirmed that the posterior malleolus has a vital role in ankle joint load transfer and limiting posterior dislocation. Inadequate internal fixation may result in loss of reduction.9,20 However, when medial and lateral malleolus fractures are associated with 2-part posterior malleolus fractures, and the fracture line extends behind the medial malleolus, it is difficult to expose and fix the posteromedial fragment of the posterior malleolus using the posterolateral approach. If the posterolateral approach is performed first, reduction of the posteromedial fragment of the posterior malleolus may be affected by inappropriate reduction of the posterolateral fragment, which can result in longer operation time and unsatisfactory clinical outcomes.

In this study, we evaluate an innovative operational approach for 2-part posterior malleolus fractures associated with medial and lateral malleolus fractures, which simultaneously combined posteromedial and posterolateral approaches to reduce fractures in the prone position.

Methods

The inclusion criteria were (1) acute ankle fractures, (2) the oblique fracture line of the lateral malleolar fracture was at the level of distal tibiofibular syndesmosis, and (3) there were 2 fragments of the posterior fragment (posteromedial and posterolateral fragments). The exclusion criteria were (1) an old ankle fracture defined as an injury more than 31 days old,5 (2) fractures associated with deltoid ligament injury, and (3) patients who were unable to undergo surgery.

A total of 27 patients were included in the study, including 11 males and 16 females aged 53 to 67 years (mean, 61.5 years). A total of 22 patients were followed up for an average of 30 months (range, 18-48 months) (Table 1). The mechanism of injury was twisting injury when descending stairs or descending from a stool. The fracture types were all 2-part posterior malleolus fractures, namely Haraguchi type II, Bartoniček type III, and Mason type IIB. All lateral malleolus fracture lines were oblique and located at the level of distal tibiofibular syndesmosis. We examined the medial clear space on a stressed mortise radiograph for every patient. On neutral or dorsiflexion mortise views, if a wide medial clear space was >4 mm and at least 1 mm larger than the superior tibiotalar clear space, then we diagnosed deltoid ligament ruptures.2,15 Some patients received magnetic resonance imaging (MRI) for greater accuracy.6,10 All medial malleolus fractures were avulsion fractures, but there were no deltoid ligament injuries. The posterior malleolus fractures were closed 2-part fractures (posteromedial and posterolateral fragment) involving the posterior aspect of the medial malleolus, which were classified as Haraguchi type II.

Anterior-posterior and lateral radiographs of the ankle and 3-dimensional reconstructions of CT scans were performed before the operation. Calcaneal traction was performed before the operation, and the operation was performed 7 to 14 days after injury (average, 10 days). Calcaneal traction was helpful for fracture reduction, decreased swelling, and pain relief, and shortened the waiting time for operation.7 All patients signed informed consent, and the study was approved by our hospital.

Operative Technique

The operation was performed with the patient in the prone position under spinal anesthesia or nerve blocking anesthesia with a pneumatic tourniquet. The combined posterolateral

<table>
<thead>
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<th>Table 1. Demographics.</th>
<th>Value</th>
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<tbody>
<tr>
<td>Patients, n (%)</td>
<td>22 (100.0)</td>
</tr>
<tr>
<td>Male</td>
<td>10 (45.5)</td>
</tr>
<tr>
<td>Female</td>
<td>12 (54.5)</td>
</tr>
<tr>
<td>Mean age, y (range)</td>
<td>61.5 (53-67)</td>
</tr>
<tr>
<td>Mean body mass index, kg/m²</td>
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<tr>
<td>Smoker, n (%)</td>
<td>5 (22.7)</td>
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<td>Underlying disease, n (%)</td>
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<tr>
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<td>3 (13.6)</td>
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<tr>
<td>Hypertension</td>
<td>7 (31.6)</td>
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and posteromedial approach was used. The 2 approaches were used simultaneously. The posterolateral approach exposed the lateral malleolus and the lateral fragment of the posterior malleolus, and the posteromedial approach exposed the medial malleolus and medial fragment of the posterior malleolus. The posterolateral incision was located approximately 1 cm posterior to the fibula and was approximately 10 to 14 cm in length. The distal end was curved toward the tip of the fibula. The lateral fragment of the posterior malleolus was exposed between the peroneus longus and the flexor hallucis longus tendons. The lateral fracture was reduced and fixed with a lateral plate or posterior plate either anterior or posterior to the peroneal tendons. The posteromedial approach was located at the posterior edge of the medial malleolus and the tibia. Along the medial side of the tibialis posterior tendon, the medial fragment of posterior malleolus fracture was exposed by retracting the tarsal tunnel contents posterolaterally. The fragment of medial malleolus was exposed by curving the distal end of the incision toward the medial malleolus.

