

High Incidence of Implant Failure Happened Using Anterior-posterior Screws for the Fixation of Tibial Posterior Pilon Fracture.

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Research

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Abstract

Objective—To explore the mechanism of posterior pilon fracture with different proportion of the medial malleolus involved and evaluate clinical outcomes of anterior-posterior screws fixation.

Methods: Patients admitted to our hospital with diagnosis of tibial posterior Pilon fracture were identified from January 2014 to January 2018. Mechanism from medical history, proportion of the medial malleolus involved (not involved/partial involved /total involved) from axial CT scan were recorded to figure out the mechanism. Burwell—Charnley radiographic criteria of reduction, American orthopaedic Foot—Ankle society ankle-hindfoot scale at 12 month follow-up were recorded to evaluate the curative effect of anterior-posterior screws fixation.

Result: Sixty-nine patients were identified in this retrospective study. 43 males and 26 females were included, with mean age 46.9 years old—range, 21-76 years—. Mechanism of the 8 cases with fracture line do not involve medial malleolus but accompanied with die-punch fragment included 4 ground level fall, 2 fall off stairs, 1 sport injury, 1 fall from bike. Mechanism of the 52 cases with medial malleolus partial involved included 14 motor vehicle accident, 14 fall off stairs, 5 sport injury, 3 fall from bike and 16 fall from height. Mechanism of the 9 cases with medial malleolus totally involved included 6 falling from height, 2 falling of stairs and 1 motor vehicle accident. Five patients were treated with the fixation of Anterior-Posterior screws, fracture line of four cases do not involve medial malleolus and the rest one partial involved. The Burwell—Charnley radiographic criteria of reduction were fair in 4 and poor in one on the post-operation X-ray. Three of them got implant failure. The AOFAS ankle-hindfoot scale 12-month post-operation for the rest two patients were 78 and 72.

Conclusion: There is a high risk of implant failure using A-P screws for the treatment of posterior pilon fracture. The mechanism of posterior fracture involve medial malleolus is mainly vertical force.

Introduction

Posterior malleolar fracture account for 7%-44% of all ankle fractures^[1]. Recently, various descriptive names of “Posterior Pilon fracture” or “pilon variant posterior malleolar fracture” were used to describe a special kind of posterior malleolar fracture which is characterized by posterior malleolar fracture with medial malleolus involved or articular impaction. Different from rotational-force ankle fracture, the mechanism of posterior pilon fracture was reported to be both vertical and rotational violence recently^[1-3]. Vertical force was believed to be the reason for medial malleolus involved or articular impaction. Although vertical force posterior pilon fracture was distinguished with ground-level rotational force posterior malleolar fracture, the difference of mechanism among posterior pilon fragment with different proportion of the medial malleolus involved was seldom discriminatively reported. As posterior pilon fracture do have different variation of medial malleolus involved clinically (not involved but accompanied with die-punch fragment/partial involved /total involved), it is important to identify the difference of mechanism among them so that the mechanism of posterior pilon fracture could be fully understood.

Traditionally, the choice of fixation for posterior malleolar fracture include screws from anterior to posterior (A-P screws), screws from posterior to anterior (P-A screws) and plate. Outcomes of P-A screws and plate fixation were reported by recent studies^[4-5]. But the clinical outcome of A-P screws was seldom reported. However, large intact fragment is common in posterior pilon fracture, and anterior to posterior screws fixation is an traditional method^[6] to fix the large intact fragment. Although seldom reported, A-P screws is still widely used, especially in primary hospitals in China. We respectively studied our patients in an attempt to figure out the difference of mechanism among posterior pilon fracture with different proportion of the medial malleolus involved and clinical outcomes of A-P screws fixation for the treatment of posterior pilon fractures. The purpose of this study includes: (i) Exploring the relationship between mechanism and characteristic of posterior pilon fracture.(ii)Evaluating clinical outcomes of anterior-posterior screws fixation.

