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Original Article

A better approach yields a better result: comparison of two different surgical procedures for bi- and trimalleolar fractures with posterior fragments

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Abstract: Bimalleolar and trimalleolar fractures are common orthopedic injuries. There are different techniques of fixation and various surgical approaches. We compared our method of fixation, especially fractures with posterior fragments, with the traditional method. From January to June 2008, 73 cases of ankle fracture were treated in our trauma center. All cases were bimalleolar or trimalleolar fractures, and required open reduction and internal fixation. The posterolateral approach was used for both lateral and posterior malleolar fixation. All patients were followed up, and computed tomography was used to evaluate alignment of posterior fragments. In all patients, function was compared with that in previous cases treated with traditional approaches. All fractures healed without failure of hardware. There was no complication of traumatic osteoarthritis on follow-up. The presented approach leads to better ankle function than with the traditional procedure. The difference is significant ($P < 0.05$), according to an ankle scoring system (Baird RA, Jackson ST. JBJS, 1987, 69A: 1347). The posterolateral approach provided better exposure of posterior malleolar fragments and achieved better functional results. Our method of fixation conforms to biological theory. This surgical approach with its anatomical advantage can treat both lateral and posterior malleolar fractures through the same incision, and should become the preferred method of treatment.

Keywords: Posterior lateral, posterior malleolar, ankle fracture, surgical approach

Introduction

Most ankle fractures are caused by rotational violence. Structures such as the deltoid ligament, medial, lateral, and posterior malleoli, and the syndesmosis are key factors in the stability of the ankle joint. Thus, damage to 2 or more structures may lead to instability. In a serious ankle injury, the most important thing is to restore the stability of the joint.

In a supination-external rotation type injury, the posterior malleolus is always involved. Posterior lip fragments are extra-articular avulsions that do not involve the joint. Posterior malleolar fragments usually require reduction and fixation [1].

It is believed that precise open reduction of the lateral malleolus often results in realignment of the posterior tibial lip fragment [2]. Some recommend routine fixation of all posterior lip fragments [3]. Fixation can be performed in various ways, but the optimal approach remains controversial. The traditional technique involves insertion of anterior to posterior screws [4] in ankle dorsiflexion position. However, posterior to anterior direction fixation is increasingly preferred [5]. Can posterior to anterior fixation after precise reduction via a posterolateral approach actually result in better function?

Materials and methods

Subjects

We surgically treated 73 bimalleolar or trimalleolar fractures in our trauma center. Causes of injury included falls, sports, and traffic accidents. Patient ages ranged from 28-57 (43.2 on average), of whom 44 were female. According to the Muller AO classification, 18 cases were

type A, 24 were type B, and 31 were type C. According to the Denis classification, 30 cases were type B and 43 were type C. According to the injury mechanism (Lauge-Hansen classification), 39 were SE (supination-external rotation) cases, 19 were PA (pronation-abduction) cases, and 15 were PE (pronation-external rotation) cases. Routine computed tomography (CT) with 3-dimensional (3D) reconstruction was used in all cases to identify posterior malleolar fractures and sizes of fragments. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Shanghai Jiao Tong University. Written informed consent was obtained from all participants.

A control group included 68 similar bimalleolar or trimalleolar fractures surgically treated in the previous year. All related factors including age, gender, and type of fracture were matched to the experimental group, except for the surgical approach and method of fixation.

Operative technique

With the patient prone, a skin incision is made at the lateral side of the Achilles tendon. First, the peroneal tendons are pulled laterally to enable lateral malleolar reduction and fixation. Then, posterolateral exposure of the posterior lip is performed through the interval between the peroneal tendons and the Achilles tendon (flexor hallucis on the deep side). The posterior lip fragment is reattached with a small buttress plate. The peripheral margin of the fragment is used as a guide for fragment reduction. An intraoperative lateral radiograph should be taken following provisional K-wire fixation of the fragment. Finally, another anteromedial incision is made for the medial fragment. After fixation of all fragments, a Hook test should be performed to determine whether a syndesmosis screw is needed.

