

Pilon Fractures

Anatomy and Classification

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Introduction

- Anatomy
- Classification
- Surgical approaches
- What is the evidence?

What are pilon fractures?

- Intra-articular # distal tibia
- *Pilon (pestle)*
 - Destot 1911
- *Plafond (ceiling)*
 - Bonin



Anatomy of the distal tibia

- Anterior, medial, posterior, lateral, distal surfaces
- Medial malleolus
- $\sim 30^\circ$ external rotation
- Articular surface
 - Wider anteriorly
 - Concave sagittally
 - Slightly convex transversely



Anatomy of the distal tibia

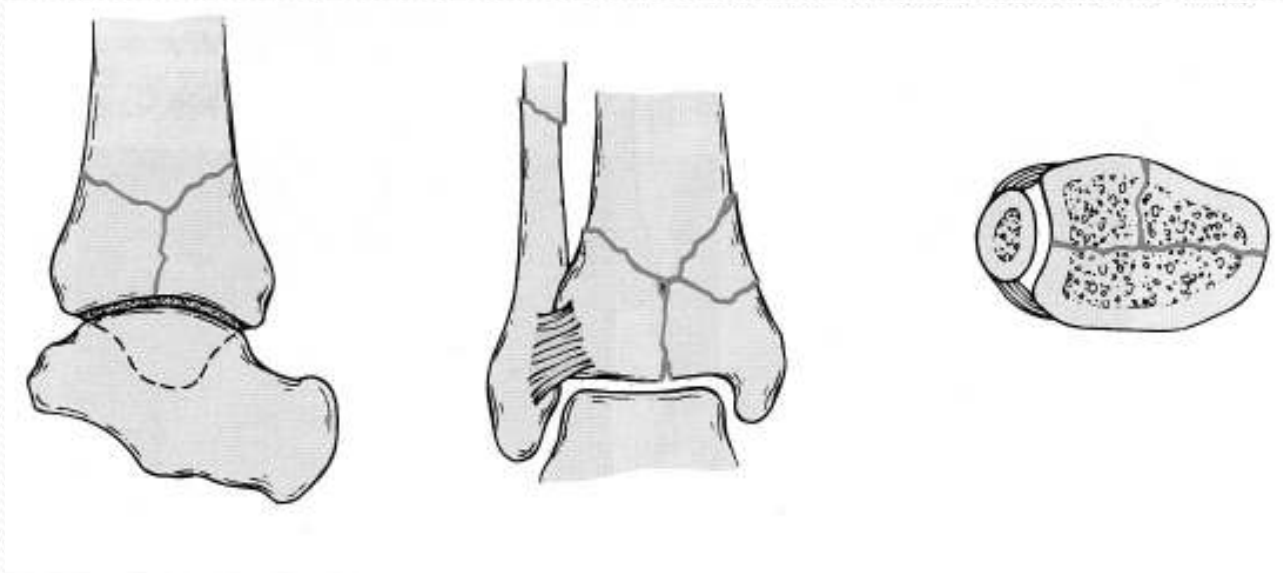
- No muscular attachments
- Vascular supply
 - Endosteal: from post tibial artery
 - Periosteal: anastamosis
 - Dorsalis pedis, posterior tibial and peroneal arteries
- Innervation
 - Deep peroneal, posterior tibial, saphenous, sural nerves

Classification

- Rüedi and Allgöwer¹
- AO-OTA²
- Topliss³
- Tscherne classification⁴

Rüedi and Allgöwer

- Descriptive
 - undisplaced low energy → severely comminuted high energy
- Type 1
 - Cleavage # without significant displacement