Patients And Methods

Inclusion and Exclusion Criteria

Patients were selected using the following inclusion criteria: (i) patients with diagnosis of posterior pilon fracture, which is defined as posterior malleolus fracture do not involve midial malleolus but accompanied with die-punch fragment and subluxation of talus or posterior malleolus fracture involve midial malleolus and subluxation of talus^[7],with or without die-punch fragment; (ii) patients treated by operation with at least 12-months follow-up period. (iii) Patients with complete medical and radiographic records.

The exclusion criteria included: (i) Patients with age \geq 16 years old. (ii) patients had an open ankle fracture. (iii) patients had a less-than-12-months follow-up period.

Study Design

This retrospective study got approved by Ethics Committees of the hospital. Patients with diagnosis of posterior pilon fracture in our institution between January 2014 to January 2018 were reviewed. Informed consent was provided by all participants.

Classification Of Posterior Pilon Fracture

The characteristics of posterior pilon fracture reported by former researches^[1-7] include: posterior malleolus fragment displace proximally, posterior dislocation of talus, die-punch fragment, posterior malleolus fracture line extending to midial malleolus. However, the proportion of the midial malleolus involved is not fully discussed. We noticed on the axial CT scan that posterior malleolus patients with the characteristics of posterior malleolus fragment displace proximally, posterior dislocation of talus and die-punch fragment could partially, totally or negatively involved. To investigate the relationship between

mechanism and characteristic of posterior pilon fracture, we classified posterior pilon fracture into three categories : **(i)** Medial malleolus not involved: posterior pilon fracture with fracture line do not involve medial malleolus but accompanied with die-punch fragment(Fig. 1N); **(ii)** Medial malleolus partially involved: posterior pilon fracture with medial malleolus partial involved(Fig. 1P); **(iii)**: Medial malleolus totally involved: posterior pilon fracture with total medial malleolus involved(Fig. 1T). The difference was believed to be related to the mechanism. So the mechanism of each type was retrospectively studied to figure out the difference of mechanism among three groups.

For patients treated by A-P screws fixation, the quality of reduction and functional outcome were evaluated by following criterion. Burwell–Charnley radiographic criteria of reduction^[8] was used to evaluate the quality of reduction. Three categories including anatomical, fair and poor were used in this criteria. AOFAS ankle-hindfoot scale^[9] was used to evaluate the functional outcome of A-P screws fixation at 12-month. The AOFAS ankle-hindfoot scale was measured in pain, function, alignment on a maximum of 100.

Results

General Results

Sixty-nine patients were identified in this retrospective study. Including 43 males and 26 females, with mean age 46.9 years old (range, 21–76 years). The mechanism of the 69 patients included 4 ground level fall, 15 motor vehicle accident, 18 fall off stairs (> 2 stairs), 6 sport injury, 4 fall from bike and 22 fall from height (> 1 m). Time of follow-up for sixty-nine patients was 16.7months(range,12–48 months). Five patients was treated by A-P screws fixation, 35 patients were treated by P-A screws fixation and 29 patients were treated by plate fixation. The five patients treated by A-P screws fixation all got anatomical or fair reduction by medical records according to Burwell–Charnley radiographic criteria by the evaluation of intra-operation fluoroscope. Time of follow-up for the five patients was 24 months(range,18–48 months).

Mechanism of Posterior Pilon Fracture with different proportion of the medial malleolus involved

(i) Medial malleolus not involved: Mechanism of the 8 cases with fracture line do not involve medial malleolus but accompanied with die-punch fragment included 4 ground level fall, 2 fall off stairs, 1 sport injury, 1 fall from bike. **(ii)** Medial malleolus partially involved: Mechanism of the 52 cases with medial malleolus partially involved included 14 motor vehicle accident, 14 fall off stairs, 5 sport injury, 3 fall from bike and 16 fall from height. **(iii)** Medial malleolus totally involved: Mechanism of the 9 cases with medial malleolus totally involved included 6 fall from height, 2 fall of stairs and 1 motor vehicle accident. Because low energy ground-level fall only happened in 4 cases, statistics analysis is not available in this study.

