MULTIPLANAR CT ANALYSIS OF 5TH METATARSAL MORPHOLOGY: IMPLICATIONS FOR SURGICAL MANAGEMENT OF ZONE II 5TH METATARSAL FRACTURES

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Disclosures are in the final AOFAS mobile App
We have no potential conflicts with this presentation
Background

- Percutaneous internal fixation is currently the method of choice for most surgeons treating proximal zone II fifth metatarsal fractures in active and athletic populations.

- Complications with this method have been reported, including refractures and fracture gapping, due to:
  - Poor blood biological environment of the proximal fifth metatarsal (Smith et al. 1992)
  - Unique anatomy of fifth metatarsal (Ebraheim et al. 2000)
    - Lateral curvature plantar bow
    - Variable intramedullary canal width between individuals
  - Poor screw placement (Den Hartog 2005 and Johnson et al. 2004)
  - Inadequate screw sizing (Kelly et al. 2001 Shah et al. 2001)
    - Too long → straightens bone, produces fracture gapping w/ increased risk of delayed union or nonunion
    - Too wide → diaphyseal longitudinal fractures

Den Hartog 2009
Study Aims

• To ensure proper screw selection and to treat proximal fifth metatarsal fractures more effectively, a better understanding of fifth metatarsal morphology is needed

• **Purpose:** define the morphology of the fifth metatarsal using multiplanar computed tomography (CT) analysis in order to help guide surgeons in terms of selecting the appropriate screw size before entering the operating room
Study Design

• Multiplanar analysis of fifth metatarsal morphology was completed using CT scans from 241 patients who had previously undergone CT imaging as part of the institution’s Foot and Ankle service outcomes registry.

• Specific parameters of the fifth metatarsal were analyzed and defined in anteroposterior (AP), lateral, and oblique views.

• 12 different measurements performed for each patient in the institution’s picture archiving and communication system (PACS) (Sectra IDS7, Sweden):
  – Metatarsal length (AP and lateral)
  – Distance from the metatarsal base to the apex of curvature (AP and lateral)
  – Apex medullary canal width (AP and lateral)
  – Apex height (AP, lateral, and oblique)
  – Fifth metatarsal angle (AP, lateral, and oblique)
Study Design

Fifth metatarsal measurements:

Metatarsal length (A1, C1), distance from metatarsal apex to base (A2, C2), apex medullary canal width (A3, C3), apex height (A4, C4), and fifth metatarsal angle (B5, D5) were measured in AP and lateral views. Apex height (E1) and fifth metatarsal angle (F2) were also measured in the oblique view.
Results

• 241 patients included: 127 men and 114 women w/ a mean age of 53.4 ± 15.16 years (range, 16-82 years)
• Average metatarsal length
  – AP: 71.40 ± 6.07 mm
  – Lateral: 70.38 ± 5.99 mm
• Average medullary canal width at the apex of curvature
  – AP: 4.05 ± 0.91 mm
  – Lateral: 5.33 ± 1.08 mm
• Average distance from the apex of curvature to the base of the metatarsal
  – AP: 42.56 ± 5.75 mm
  – Lateral: 40.36 ± 6.42
• Males had significantly longer (p <0.0001) and wider (p = 0.0004) fifth metatarsals than females
• Every measurement taken of the fifth metatarsal in the AP, lateral, and oblique views had a significant correlation with height (α = 0.05)
• Canal observed to be elliptical in shape
Results: CT Measurement Distributions

Distribution of metatarsal length in the lateral view (LatmetLength)

Average LatmetLength was 0.38 ± 5.99 mm with 95% of patients having metatarsals between 58.41 and 82.36 mm.

Distribution of distance from the apex of curvature to the base of the metatarsal in the AP view (APapexToBase)

Average APapexToBase was 0.36 ± 6.42 mm with 95% of patients having measurements ranging between 27.51 and 53.21 mm.

Distribution of medullary canal width at the apex of curvature in the AP view (APapexMedCanalWidth)

Average APapexMedCanalWidth was 4.05 ± 0.91 mm with 95% of patients having widths between 2.23 and 5.87 mm.

Distribution of medullary canal width at the apex of curvature in the lateral view (LatapexMedCanalWidth)

Average LatapexMedCanalWidth was 5.33 ± 1.08 mm with 95% of patients having widths between 3.17 and 7.49 mm.
Discussion

• When determining desired screw length, lateral radiographs should be used since distance from the base of the metatarsal to the apex of curvature was smaller in the lateral view (average 40.36 mm) compared to the AP view (average 42.56 mm)

• When determining desired screw diameter, the AP view should be used because canal shape is elliptical and width was found to be significantly smaller in the AP view (4.05 ± 0.91 mm) compared to the lateral view (5.33 ± 1.08 mm) (p < 0.0001)

• Absolute angle of the fifth metatarsal was related to height, with the height of the apex of curvature increasing with increasing height and the fifth metatarsal angle decreasing with increasing height, suggesting larger individuals are likely to have more bowing in their metatarsal shafts
Conclusions

• An average screw length of 40 mm or less should be favored (depending on fracture location and orientation) to avoid going distal to the apex of the curvature and potentially distracting the fracture site.

• Most canals can accommodate at least a 4.0 or 4.5 mm screw diameter and one should use the largest diameter screw possible as determined by AP radiographs.

• Larger individuals are likely to have more bowing in their metatarsal shafts which may have a higher tendency to distract.
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References