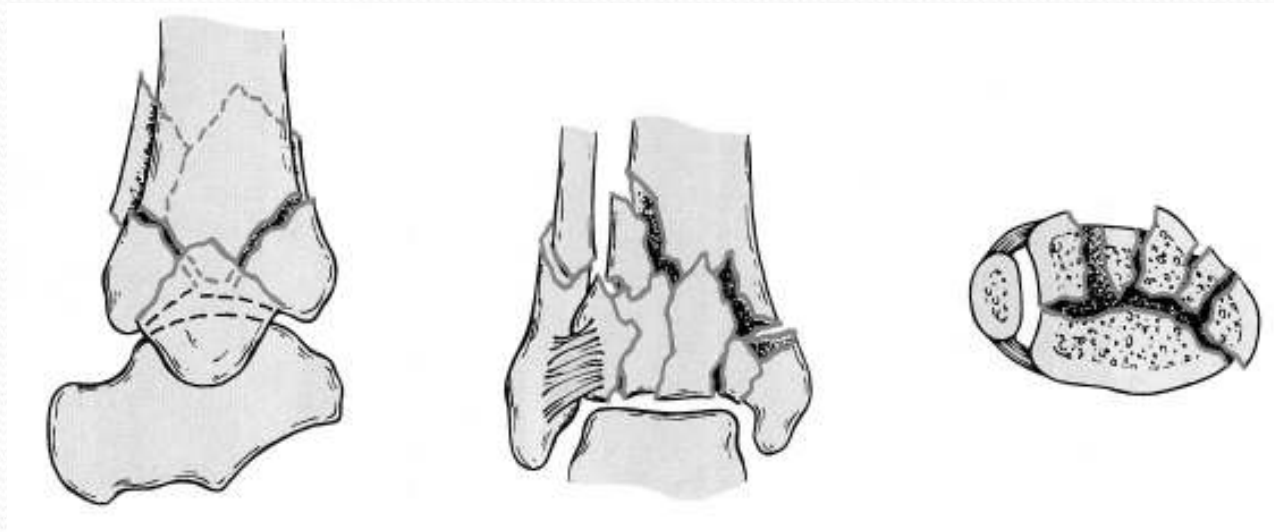
Rüedi and Allgöwer

- Type 2
 - Displacement articular surface but not crushed or grossly comminuted



Rüedi and Allgöwer

- Type 3
 - Impaction & comminution joint surface and metaphysis



AO-OTA

- Distal tibia (43)
 - Extra-articular A
 - Partial articular B
 - Complete articular C