These 2 approaches were performed simultaneously and also helped evaluate the reduction. The medial and lateral fractures were reduced and temporarily fixed with Kirschner wires. Intraoperative fluoroscopy was used to assess the fracture reduction. Then, the lateral malleolus fracture was fixed with a lateral or posterior fibular plate. The medial and lateral fragments of the posterior malleolus were fixed with a one-third tubular plate or cannulated screw according to its size and displacement. The medial malleolus fragment was fixed with cannulated screws. Finally, intraoperative fluoroscopy was used to confirm the appropriate position and length of the implants (Figure 1). Layered closure was performed and suction drains were placed.

**Postoperative Protocol**

All patients were not fixed by splint during the day and used night splint at night for 2 weeks after surgery. Functional exercises for the ankle were performed under the guidance of rehabilitation physician. Passive flexion and extension exercises of the toes, ankles, and knee, and elevation exercises of the quadriceps were started on the first day after surgery. Active flexion and extension exercises of the toes and ankles were started on the second day after operation. Suction drains were removed within 48 hours after surgery. Patients were instructed to begin partial weightbearing 6 weeks after surgery, with pain tolerance as the guide to limit the activity. Radiographic imaging and functional recovery follow-up examinations of the foot and ankle were performed at 6 weeks, 3 months, 6 months, and 1 year after operation. The American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot Scale was used to evaluate functional recovery at the final follow-up.

**Statistical Analysis**

The Statistical Package for Social Sciences (SPSS v19.0 for Windows; IBM Corp, Armonk, NY) was used. The measurement data were tested for normal distribution using the Shapiro-Wilk test. Measurement data displayed normal distribution, and the homogeneity of variance was expressed as \( \bar{x} \pm s \). The AOFAS score was used to evaluate postoperative function of the ankle.

**Results**

The postoperative wounds did not appear infected and temperature remained normal. No abnormalities were observed in white blood cells (WBCs), C-reactive protein (CRP), procalcitonin (PCT), and other infection indicators after operation. Sutures were removed 2 weeks after operation. Primary healing was achieved in all patients.

Postoperative radiograph examination showed that the average time for fracture healing was 12.5 weeks (range, 10-15 weeks). There were no nonunion or internal fixation failures. Patients were able to walk with complete weight-bearing at 13 weeks (range, 11-16 weeks) without significant pain or discomfort. At the final follow-up, the AOFAS score was 85.4 ± 5.5 (range, 80-92); 13 cases were excellent (scores 90-100) and 9 cases were good (scores 75-89).

**Discussion**

It is challenging to differentiate between posterior malleolar fractures and posterior pilon fractures. Ankle fractures are caused by rotational force, whereas pilon fractures are caused by vertical force. However, many fractures are caused by both rotational and vertical forces. Therefore, it is important to obtain the history and cause of injury to determine which force played a leading role. The fracture type also depends on whether the line of the posterior fracture exceeds 50% of the fibula notch, or whether the anterior colliculus of the medial malleolus is involved. All patients in our study experienced vertical forces (twisting injury when descending stairs or falling down from a stool) from heights of approximately 20 to 40 cm. The forefoot landed first, and the ankle joint was in plantarflexion. Therefore, the talus impacted the posterior malleolus while being subjected to rotational forces, which simultaneously caused lateral, posterior, and medial malleolus fractures.

These fractures are primarily caused by rotational forces. Switaj et al proposed a posterior pilon variant: 50% of 270 ankle fracture cases were associated with posterior malleolar fractures, whereas posterior pilon variants accounted for 20% of cases. The risk factors for this type of fracture include older age, female sex, and being diabetic. Most of patients in our study were elderly, and females were more common than males. Therefore, we believe that the ankle...
fractures in our study were affected by both rotational and vertical forces, although the rotational force was the predominant factor. Most of the fractures were posterior pilon-like variants caused by talus rotation impacting the posterior malleolus when the ankle joint was in plantarflexion.

Operative treatment of posterior malleolar fracture has been advocated by many researchers. It is believed that fixation of the posterior malleolus facilitates restoration of the articular surface, maintenance of tibia length, and stability of distal tibiofibular syndesmosis, thereby minimizing placement of tibiofibular syndesmosis screws and allowing early rehabilitative exercises.21 The classic posterolateral approach has been widely used clinically. It is located between the posterior border of the lateral malleolus and the lateral border of the Achilles tendon. The Volkman fragment and lateral malleolus fracture can be exposed at the same time between the peroneal and the flexor hallucis longus tendons. If the posterior malleolar fracture is a 2-part fracture that extends to the posterior of the medial malleolus, the medial portion of the posterior malleolus cannot be exposed through this approach.1

