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Size matters: The influence of the posterior fragment on patient outcomes in trimalleolar ankle fractures

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KEYWORDS

ankle fracture
posterior malleolar fracture
CT
radiographs

List of abbreviations:
PMF: posterior malleolar fracture
CT: computer tomography
SD: standard deviation
AO: Arbeitsgemeinschaft für Osteosynthesefragen
AOFAS: American Orthopaedic Foot and Ankle Society

ABSTRACT

Introduction: Ankle fractures are increasing in incidence. The more complicated the lesion is, the higher the risk of developing posttraumatic arthrosis. Severe posttraumatic arthrosis results in a reduced quality of life. Therefore, the treatment of a trimalleolar fractures is crucial. However, the treatment guidelines for posterior malleolar fractures (PMF) are still based on recommendations from 1940. Only a few retrospective studies have been conducted, which analysed patient outcomes based on lateral X-rays of the ankle.

The purpose of this retrospective analysis was to survey patient outcomes in relation to the size of the PMF on the basis of CT-scans.

Methods: We retrospectively examined 42 patients with trimalleolar fractures with an average follow-up of 2.5 years. Twenty-four patients (57%) received a CT scan of the ankle joint. The radiologic images were analysed for the size of the PMF and the involvement of the joint surface using lateral X-rays and available CT images.

We examined all 42 patients clinically and radiologically, and estimated the grade of arthrosis of the ankle in accordance with the Bargon Score and assigned AOFAS Scores for each patient.

We divided our patients into different groups according to the size of their PMF and evaluated patient outcomes in accordance with the compiled data first on the basis of X-ray data and then on the basis of CT data.

Results: Comparing the measurement results by two different radiologic methods revealed that CT results in a more precise determination of PMF size in contrast to lateral X-rays, by which measurements were generally overrated.

The statistical evaluation of our data demonstrated that patients with an osteosynthesis of the PMF and a PMF size of >25% showed signs of posttraumatic arthrosis but had better outcomes in accordance to the AOFAS score. All results were not significant.

Conclusion: An exact evaluation of CT images of posterior malleolar fractures in patients with trimalleolar ankle fractures is crucial for the decision to perform an osteosynthesis of the PMF and, therefore, an analysis of patient outcomes. The results of previous studies should be evaluated cautiously due to missing CT data. To date, this is the largest retrospective patient series of patient outcomes based on CT data.

Introduction

The incidence of ankle fractures is on the rise [1]. Retrospective studies have demonstrated that patients with bimalleolar fractures have a 4% risk of developing posttraumatic arthrosis, and in patients with trimalleolar fractures, the risk is as high as 34% [2]. Therefore, the anatomic reconstruction of the fracture is increasingly necessary the more complicated the fracture becomes.

Textbooks and many studies have indicated that in the case of posterior malleolar fracture (PMF) in trimalleolar fractures, osteosynthesis is indicated when the fracture affects at least 25% of the joint surface of the distal tibia. This statement originates from a study dated from 1940 [3], and to date, there are no substantial data to prove otherwise [4].

Clinical studies have found very different results [5-10]. Most authors agree that the presence of a PMF worsened patient clinical outcomes. However, the debate continues whether small PMFs with less than 25% of joint surface affected should be anatomically reduced and fixed as well.

The available clinical studies are difficult to compare due to different emphases and different examination methods. Several studies showed that in cases of a PMF, a CT scan should be conducted to exactly determine its size [11-13].

Most retrospective studies have only evaluated patient outcomes on the basis of conventional X-rays.

Currently, CT scans in trimalleolar fractures provide more precise information about the size of the PMF and joint involvement.

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However, there is a lack of studies on patient outcomes and the rate of post-traumatic arthrosis based on CT data.

Patient and methods

We conducted a retrospective analysis of all patients between 18 and 100 years of age with trimalleolar fractures who were operatively treated in our clinic between 2005 and 2011. An open reduction an internal fixation was conducted according to AO (Arbeitsgemeinschaft für Osteosynthesefragen) methods.

The follow-up was at least 6 months after operation, with an average follow-up of almost 2.5 years (range: 8.5–85.3 months). Eighty-one patients were eligible for inclusion, and all data were checked for integrity. Institutional Review Board or Ethical Committee Approval was not applicable because the concomitant ankle lesions were retrospectively diagnosed and treated as part of usual patient treatment and not specifically as part of this study.

Only patients, who were seen at outpatient clinics at least 6months after their operations and had completed AOFAS scores and postoperative X-rays of the ankle in anterior posterior (AP) and lateral views, were acquired.