**Extra
articular**



43-A1
metaphyseal simple



✓ select

43-A2
metaphyseal wedge



✓ select

43-A3
metaphyseal
complex



✓ select

**Partial
articular**



43-B1
pure split



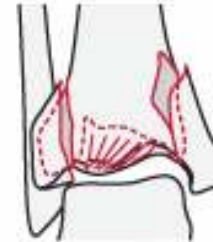
✓ select

43-B2
split-depression



✓ select

43-B3
multifragmentary
depression



✓ select

**Complete
articular**



43-C1
articular simple



✓ select

43-C2
articular simple,
metaphyseal
multifragmentary



✓ select

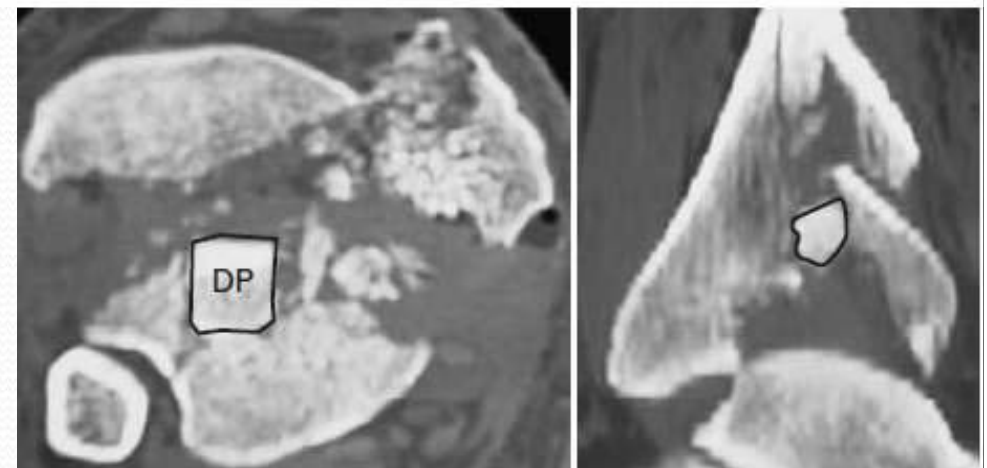
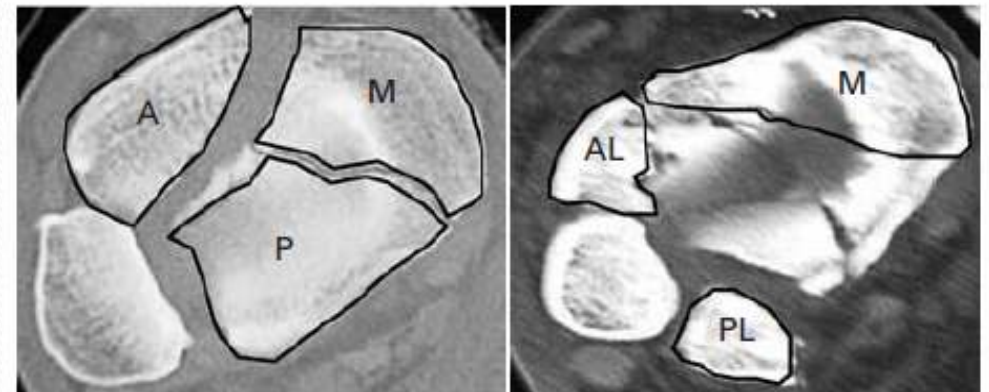
43-C3
articular
multifragmentary



✓ select

Topliss

- X-ray and CT based
- Described 6 main fragments
- 2 main # families
 - Coronal
 - Sagittal (higher energy)
 - Unclassifiable
- Implications for approach and implant



Tscherne Classification

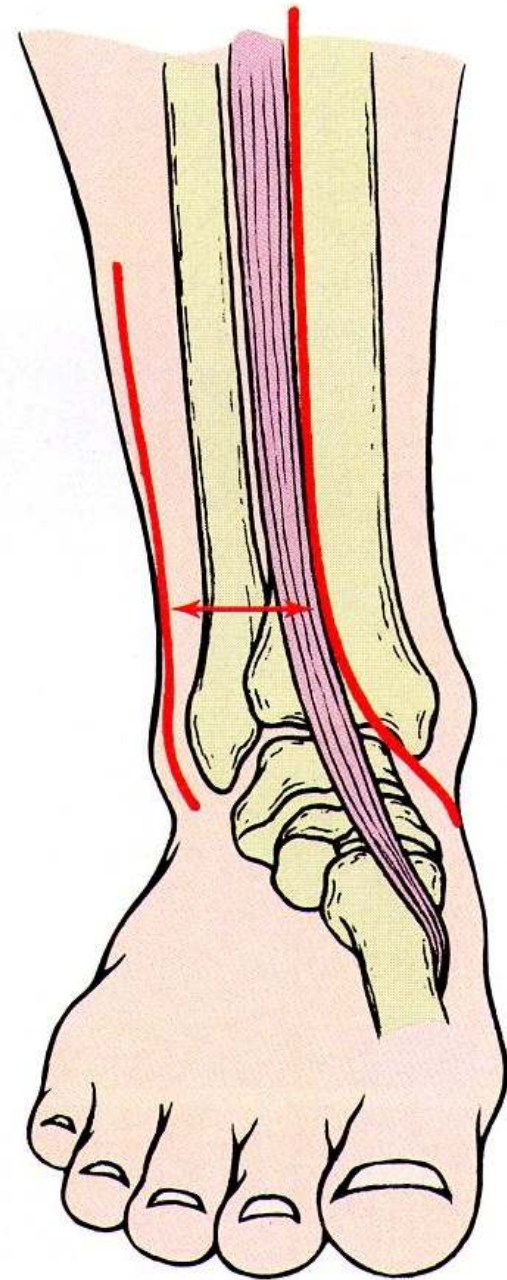
- **Grade 0**
 - **Minimal soft tissue damage.** Indirect violence. Simple fracture pattern e.g. spiral fracture of the tibia.
- **Grade 1**
 - **Superficial abrasion or contusion** caused by pressure from within. Mild to moderately severe fracture configuration e.g. pronation fracture-dislocation of the ankle with soft tissue lesion over the medial malleolus.
- **Grade 2**
 - **Deep contaminated abrasions** associated with localised skin or muscle contusion. Impending compartment syndrome. Severe fracture configuration e.g. segmental “bumper” fracture of the tibia.
- **Grade 3**
 - **Extensive skin contusion or crush.** Underlying muscle damage may be severe. Subcutaneous avulsion. Decompensated compartment syndrome Associated major vascular injury. Sever or comminuted fracture configuration.