Clinical Outcome Of A-p Screws Fixation

Fracture characteristic: Five patients with diagnosis of posterior pilon fracture were treated by A-P Screws fixation. The posterior malleolus fracture characteristic in four were medial malleolus not involved and one medial malleolus partially involved.

Burwell—Charnley radiographic criteria of reduction : Post-operation X-ray on the second day were used to evaluate the quality of reduction according to Burwell—Charnley radiographic criteria of reduction. The result showed fair in 4 and poor in one.

Implant failure happened in 3 patients. One patient treated by A-P screws was a 53-year-old female with the mechanism of falling from a bike. She removed her plaster 3 weeks post-operation and the X-ray two days later showed displacement of the fragment without any complaint of pain or snap (Fig. 2). The second patient was a 76-year-old male with the mechanism of falling off stairs, the Burwell—Charnley radiographic criteria on the post-operation X-ray was poor. The plaster was removed 6 weeks later and X-ray showed implant failure (Fig. 3). The third patient was a 69-year-old male with the mechanism of falling off stairs. The plaster was removed by himself 4 weeks post-operation. He complained a snap at the same day while moving his ankle passively after removing the plaster. The emergency X-ray showed displacement of the fragment. The three patients with implant failure patients were all re-operated with plate fixation. The AOFAS ankle-hindfoot scales for the three patients with implant failure at 12-month follow-up were 66, 42 and 61. The rest two patients include one 49-year-old female and one 55-year-old male. The AOFAS ankle-hindfoot scales of the two patients at 12-month follow-up were 78 and 72.

Discussion

Our respective study showed high incidence of implant failure happened using A-P screws for the treatment of posterior pilon fracture. We believe the main reason for this is that lever arm of A-P screws is short and not enough to resist the vertical force inflicted to fragments by talus during extension-flexion movement of the ankle. The Burwell—Charnley radiographic criteria of reduction in 5 patients treated with A-P screws were fair in 4 and poor in one. This indicated that anatomically reduction could not be achieved by close reduction in this group. The reason for this may be related to the mechanism of vertical force. As fracture displacement was caused by impaction of talus, it can not be restored by tension of soft tissue. Un-anatomical reduction may be the second reason for implant failure.

Treatment choice for posterior malleolus include A-P screws, P-A screws and plate. A-P screws used to be popular, especially for large posterior malleolus fragments. Although seldom reported, A-P screws are still used for the treatment of posterior malleolus in recent years. The posterior pilon fracture patients treated with A-P screws in this group were group A or B with intact fragment. The result showed high incidence of implant failure by A-P screws for the treatment of posterior pilon fracture, even for large intact fragment.

Although the clinical outcome of A-P screws was seldom reported, in one biomechanical study of the 3 different types of fixation, Anwar^[10] reconstructed the three dimensional (3D) model of the ankle joint of healthy volunteer, and fixed fracture model by three different fixation modalities (A-P screws, P-A screws, plate). The result of biomechanical study showed A-P screws had the most relative micro-motion and vertical displacement.

The mechanism of ankle fracture is closely relative to the fracture line. In this study, posterior pilon fracture was classified into three categories: (i) posterior pilon fracture with fracture line do not involve medial malleolus but accompanied with die-punch fragment; (ii) posterior pilon fracture with medial malleolus partial involved; (iii) posterior pilon fracture with total medial malleolus involved. The reason for different categories is related to different flexion position according to the medical history, in which more flexion resulted in less medial involved. The purpose of the categories was not proposing a novel classification but to identify the difference of mechanism, whether more flexion resulted in less medial involved need to be proved by biomechanical test. Several classification were proposed for posterior pilon fracture in the past few years^[3,11], basically based on the morphology of the fragment only. We believe the mechanism is more important for the diagnosis and prognosis of posterior fracture. Biomechanical studies^[12] should be done to figure out the relationship between mechanism and morphology of posterior pilon fracture in future. Only with knowledge of mechanism can surgeons suggest potential associated injuries, which is helpful in diagnosis and treatment^[13]. Clinically, our study simply showed posterior pilon fracture which involve medial malleolus ,partially or totally,were mostly caused by vertical force, as falling from height or motor vehicle accidents.