Some surgeons have proposed a posteromedial approach between the flexor hallucis longus tendon and the neurovascular bundle, which fully exposes the entire posterior malleolus.13 However, another 2 incisions are required to make separate incisions for each malleolus fracture for the 2-part posterior fractures associated with medial and lateral malleolus fractures. This skin bridge is narrow, and soft tissue skin complications are prone to occur. Therefore, some researchers proposed a modified posteromedial approach: the L-shaped incision started longitudinally along the medial border of the Achilles tendon and then curved distally to the medial malleolus toward the talonavicular joint.24 The posterolateral fragment was fixed through the approach between the flexor hallucis longus tendon and neurovascular bundle. The interval between the flexor digitorum longus tendon and tibialis posterior tendon was used to fix the posteromedial fragment. The incision was

Figure 1. (A, B) Male, 56 years old, with left medial and lateral malleolus fractures associated with a posterior malleolus fracture caused by a sprain. Anterior-posterior and lateral radiograph showing left trimalleolar fractures. (C, D) Preoperative 3-dimensional reconstruction of computed tomography (CT) showing left trimalleolar fractures and obvious displacement of the posterior fragments. (E) CT scan before surgery showing that the left posterior malleolus fracture was 2-part, involving the posterior medial malleolus. (F, G) Lateral and medial approaches. (H) Postoperative CT showing the fracture had been reduced. (I) Anterior-posterior and lateral radiograph of the final follow-up. (J) Functional photos of ankle mobility at the final follow-up.
equivalent to lifting the entire posterior medial skin flap, which posed a high risk of soft tissue complications. This also opened the tarsal tunnel to expose the posterior malleolus fragment, which increased the risk of irritating blood vessels, tendons, and nerves.

To address these potential complications, we combined posteromedial and posterolateral approaches in the prone position. The classic posterolateral approach fully exposed the lateral malleolus fracture and the lateral fragment of the posterior malleolus. Entering along the medial side of the Achilles tendon, the posteromedial fragment was exposed after retracting the tarsal tunnel contents laterally and exposing the bone surface. The distal part of the incision curved along the medial malleolus exposing the fracture. The skin bridge between the 2 incisions was approximately 5 to 6 cm, which was sufficiently wide to avoid ischemic necrosis. The 2 incisions were opened and closed simultaneously, which also reduced the need to change the position of the patient. The entire procedure was completed more rapidly than traditional approaches. All patients in this group achieved good exposure, reduction, and fixation. No skin or soft tissue complications occurred.

Two-part posterior malleolar fractures associated with medial and lateral malleolar fractures are challenging. First, the fractures are caused by both rotational and vertical forces. The ankle joint has a tendency to sublux. Therefore, the clinician must examine the soft tissue condition in addition to the fracture. Calcaneal traction is beneficial for swelling, pain relief, and preliminary reduction, which all facilitate anatomical reduction during the operation. Second, patients are placed in the prone position during the operation. The 2 approaches are synergistic, which is beneficial to the anatomical reduction of the posterior fragment, especially the fragment with rotational displacement in the coronal plane. Third, the fibula fracture can be distracted, and the posterolateral fragment of the posterior malleolus can be released via the fibula fracture gap, especially when there is an impacted fragment on the posterolateral side. Fourth, the exposure is performed along the intermuscular space, which can directly reach the posterior malleolus surface and avoid tearing the muscles. Therefore, it can avoid excessive retraction of the flexor hallucis longus and reduce the possibility of postoperative adhesion. Fifth, postoperative functional rehabilitation is very important. Passive flexion and extension exercises of the toes and ankles begin on the first day after operation. Active flexion and extension exercises of the toes and ankles begin on the second day after operation.

All patients in our study had 2-part posterior malleolar fractures associated with medial and lateral malleolar fractures. The traditional surgical method positioned patients supine on the operating table. The incision was made along the tibialis posterior tendon, and the proximal limit of the incision depended on the metaphyseal extension of the fracture and used a posteromedial approach to fix the medial fragment of the posterior malleolus fracture. After fixing the medial fragment of the posterior malleolus fracture, patients were positioned lateral on the operating table. The incision was made between the posterior border of the lateral malleolus and the border of the Achilles tendon and used a posterolateral approach to fix the lateral fragment of posterior malleolus fracture. Changing of the position during surgery increases the time and difficulty of the operation for the surgical team. Furthermore, after the fragment is fixed on one side it is often difficult to achieve satisfactory reduction and adjustment on the other side, which increases the difficulty. In this study, we confirmed that a combination of posteromedial and posterolateral approaches to treat 2-part posterior malleolar fractures associated with medial and lateral malleolar fractures successfully achieved satisfactory surgical and rehabilitation outcomes.

**Conclusion**

Two-part posterior malleolar fractures associated with medial and lateral malleolar fractures are challenging to treat. The combination of posterolateral and posteromedial approaches in the prone position achieved sufficient exposure of the fractures and facilitated satisfactory reduction and fixation. The clinical efficacy was good.

**Declaration of Conflicting Interests**

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