How useful are these classifications?

- Poor to moderate inter and intraobserver reliability⁵⁻⁷
- ? Topliss more reproducible

Surgical approach

- Governed by #
- Classically 2 incisions
 - Anteromedial tibia
 - Posterolateral fibula
- Supine
- Tourniquet
- Leg on block



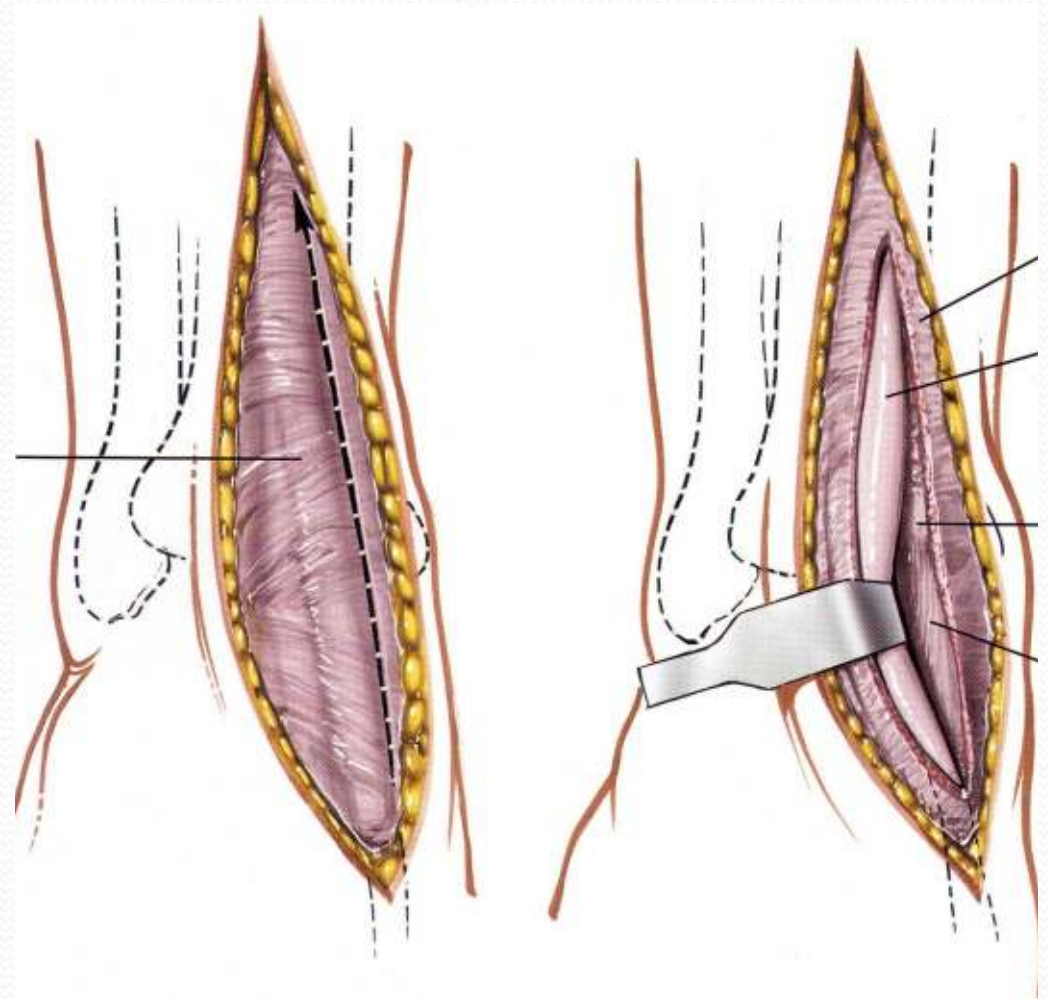
Anteromedial approach

- Just lateral to tibial crest
- Extend distally to ankle
- Curves medially towards medial malleolus/tib ant tendon