Forty-two patients could be attained for follow-up examinations. Of these, 24 patients (57%) had a CT scan of the ankle joint. All patients were examined using plain radiographs of the fractured ankle mortise and the lateral view.

Lateral plain radiographs were used for the first analysis of the fracture pattern and especially the size of the PMF. The size of the joint surface and the size of the PMF in centimetres were measured, and the percentage of the PMF in relation to the overall joint surface was ascertained, (Fig. 1).

All available CTs scans were then analysed. The axial CT slices were measured in square millimetres with AQNET (Aquarius Netviewer, Version 4.4, TeraRecon, Foster City, USA) (Fig. 2).

We chose a representative CT-slice with the largest measurable diameter, in which the contour of the unfractured tibial joint surface could be measured. We did not measure the medial malleolus because it carries no weight-bearing joint surface. We then added the area of the fractured tibial joint surface. Through the rule of three, the fractured fragment percentage of the joint was determined.

$$\frac{100\%}{\text{total joint area in square millimetres}} = \frac{X\%}{\text{area of PMF in square millimetres}}$$

Fig. 1. Schematic depiction of the measurement of the PMF size with a measurement tool using the lateral X-ray (T: Tibia, V: posterior malleolar fragment, dashed-line: overall joint surface in millimetres, dotted-line: fragment size of PMF).

According to the size of the PMF, the patients were divided into 2 groups: lesser than (group I) and greater than 25% joint surface involvement (group II).

We also compared the X-ray results with results from CT-data evaluation.

Additionally the fracture type of the PMF was assigned according to the CT classification by Bartonicek et al [14].

Finally, X-rays and CTs, if available, were analysed for postoperative joint incongruency and joint-steps. All incongruences or steps of the joint surface greater than 2 mm were assessed as incongruent.

The level of posttraumatic arthrosis for the ankle was determined by two experienced surgeons, according to the Bargon Score [15]:

0 = Sclerosis in a weight-bearing area, without any joint space reduction
1 = Sclerosis in a weight-bearing area, with a slight joint space reduction and osteophytes
2 = Sclerosis with further joint space reduction and osteophytes
3 = Joint space reduction, subchondral lesions and cystic alterations in the subchondral bone

The AOFAS (American Orthopaedic Foot and Ankle Society) Ankle-Hindfoot Scale questionnaire was administered to obtain objective and subjective patient outcomes.

We determined the arithmetic means with reference to the different scores and calculated the standard deviations. Furthermore, we identified the p-values and the confidence intervals with regard to the alternative hypothesis that an internal fixation should also be conducted with a fracture fragment

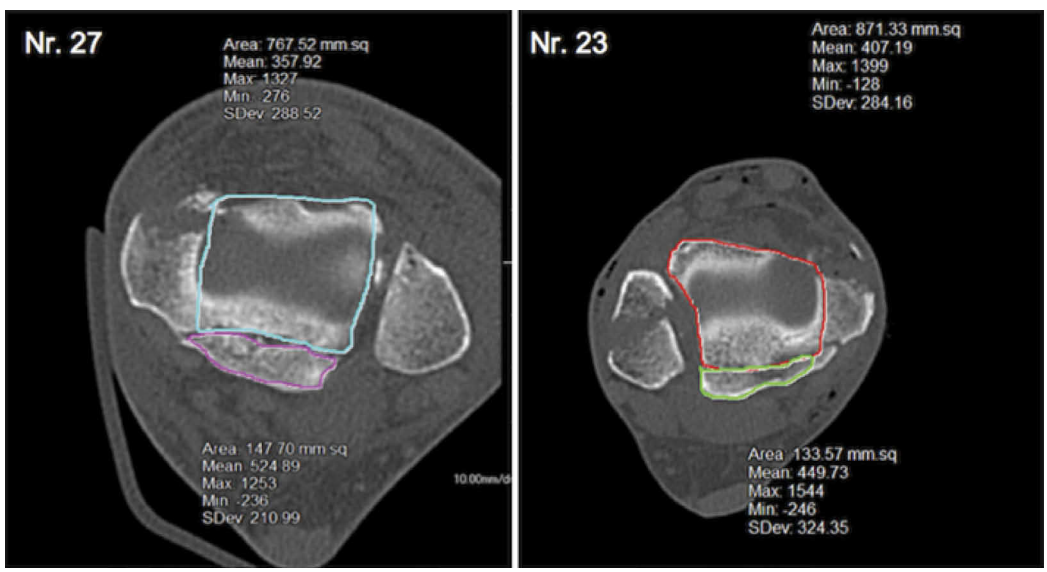

Fig. 2. Examples of joint-surface-involvement measurements with the AQNET Tool in square millimetres for two different patients (internal number 23 and 27).