Distal tibia

The role of CT in diagnostics and preoperative planning

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Why preoperative CT?

- Occult intra-articular fracture
- Preoperative planning

Why not preoperative CT?

- Iatrogenic risk of cancer
High Association of Posterior Malleolus Fractures with Spiral Distal Tibial Fractures

- 37 fractures with spiral fracture pattern
  - 56% associated posterior malleolus fracture

- 62 fractures of the distal third of the tibia diaphysis
  - 39% associated posterior malleolus fracture

- 24% of posterior malleolus fractures were not seen on plain x-rays but only on CT scans
High Association of Posterior Malleolus Fractures with Spiral Distal Tibial Fractures

Table 1. Incidence rates and comparison of fractures before and after protocol

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preprotocol</th>
<th>Postprotocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with lower third shaft fractures</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>Associated posterior malleolus fractures</td>
<td>13 (33%)</td>
<td>11 (48%)</td>
</tr>
<tr>
<td>Spiral fractures</td>
<td>19 (49%)</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>Low-energy injuries</td>
<td>22 (56%)</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>Delayed/missed diagnosis of associated posterior malleolus fracture</td>
<td>2 (5%)</td>
<td>0</td>
</tr>
</tbody>
</table>

- One missed posterior malleolus displaced during mobilisation
- All recognized posterior malleolus fractures treated with internal fixation

CT scan decided by treating surgeon
All CT scan
67 distal third tibial fractures:

• 29 (43%) intra-articular fracture:
  • 17 screw fixation
  • 29 splinted and non-weight-bearing

No follow-up
2012: The Nordic Nuclear Safety Research raised concern about the increased use of CT scan in Nordic countries

"kun at anvende CT, hvor der foreligger et relevant klinisk spørgsmål, hvor udfaldet af den kliniske problemstilling afhænger af CT-undersøgelsen"
Does preoperative CT scanning of tibial diaphyseal fractures below isthmus change fracture treatment?

- Retrospective study, Aalborg University Hospital

- Inclusion criteria:
  - *Tibial diaphyseal fracture below the isthmus in a skeletally mature adult*
  - Preoperative X-ray *and* CT of the tibia

- Exclusion criteria:
  - Pilon fracture

Nekrasas et al. NOF 2012
Intra-articular fractures in 27 out of 34 included tibial fractures

<table>
<thead>
<tr>
<th>AO-type</th>
<th>X-ray</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>43-B</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>43-C</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>SUM</td>
<td>18</td>
<td>27</td>
</tr>
</tbody>
</table>

- 9 of 27 intraarticular fractures only visible on CT
- 5 of the 9 occult intraarticular fractures had additional screw fixation
- Preoperative CT led to change in surgery in 5 out of 34 cases

Nekrasas et al. NOF 2012
Are all intra-articular fractures detected with CT?
34 tibial shaft *spiral* fractures

- X-ray: 3 posterior malleolar fractures
- CT: 24 posterior malleolar fractures
- MRI: 3 posterior malleolar fractures

Combined tibial fracture and posterior malleolar fracture: 30/34 (88%)
Ankle injuries in distal tibial spiral shaft fractures: results from an institutional change in imaging protocol

Distal third spiral tibial shaft fractures
n=25

Ankle fracture identified on CT
n=14

Ankle fracture identified on XR
n=7

Underwent MRI
n=11

Ankle fracture identified on MRI
n=7

No ankle fracture
n=4
Ankle injuries in distal tibial spiral shaft fractures: results from an institutional change in imaging protocol

Combined tibial fracture and ankle fracture: 21/25 (84%)

71% fixation of ankle fracture

100% of ankle fractures: restricted post-operative weightbearing
CT in preoperative planning

- Nail or frame? (or plate?)
- Additional screw?
- Reduction?
• Exact fracture reduction
• Olive drop-wire, good stability
• No foot frame
Nail or frame?
5 months post-operative
Anatomy of pilon fractures of the distal tibia

C. J. Topliss, FRCS, Specialist Registrar; M. Jackson, FRCS (Tr & Orth), Consultant Senior Lecturer; and R. M. Atkins, DM, FRCS, Consultant Reader

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CT.
Fracture fragments.
Articular CT scans were available in 108 of the 126 fractures. Six distinct fragments could be recognised although not all were universally present. The major fragments were anterior, posterior, medial, anterolateral, posterolateral (Fig. 5) and die-punch (Fig. 6).

Two fracture families: 33% sagittal split; 56% coronal split
CT: *iatrogenic risk of cancer?*
Computed Tomography — An Increasing Source of Radiation Exposure


![Graph showing lifetime attributable risk of death from cancer per million patients exposed to 10 mGy.](image-url)
Subjecting Radiologic Imaging to the Linear No-Threshold Hypothesis: A Non Sequitur of Non-Trivial Proportion

Jeffry A. Siegel¹, Charles W. Pennington², and Bill Sacks³

¹Nuclear Physics Enterprises, Marlton, New Jersey; ²NAC International (retired), Norcross, Georgia, and executive nuclear energy consultant, Alpharetta, Georgia; and ³U.S. Food and Drug Administration (retired), Green Valley, Arizona

The Journal of Nuclear Medicine Vol 58, Jan 2017. (impact factor: 5.8)

Non sequitor: an invalid argument where the conclusion could be either true or false.

Non-existing evidence of imaging-related (particulary CT/PET-CT) carcinogenic risk.

Radiophobia centered and not scientific approach has led to the guidelines of “as low as reasonable achievable doses”.
Iatrogenic risk of cancer

• Background radiation dose in DK: 4 mSv/year

• Tibial CT scan (80 kV, 30 mAs):
  – effective radiation dose: 0.03 mSv
  – About 50 hours additional background radiation
  – Additional risk of death due to cancer increases 0.0001%
  – Risk of death due to cancer increases from 30% to 30.0001%
Why preoperative CT?

• Occult intra-articular fracture?
  – Risk of displacement during
    • Nailing
    • Postoperative mobilisation

• Preoperative planning:
  – Nail / (plate) / Ring fixation
  – Reduction, key-fragment

Why not preoperative CT?

• Iatrogenic risk of cancer??
  • Small, questionable