Anteromedial approach

- Full thickness flaps
- Incise retinaculum medial to tib ant (do not open sheath)
- Retract tib ant laterally
- Saphenous bundle at medial malleolus
- Deep peroneal nerve and ant tibial artery between EHL and EDL



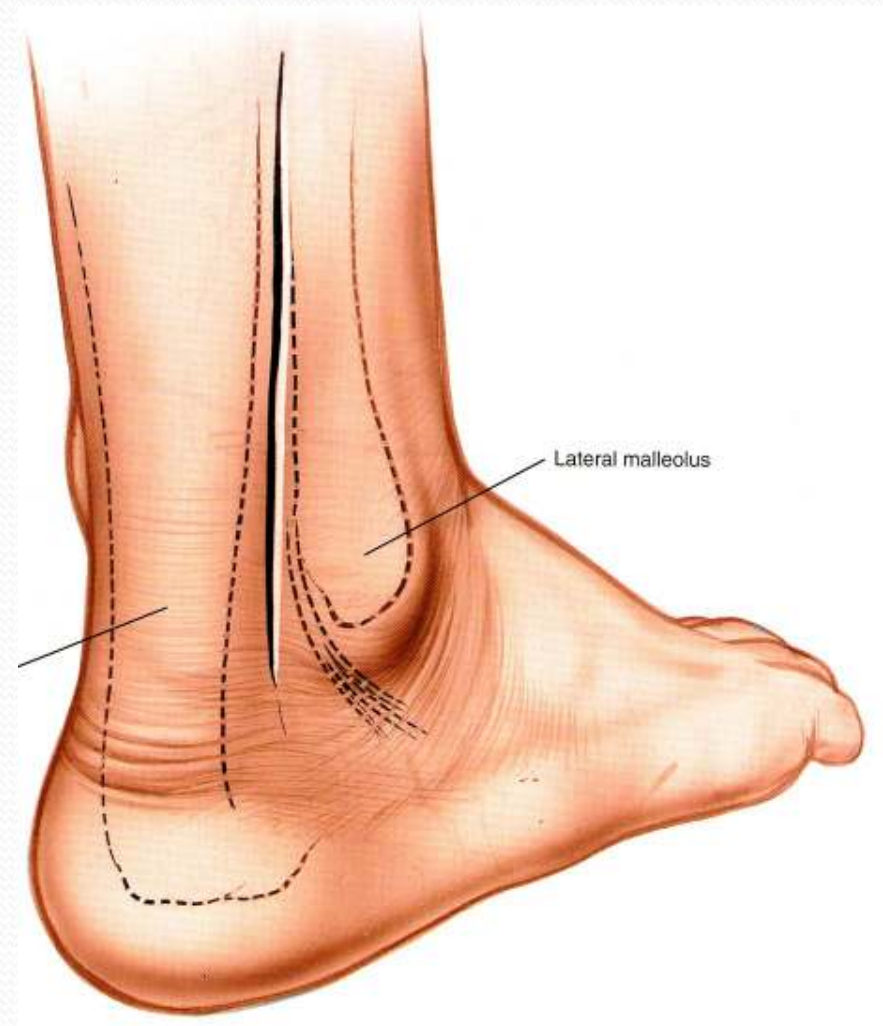
Anterolateral approach

- Longitudinal incision over lateral tibia, 3rd/4th metatarsals
- Superficial peroneal n
- Incise ext retinaculum
- EDL, peroneus tertius, neurovascular bundle medially
- Can limit fibular incision
- EDB mobilised talus