This study has several limitations. Firstly, it is a respective study without control. Secondly, the classification is based on small sample. The purpose of the classification is neither instructing the treatment nor predicting prognosis, but trying to find out the relationship between mechanism and pathoanatomy. Thirdly, fracture line of the fibular and the size of the posterior malleolar fragment^[14]were not studied, we believed lateral malleolus fracture by vertical force is different from that of traditional rotation force and the size of posterior pilon fragments with medial malleolus totally involved can not be simply measured by size.

Conclusion

This study demonstrated demonstrated a high risk of implant failure using A-P screws for the treatment of posterior pilon fracture. Vertical mechanism above-ground- level,like falling from height or motor vehicle accidents is the main mechanism of posterior fracture which involve medial malleolus.

Declarations

Ethics approval and consent to participate:

The research got approved by Ethics Committee of Army General Hospital (LZEC2019-YW-085)

Consent for publication:

Informed consent was provided by all participants

Availability of data and materials :

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

Competing interests□

The authors declare that they have no competing interests

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Authors' contributions:

1:Hao Wang. Huayong Zheng: design of the work; the acquisition and analysis,

2: Dongdong Lv .lianhua Li. Jianzheng Zhang . interpretation of data

Tiansheng Sun:drafted the work or substantively revised it

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NO

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Figures

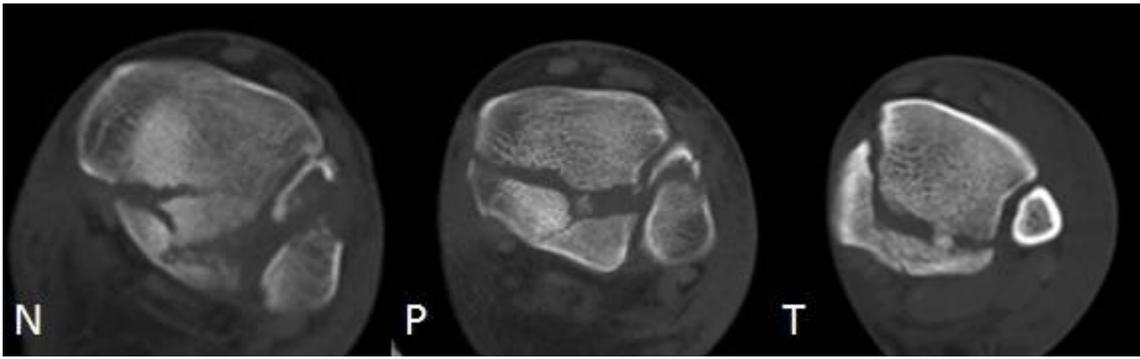


Figure 1

N: posterior pilon fracture with fracture line do not involve medial malleolus but accompanied with die-punch fragment. P: posterior pilon fracture with medial malleolus partial involved. T: posterior pilon fracture with total medial malleolus involved.



Figure 2

2a-2b: 53 year old female patient with the mechanism of falling from bike, X-ray preoperative showed trimalleolar fracture and subluxation of talus; 2c: transverse CT showed the posterior pilon fragment do not involve medial malleolus but accompanied with die-punch fragment; 2d-2e: the postoperative X-ray showed reduction of the fragment was fair according to Burwell–Charnley radiographic criteria of reduction; 2f-2g: X-ray 3 weeks post-operation showed implant failure happened; 2h: revision with plate fixation.



Figure 3

76 year old male patient with the mechanism of falling off stairs , 3a-3b:X-ray preoperative showed trimalleolar fracture and subluxation of talus;3c:transverse CT showed posterior pilon fracture with medial malleolus partial involved;3d:transverse CT showed posterior pilon fracture with medial malleolus partial involved;3d-3e:the postoperative X-ray showed the reduction of the fragment was poor;3f: X-ray 6 weeks post-operation showed implant failure happened;3g:revision with plate fixation.