Classification of Pilon Tibial Fractures

J de Halleux, MD
Geneva, June 2th 2016
Fracture of the distal tibial metaphysis

(intra or extra articular)

- Destot 1911: “Pilon fracture”
- Bonin 1950: “Plafond fracture”
PILON FRACTURE

Talus acts as a hammer that impacts and injures the tibialplafond
• There is virtually no resistance to a compressive force more than 3cm proximal to the subchondral bone plate (Atiken et al.)

• High-energy which is axially loaded => pilon fracture
Mechanisme of injury

High (ski-road accident)
Low (osteoporosis)

Axial loaded compr F
Torsional component

ENERGY

FORCES

POSITION OF THE FOOT

Varus-valgus
Plantar-dorsiflexion
Pilon Fractures: Mechanism of Injury

Rotation Force
- Slow rate of load application
- Little energy released at failure (yield point)
- Little comminution
- Predominant translation displacement of the talus
- Minimal soft tissue injury

Axial load Force
- Rapid rate of load application
- Large amount of energy released
- Comminuted articular surface and metaphysis
- Proximal displacement of the talus
- Severe soft tissue injury

Courtesy of Marsh JL, Saltzman CL
Mechanisme of injury

Böhler

1951

Position of the foot at the time of injury

Böhler and all, in Technik der knochenbruchbehandelung. Vienna: Aufi Maudrich; 1951; p12-3
Classification

RÜEDI AND ALLGÖWER

1968
Most commonly used

- Severity of the injury
- Outcome
- Planning the surgical approach

Rüedi, Allgöwer, Injury, 1973; 5:130—4
Rüedi and Allgöwer CLASSIFICATION

only intrarticular fracture!

**TYPE 1**  
Non displaced

**TYPE 2**  
Large articular fragments

**TYPE 3**  
Communion + impaction

Rüedi, Allgöwer, Injury, 1973; 5:130—4
Classification SOFCOT, 1991
(706 patients)

- PARTIAL 43% (continuity tibial diaphysis/epiphysis)
- COMPLETE 57% (NO continuity tibial diaphysis/epiphysis)

Copin G and all. Les fractures du pilon tibial de l’adulte
## AO/OTA Classification

### Intra + extrarticular

#### More details

| Extra-articular | 43A | 1 | 2 | 3 |
| Partial intra-articular | 43B | 1 | 2 | 3 |
| Completely intra-articular | 43C | 1 | 2 | 3 |

**Degree of Fracture Comminution**

**Others**: fracture direction + description + localisation

impaction
degree of comminution

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*Müller M and all, The comprehensive classification of fractures of long bones. Berlin: Springer verslag; 1990*
Classification AO
distal Tibia: 43

43-A: extraarticular

Picture from M Assal
Classification AO distal Tibia: 43

43-A: extraarticular
NO continuity diaphysis/articular surface

Picture from M Assal
Classification AO
distal Tibia: 43

43-B: partial intraarticular (torsion mechanism)
Classification AO
distal Tibia: 43

43-B: partial intraarticular (torsion mechanism) with continuity diaphysis/articular surface
Classification AO

distal Tibia : 43

43-C: completely intra articular (high energy compr F)
Classification AO
distal Tibia : 43

43-C: completely intra articular (high energy compr F)
NO continuity diaphysis/articular surface
CLASSIFICATIONS

No informations of fibula fracture (75-85% *)!

CLASSIFICATIONS

No informations about medial, lateral or axial deviation

Medial compression

Lateral compression

Axial compression

Barei et al. J Orthop Trauma, Volume 20, Number 1, January 2006
CLASSIFICATIONS

- **In Theory**: Helpfull for scientific interest 
  *(studies, publications)*

- **In Practice**: Doesn’t give us really all the necessary needed informations

→ **Ct-scan!!!**
Ct Scan and the pilon map

- Understanding the anatomy of the fracture
- Primary and secondary fracture lines
- Improve operative techniques
POSTERIOR PILON TIBIAL FRACTURE

Posterior Pilon Fractures: 
A Retrospective Case Series 
and Proposed Classification System

Georg Klammer, MD¹, Anish R. Kadakia, MD², David A. Joos, MD³, 
Jeffrey D. Seybold, MD³, and Norman Espinosa, MD¹

Evaluation of Posterior Malleolar Fractures 
and the Posterior Pilon Variant in 
Operatively Treated Ankle Fractures

Paul J. Switaj, MD¹, Brian Weatherford, MD², Daniel Fuchs, MD¹, 
Brett Rosenthal, MD¹, Eric Pang, MD¹, and Anish R. Kadakia, MD¹
Malleolar fracture?
Tibial Pilon fracture?