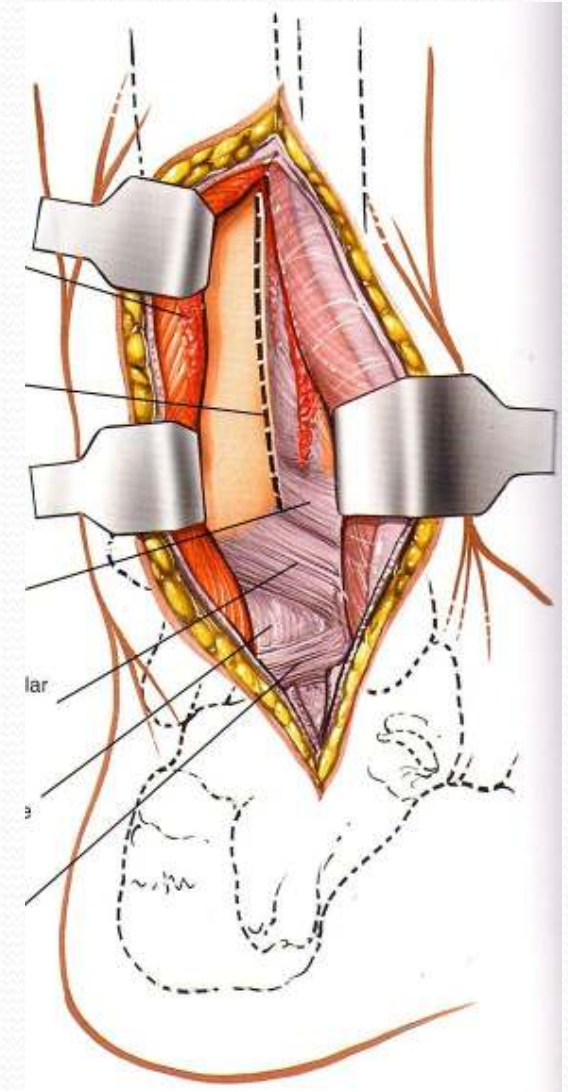
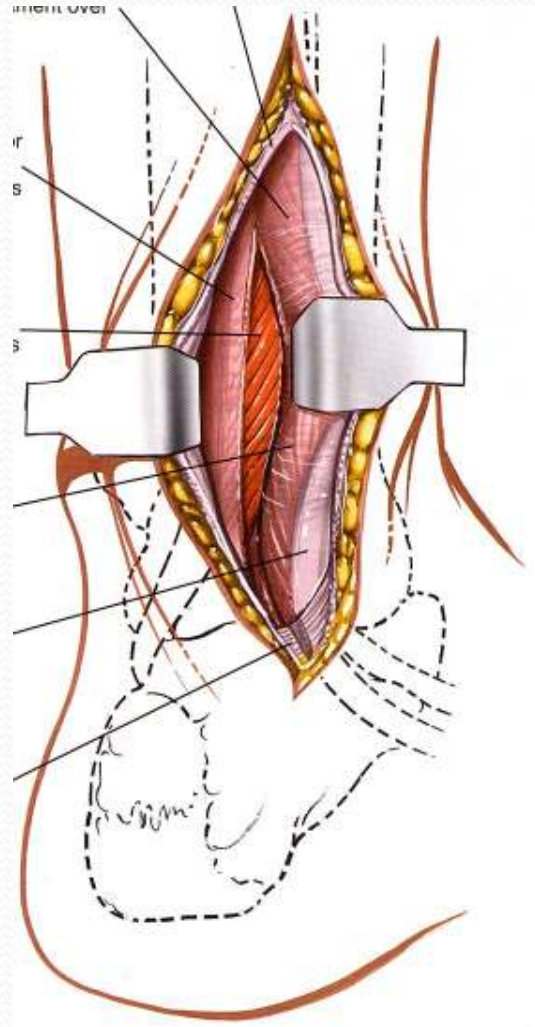
Posterolateral approach