The control group underwent a conventional approach. First, the lateral malleolus was reduced and fixed through a lateral approach. Then, the posterior fragment was reduced with a forceps and fixed by anterior-posterior screws through a stab incision.

Postoperative treatment

A short-leg splint is applied to hold the ankle dorsiflexed in cases with ligament injuries. We encourage the patient to do some ankle flexion-extension exercise as soon as possible. Monthly outpatient follow-up is continued until bone union. Partial weight bearing should be permitted for at least 6 weeks postoperatively, when clinical healing of the fracture has occurred. We also perform postoperative CT in all cases to evaluate surgical reduction and syndesmosis. Six months later, ankle scoring is performed for function recovery.

Statistical analysis

The chi-square test of the fourfold table of statistical software (SAS 8.10) was used in comparing clinical data, and statistical significance was defined as $P < 0.05$.

Result

Incision and bone healing

With the posterolateral approach, all cases achieved bone union during follow-up. Superficial infection occurred in 5 cases. These eventually healed with wound dressings and antibiotics. No cases developed deep tissue infection. We did not use syndesmosis screws in the study. However, with the previously performed traditional fixation (lateral approach for lateral malleolar and antero-posterior fixation of posterior fragments with an anterior stab incision), more cases required syndesmosis screws and some developed skin necrosis (2 cases) and plate exposure (1 case) at the lateral malleolus. Flap transfer was required to cover the hardware in certain cases. One case had a broken screw and significant reduction, and some experienced early signs of ankle osteoarthritis.

Functional recovery

We used an ankle scoring system for pain, ankle stability, walking stability, range of motion, X-ray findings, and other components (Baird, R.A., Jackson, S.T. JBJS. 1987, 69A: 1347) to evaluate ankle function. Compared with the traditional operation (57 of 68 cases, 84%), more cases in our study had an excellent-to-good rating (69 of 73 cases, 95%) by the final follow-up. There were no cases of osteoarthritis during follow-up. The traditional group

Figure 1. Posterior lateral approach for ankle fracture with posterior fragment. A. A-P view of ankle joint pre-operation; B. Lateral view of ankle joint pre-operation; C. CT-scan cross section pre-operation; D, E. CT-scan sagittal view pre-operation; F. A-P and lateral X-ray post-operation; G. CT-scan cross section post-operation; H, I. CT-scan sagittal view post-operation.

included cases that underwent surgery during the same duration in 2007. The composition of fracture type, age, and gender matched that of our research cases.

Figure 2. Traditional anterior-posterior fixation of posterior fragment. A. X-ray pre-operation; B. X-ray post-operation; C. X-ray last follow-up.

Case 1

A 43-year-old male sustained an ankle sprain playing badminton. A bimalleolar fracture was classified according to routine X-ray (**Figure 1A**, **1B**) as follows. Orthopaedic Trauma Association (OTA): 44B; Weber: B; Lauge-Hansen: supination-external rotation (grade IV with deltoid ligament failure). There was a posterior fragment (**Figure 1C**, **1D**); cross-sectional CT showed incongruence of the tibiotalar articular surface (**Figure 1E**; sagittal CT reconstruction). We performed open reduction and internal fixation via the posterolateral approach 2 days after the injury. A posterior buttress plate was applied to fix the posterior fragment (**Figure 1F**). After the operation, we performed 3D CT to compare the pre- and postoperative reduction status. The fragment was anatomically reduced and rigidly fixed. The articular surface was smooth and in congruence (**Figure 1G-I**: postoperative 3D CT). A cast was also used for deltoid ligament failure. The cast was used for 3 weeks, followed by ankle functional exercise. During follow-up, function was good, and the patient had no pain.

Case 2

A 56-year-old male sustained an ankle sprain when walking downstairs. A trimalleolar fracture was classified as follows. OTA: 44c; Weber: c; Lauge-Hansen: pronation-external rotation (grade IV with internal malleolar avulsion) (**Figure 2A**). Open reduction and internal fixation was performed via lateral (lateral malleolar) and medial (medial malleolar) approaches. For the posterior fragment, we used 2 screws through an anterior stab incision from anterior to posterior (**Figure 2B**). After a year, the fractures were healed (**Figure 2C**). There was still some pain and malfunction on dorsiflexion of the ankle joint.