DIFFERENCES
Mechanism of injury / Classification / Surgical treatment
Classification of malleolar fracture

<table>
<thead>
<tr>
<th>WEBER</th>
<th>LAUGE HANSEN</th>
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<tbody>
<tr>
<td>A</td>
<td>Supination Adduction</td>
</tr>
<tr>
<td>B</td>
<td>Supination Exorotation</td>
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<tr>
<td>C</td>
<td>Pronation Exorotation</td>
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POSTERIOR PILON TIBIAL FRACTURE

**AP view**: Medial malleolar double contour sign

**Lateral view**: Posterior articular impaction

**Mortise view**: Sagital split of the posterior malleolus

Figure 1. These radiographs represent the characteristics of the posterior pilon variant fracture pattern (A) Anterior-posterior radiographs with arrows demonstrating the medial malleolar double contour sign. (B) Mortise radiographs with arrows demonstrating the sagittal split of posterior malleolus. (C) Lateral radiographs with arrows demonstrating posterior articular impaction.

Paul J. Switaj et al. Foot and ankle international 2014
The usual posterior lip fragment (posterior malleolus) is of triangular shape with its base laterally. The fracture line exits medially at the middle of the medial fragment (groove). Fracture hematoma is directly visible on the anteroposterior (mortise) view, while the lateral radiographic view reveals the posterior tibial nerve or artery. Aggressive retraction has the potential to lead to injury to the posterior tibial tendon. Fracture hematoma is reconstructed CT images (Figure 5) show the large posterior fragments, whereas the posterior tibial nerve or artery is directly visible in the anteroposterior view.

On the basis of the mortise or lateral radiographic view, all fracture patterns were categorized on the basis of the Lauge-Hansen classification system. Fracture anatomy shows the presence of posterior fragments. The usual posterior lip fragment (posterior malleolus) is disabled due to the presence of posterior fragments. There are usually two main posterior fragments: the larger posteromedial and a smaller posterolateral fragment. One or more posterior fragments are captured by the osteochondral fragments. Osteochondral fragments are detached (nine of ten patients), and are dislocated proximally, under the posteromedial plafond (nine of ten patients).

Stage II fractures (two fractures) are those that demonstrate the posterior half of the medial malleolus. Fractures stage III (four fractures) or stage IV (forty fractures), seven pronation-external rotation fractures are dislocated proximally, under the posteromedial plafond (nine of ten patients), with the posterior half (posterior colliculus) of the medial malleolus. Additional osteochondral fragments are detached (nine of ten patients). Two of ten patients have an additional lateral fragment.

Fracture type and location (Figure 1) represent the average amount of exposure and access required to the posterior fragments. For many cases, a standard posterolateral approach to the ankle is sufficient. A standard small fragment set (3.5- and 2.7-mm cortical screws, 3.5-mm cancellous screws, and a 5.5-mm cannulated screw) and an image intensifier are required. A standard large fragment set (4.5- and 6.5-mm cortical screws) is additionally used for better visualization of the ankle.

The patients were positioned prone, with a bolster or towel roll underneath the distal lower leg to allow a standard posterior fragment approach to the ankle. Maneuver allows access to the posterior fragment for reduction. A stab incision is made, and the fracture fragments are directly visualized. A flexible holding wire is inserted into the medial malleolus to temporarily hold the fracture. If a posterior medial fragment is identified, a screw is inserted into the talar neck. Cortical screws and an image intensifier are required. A headlight is optionally used for better visualization of the ankle.

Antibiotics are administered preoperatively. A headlight is used for better visualization of the ankle. Fracture type and location represent the average amount of exposure and access required to the posterior fragments. A standard posterolateral approach to the ankle is sufficient. A standard small fragment set (3.5- and 2.7-mm cortical screws) is used for better visualization of the ankle. A headlight is optionally used for better visualization of the ankle.

A standard small fragment set (3.5- and 2.7-mm cortical screws, 3.5-mm cancellous screws, and a 5.5-mm cannulated screw) and an image intensifier are required. A standard large fragment set (4.5- and 6.5-mm cortical screws) is additionally used for better visualization of the ankle. A headlight is optionally used for better visualization of the ankle. Fracture type and location represent the average amount of exposure and access required to the posterior fragments. A standard posterolateral approach to the ankle is sufficient. A standard small fragment set (3.5- and 2.7-mm cortical screws) is used for better visualization of the ankle.
The kappa value for interobserver reliability of the Lauge-Hansen classification system was 0.60, indicating "moderate" agreement (Table 3). The observed agreement percentage was 82.6%. The kappa value for AO/OTA classification system with subgroups was 0.57, indicating "moderate" agreement. The observed agreement percentage was 70.0%. When just main groups for the AO/OTA classification were considered, there was a kappa value of 0.67, indicating "substantial" agreement. The observed agreement was 87%. These values are consistent with previously published data. The kappa value regarding identification of posterior malleolar fractures was 0.79, indicating "substantial" agreement. The observed agreement percentage was 91.1%.

When using the radiographic parameters outlined previously for defining a posterior pilon variant, the observers demonstrated a kappa value of 0.74, indicating "substantial" agreement. The observed agreement percentage was 89.3%.