- Patient prone
- Incision between lateral malleolus and TA



Posterolateral approach

- Retract peroneal muscles anteriorly
- Incise lateral FHL, retract medially



Evolution of care

- Early 1960's and earlier, surgical results poor
- Rüedi & Allgöwer, Injury, 1969⁸
 - 74% good to excellent functional results with ORIF
 1. restoration of length (fixation of fibula)
 2. reconstruction of the articular surface
 3. bone grafting
 4. reattachment of the metaphysis to diaphysis

Evolution of care

- Increasing incidence of internal fixation
- Increasing complications (up to 54%)⁹⁻¹¹
 - Infection, wound breakdown
 - Non-unions
 - Amputation
- Teeny & Wiss, Clinical Orthopaedics, 1993¹²
 - *“if anatomic reduction without soft tissue complications cannot be predicted preoperatively, consideration should be given to alternative types of treatment”*

Evolution of care

- Tornetta et al, J Orthop Trauma 1993¹³
 - 26 patients
 - Limited internal fixation & hybrid external fixation
 - Good to excellent in 81% (69% in Type III #s)
 - 1 varus malunion
 - 1 superficial infection
 - 3 pin track infections
 - 1 deep infection

Evolution of care

- Bone et al, Clin Orthop, 1993¹⁴
 - 20 patients
 - No soft tissue complications
 - 5 (25%) delayed unions,
 - 3 bone grafted
 - 2 plate stabilisation
- Similar findings from Anglen¹⁵ and Pugh et al¹⁶

Evolution of care

- Watson et al, Clin Orthop 2000¹⁷
 - Staged protocol
 - All #s calcaneal traction
 - Open #
 - debridement and ex fix
 - Return 2-3 days for debridement & definitive fixation
 - Closed #
 - Fixation ~5 days
 - ORIF for AO 3A&B, circular frame for AO 3C
 - 75% plate, 81% frame good/excellent results

Evolution of care

- Blauth et al, J Orthop Trauma 2001¹⁸
 - 51 patients into 3 groups
 - Formal ORIF (15)
 - Limited ORIF with definitive ex-fix (28)
 - Limited ORIF with temporary ex-fix and delayed ORIF (8)
 - Higher infection in initial ORIF
 - Staged group less pain, more back to work

Evolution of care

- Staged protocol backed by others^{19,20}
 - 1st stage within 24hrs
 - Fix fibula if soft tissues permit
 - Closed reduction of metaphysis/diaphysis
 - Bridging external fixator
 - 2nd stage when soft tissues settled
 - 7-14 days
 - formal ORIF



Should we fix the fibula?

- Yes

- Rüedi & Allgöwer & others^{2,19,20}
- Prevent 2° valgus
- Preserve length
- Help reduce lateral tibial metaphysis

- No^{21,22}

- If not anatomic, interferes with reconstruction
- Tibial comminution, may lead to varus collapse
- Further incision

Circular frames

- Results similar to plates²³⁻²⁵
- 1 RCT!
 - Wang et al, Arch Orthop Trauma Surg, 2010²⁶
 - Randomised 2 stage ORIF or limited internal fixation and ex-fix (LIFEFF)
 - LIFEFF more superficial infections, more radiation
 - No other statistical difference
- Most studies small, retrospective, no controls

Are we going full circle?

- White et al, J Orthop Trauma, 2010²⁷
 - 95 patients, single stage ORIF
 - 70% within 24hrs, 88% 48hrs
 - 6 deep infections (4 open #s)
 - If ORIF early, can be successful

Questions?



References

1. Rüedi TP, Allgöwer M. The operative treatment of intra-articular fractures of the lower end of the tibia. Clin Orthop 1979;138:105-110.
2. Rüedi TP, Buckley RE, Moran CG. AO Principles of Fracture Management. AO Publishing, 2007.
3. Topliss CJ, Jackson M, Atkins RM. Anatomy of pilon fractures of the distal tibia. J Bone Joint Surg 2005;87-B:692-7.
4. Tscherne H, Oestern HJ. Die klassifizierung des weichteilschadens bei offenen und geschlossenen frakturen (A new classification of soft-tissue damage in open and closed fractures). Unfallheilkunde 1982;85(3):111-5.
5. Dirschl DR, Adams GL. A critical assessment of factors influencing reliability in the classification of fractures, using fractures of the tibial plafond as a model. J Orthop Trauma 1997;11:471-6.
6. Martin JS, Marsh JL, Bonar SK et al. Assessment of AO/ASIF fracture classification for the tibial plafond. J Orthop Trauma 1997;11:477-83.

