Geometric Comparison of Second Metatarsal Shortening Osteotomy Variations using 3D Printed Patient-Specific Models

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Disclosures

No Conflict to Disclose

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Our disclosures are in the Final AOFAS Mobile App
We have no potential conflicts with this presentation
Purpose

• The purpose of our study was to investigate how much each osteotomy of the metatarsal:
  • 1. Changed the length of the metatarsal
  • 2. Changed the height and
  • 3. Relative location of the metatarsal head (MH) itself.
Methods

• Three-dimensional models of second metatarsals from 5 deidentified clinic patients were extracted from CT scans. Fixed points were plotted on the printed models and a 3D coordinate digitizing arm (Microscribe) determined (x-y-z) coordinates of each point.

• Six variations of 2\textsuperscript{nd} metatarsal osteotomies were performed using a sagital saw and a 2.4mm cannulated screw.
• (1) Classic Weil (CW) osteotomy performed at 15 and 25 degrees to the plantar surface
• (2) Classic Weil (CW) osteotomy performed at 15 and 25 degrees using a double saw blade technique
• (3) Classic Weil (CW) osteotomy performed at 25 degrees and then a parallel block of 3 or 5mm was removed
• (4) Distal closing wedge (DCW) osteotomy of the MH at 25 degrees with a wedge of 3 and 5mm
• (5) Proximal closing wedge (PCW) osteotomy of the MH made at 45 degrees removing a 3 and 5mm wedge
• (6) 45 degree oblique, midshaft, metatarsal osteotomy with 3 and 5mm of translation
Results

• The maximum metatarsal length shortening per millimeter translation was observed in osteotomy 3-5mm block (2.6 mm STD=0.34), while osteotomy 1-15°caused the least (1.1mm STD=0.26).
• Maximum dorsiflexion of the MH occurred with osteotomy 5- 5mm wedge, 13.2mm (STD= 4.9mm) and minimum with osteotomy1- 25°, 0.5mm (STD= 1.4mm). No MH plantarflexion was noted with any of the osteotomies.
• The oblique midshaft osteotomies caused lateral translation of the metatarsal head significantly different from the controls (P <0.05) although not statistically different from one another (2.4mm vs 4.3mm).
SHORTENING OF METATARSAL LENGTH (mm/mm shifted ± 1 SD)
ABSOLUTE CHANGE IN DORSIFLEXION OF MH (mm ± 1 SD)

- CW 15 degrees
- CW 25 degrees
- DCW 25 degrees
- PCW 3mm
- PCW 5mm

Double blade
3mm block
5mm block
Oblique osteotomy 45 degrees
Oblique osteotomy 45 degrees

Penn State Orthopaedics
Conclusions

• Our data shows maximal change in length/millimeter translation by performing a classic Weil osteotomy at 25° with a 5mm block resection and then translating 4 mm. This osteotomy also caused the most effective dorsal translation of the MH, thereby making it the most effective osteotomy in terms of affecting both length and MH vertical orientation.
• Should dorsiflexion of the MH be the surgeon’s goal, then the proximal closing wedge osteotomy had the greatest impact while minimally changing overall length. With this knowledge, surgeons can tailor operations based on the direction and degree of correction needed to be achieved.