Subgroup Analysis

CT Evaluation. In our series, 21 of 270 (7.8%) operative ankle fractures received preoperative CT scans, with 18 of these meeting consensus classification for presence or absence of posterior malleolar fractures. Based on plain radiographs, 15 of these patients had posterior malleolar fractures, with 12 of these patients having posterior pilon variant fractures. CT scans confirmed a posterior pilon variant fracture pattern in all 12 of these patients (Figure 2) and confirmed a posterior malleolar fracture without characteristics of the pilon variant in the remaining 3. The CT evaluation for remaining 3 fractures demonstrated that 1 posterior malleolar fracture had been missed on plain radiographic examination but did not represent a posterior pilon variant.

Age. In consensually classified fractures, the mean age of patients without a posterior malleolar fracture (n = 121) was 42.8 years, whereas patients with posterior malleolar fractures (n = 119) had a mean age of 49.0 years. The mean age of patients without a posterior pilon (n = 198) was 44.3, whereas patients with a posterior pilon fracture (n = 47) had a mean age of 52.1. A significant difference in age was seen for both posterior malleolar (P = .003) and posterior pilon fractures (P = .005; Table 4).

BMI. In consensually classified fractures, the mean BMI of patients without posterior malleolar fractures (n = 108) was 29.3, whereas the mean BMI of patients with posterior malleolar fractures (n = 108) was 30.1. The mean BMI of patients without posterior pilon fractures (n = 177) was 29.7; whereas the mean BMI of patients with posterior pilon fractures (n = 41) was 30.0. BMI did not appear to be significantly different in our analysis of posterior malleolar and posterior pilon fractures (P = .37 and P = .73, respectively; Table 4).

Gender. In the study, 57.1% of patients were female. Per consensus evaluation, 55.5% of females had a posterior malleolar fracture (compared to 42.3% of males) and 24.3% had the posterior pilon variant (compared to 13.2% of males). Calculated relative risk demonstrated that females were 1.31 (95% CI, 1.0-1.7) times more likely to sustain a posterior malleolar fracture and 1.83 (95% CI, 1.0-3.3) more likely to sustain a posterior pilon variant (Table 4).

Diabetes. Ten percent of patients with ankle fracture had diagnosed diabetes at the time of operation. Per consensus evaluation, 55.5% of females had a posterior malleolar fracture (compared to 42.3% of males) and 24.3% had the posterior pilon variant (compared to 13.2% of males). Calculated relative risk demonstrated that females were 1.31 (95% CI, 1.0-1.7) times more likely to sustain a posterior malleolar fracture and 1.83 (95% CI, 1.0-3.3) more likely to sustain a posterior pilon variant (Table 4).

PM fragment non reduced ? Risk for talar postéromédial subluxation
SOFT TISSUE

• The soft tissue envelope around the tibia is thin and constrained

• Majority of the blood supply is supported by an anastamotic network of extraosseous vessels from the PTA and ATA (Sommer et al.)
“A bone is like a plant with its roots deep in the soft tissues. Orthopaedics requires more the skills of the gardener than those of the cabinet maker”

Gathorne Robert Girdlestone (1881-1950)
Soft Tissue in closed fractures?

Tscherne Classification

(HELP FOR DECISION MAKING: DELAYED OR EARLY SURGERY?)

Grade 0
- Minimal soft tissue damage
- Indirect injury to limb (torsion)
- Simple fracture pattern

Grade 1
- Superficial abrasion or contusion
- Mild fracture pattern

Grade 2
- Deep abrasion
- Skin or muscle contusion
- Severe fracture pattern
- Direct trauma to limb

Grade 3
- Extensive skin contusion or crush injury
- Severe damage to underlying muscle
- Compartment syndrome
- Subcutaneous avulsion

Tscherne and all. Berlin: Springer-Verslag: 1984, 1-9
Closed Tibial Pilon Fracture?

- Degree of swelling
- Severity of contusion
- Presence of blisters
- Compartment syndrome
Soft tissue in open fracture?

Gustillo-Anderson classification

<table>
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<tr>
<th>Type</th>
<th>Description</th>
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| I    | Skin wound less than 1 cm  
      | Clean  
      | Simple fracture pattern |
| II   | Skin wound more than 1 cm  
      | Soft-tissue damage not extensive  
      | No flaps or avulsions  
      | Simple fracture pattern |
| III  | High-energy injury involving extensive soft-tissue damage  
      | Or multifragmentary fracture, segmental fractures, or bone loss irrespective of the size of skin wound  
      | Or severe crush injuries  
      | Or vascular injury requiring repair  
      | Or severe contamination including farmyard injuries |

Gustillo and Anderson classification of open fractures

Gustillo and all, J Bone joint Am, 1976;58:453-8
CONCLUSIONS

Consensus for pilon Tibial Fracture classification

Aim of classification: scientific interest + « make it easier »

- Good # description in the classification

- No one: all the needed information

→ Ct scanner!
CONCLUSIONS

Consensus
For Pilon Tibial Fracture severity

- Fracture Energy
- Fragment displacement (CT)
- Soft tissue swelling
Thank You