7. Ramappa M, Bajwa A, Singh A, Mackenney P, Hui A, Port A. Interobserver and intraobserver variations in tibial pilon fracture classification systems. *Foot (Edinb)* 2010;20(2-3):61-3.
8. Rüedi TP, Allgöwer M. Fractures of the lower end of the tibia into the ankle joint. *Injury* 1969;1:92-99
9. Bourne RB, Rorabec CH, McNab J. Intra-articular fractures of the distal tibia. *J Trauma* 1983;23:591-6.
10. Ovadia DN, Beals RK. Fractures of the tibial plafond. *J Bone Joint Surg* 1986;68-A:543-51.
11. McFerran MA, Smith SW, Boulas HJ, Schwartz HS. Complications encountered in the treatment of pilon fractures. *J Orthop Trauma* 1992;6:195-200.
12. Teeny SM, Wiss DA. Open reduction and internal fixation of tibial plafond fractures: variables contributing to poor results and complications. *Clin Orthop* 1993;292:108-117.

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13. Tornetta P, Weiner L, Bergman M et al. Pilon fractures: Treatment with combined internal and external fixation. J Orthop Trauma 1993;7:489-96.
 14. Bone L, Stegemann P, McNamara K, Seibel R. External fixation of severely comminuted and open tibial pilon fractures. Clin Orthop 1993;292:101-7.
 15. Anglen JO. Early outcome of hybrid external fixation for fracture of the distal tibia. J Orthop Trauma 1999;13:92-7.
 16. Pugh KJ, Wolinsky PR, McAndrew MP, Johnson KD. Tibial pilon fractures: A comparison of treatment methods. J Trauma 1999;47:937-41.
 17. Watson JT, Moed BR, Karges DE, Cramer KE. Pilon fractures: Treatment protocol based on severity of soft tissue injury. Clin Orthop 2000;375:78-90
 18. Blauth M, Bastian L, Krettek C, Knop C, Evans S. Surgical options for the treatment of severe tibial pilon fractures: A study of three techniques. J Orthop Trauma 2001;15:153-60.

19. Patterson MJ, Cole JD. Two-staged delayed open reduction and internal fixation of severe pilon fractures. *J Orthop Trauma* 1999;13:85-91.
20. Sirkin M, Sanders R, DiPasquale T, Herscovici D Jr. A staged protocol for soft tissue management in the treatment of complex pilon fractures. *J Orthop Trauma* 1999;13:77-84.
21. Borelli J Jr, Catalano L. Open reduction and internal fixation of pilon fractures: Current controversies in orthopaedic trauma. *J Orthop Trauma* 1999;13:573-82
22. French B, Tornetta P. Hybrid external fixation of tibial pilon fractures. *Foot Ankle Clin* 2000;5:853-71.
23. Barbieri R, Schenk RS, Koval K, Auroni K, Auroni B. Hybrid external fixation in the treatment of tibial plafond fractures. *Clin Orthop* 1996;332:16-22.
24. Kim HS, Jahng JS, Kim SS, Chun CH, Han HJ. Treatment of tibial pilon fractures using ring fixators and arthroscopy. *Clin Orthop* 1997;334:244-50.

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25. Raikin S, Froimson MI. Combined limited internal fixation with circular frame external fixation of intra-articular tibial fractures. *Orthopedics* 1999;22:1019-25.
 26. Wang C, Li Y, Huang L, Wang M. Comparison of two-staged ORIF and limited internal fixation with external fixator for closed tibial plafond fractures. *Arch Orthop Trauma Surg* 2010;130:1289-97.
 27. White TO, Guy P, Cooke CJ, et al. The results of early open reduction and internal fixation for treatment of OTA 43.C-type tibial pilon fractures: a cohort study. *J Orthop Trauma* 2010;24:757-63.