Discussion

De Vries et al. [6] performed long-term follow-up, and found that patients in whom posterior malleolar fragments were fixated did not have a statistically significant better outcome than those in whom the fragments were not fixated, concluding that the good results showed no evidence of the need for fixation of smaller fragments. Moreover, satisfactory results [7] were achieved in posterior malleolar fractures measuring less than 25% of the joint surface when an acceptable reduction was performed, even without osteosynthesis. Biomechanical research [8] indicated that posterior malleolar fractures cannot affect ankle stability. However, some [9] thought that posterior malleolar fractures may result in persistent posterior ankle dislocation, or a tendency toward dislocation, with compromise of the soft tissue surrounding the joint. These authors suggested placing an external fixator for provisional reduction of an unstable posterior malleolar fracture in the emergency room. In our experience, it is necessary to reduce and fix the posterior fragment, regardless of size and type, because these fragments constitute the articular surface of the ankle joint. Good reduction will result in good recovery of function [10-12]. Therefore, early weight-bearing [13] after open reduction and internal fixation of posterior malleolar frac-

tures of the ankle joint facilitates recovery, promotes fracture union, and allows the patient to assume normal activity after surgery. The reported incidence of posterior posttraumatic osteoarthritis varies in malleolar fractures, especially when a posterior malleolar fragment is present [14]. Anatomical reduction and rigid fixation, with a plate for a larger fragment and a screw for a smaller one, should be performed. Our patients actually had better scores than those who underwent traditional surgery (which cannot achieve anatomical reduction and rigid fixation) during more than 2 years of follow-up. Unevenness of the articular surface can cause pain and malfunction.

The purpose of transfixing the syndesmosis with a screw is to maintain the distal tibiofibular relationship until the syndesmotic ligaments have healed. The healing period should be 6 weeks to 3 months. In our research, we think the function of posterior malleolar stabilization of syndesmotic injuries is equivalent to that of screw fixation. Studies reported even more stable fixation [15, 16]. In addition, direct visualization of the posterior malleolar reconstruction was more accurate than syndesmotic screw fixation [17]. No cases used syndesmosis screws in our research, but still achieved very good functional recovery. This also avoided screw breakage, which allowed patients to exercise at an early stage.

Plain radiographs cannot provide enough information about ankle fractures, especially when they involve the posterior malleolus. Comminution and obliquity of the posterior lip fragment may not be appreciated on the lateral ankle radiograph. Surgically relevant information is missed, which can lead to intraoperative inability to properly reduce the fracture. The fracture lines associated with posterior malleolar fractures appear to be highly variable. Preoperative CT evaluation is recommended in all patients [18] with trimalleolar fractures, independent of the size of the posterior fragment [19]. We performed transverse CT for every case to provide images of the size, location, comminution, and displacement of posterior lip fractures. Therefore, definitive diagnosis can be made before surgery, and a buttress plate can routinely be prepared for the posterior fragment.

The surgical approach should be guided by the location of the fragment. Direct access to the posterior fragment is necessary. We formerly inserted the screw from anterior to posterior by using an anteromedial incision or a small anterolateral stab incision. A lag screw inserted from anterior to posterior posed the problem of not gaining enough purchase in the posterior fragment. The posterolateral approach allowed good exposure and stable fixation of a displaced posterior malleolar fragment with few local complications. The anatomical repositioning and stable fixation led to good functional outcome [20]. Bois and Dust [21] applied posteromedial and posterolateral approaches to treat posterior fracture dislocation of the ankle in retrospective clinical research and achieved good results. Our approach can treat both the lateral and posterior malleoli at the same time with only one skin incision. Moreover, a posterior buttress for a lateral malleolar fracture conforms to biomechanical theory. Further testing should be done to verify this hypothesis. A compression screw through a plate can also be used in such research. Kim et al. [22] reported that anatomic variation of the superficial peroneal nerve existed in 12% of the population. Therefore, a lateral approach may cause a sensory deficit in these patients. For the lateral approach, the sural nerve must be protected.

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Disclosure of conflict of interest

None.

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