Is plaster casting necessary?

Megan Balsdon, MESc
PACS Symposium – April 5th, 2013
Montreal, QC
Outline

• Background
• Method
• Static and Dynamic analyses
• Limitations and Strengths
• Significance
• Future Directions
Kinematic Measurement Techniques

• Optical Tracking
  ▫ Treats foot as a rigid segment
Multi-segment Foot Model

• Jenkyn & Nicol, 2007
• Skin motion artefact error

(Jenkyn & Nicol, 2007)
Radiostereometric Analysis (RSA)

- Tantalum beads needed – invasive
- Embedded in bones during surgery

(Seslija 2009)  (Kedgley, 2009b)
Markerless RSA

- 3D in-vivo kinematics
- Healthy (non-surgical) individuals

- Validated in 2009 by Anne-Marie Fox (Allen) for the Wolf Orthopaedic Quantitative Imaging Laboratory (WOQIL)
WOQIL Markerless RSA

- Two C-arm fluoroscopes
  - Static and dynamic capture settings
Calibration

- Calibration frame
  - (Kedgley, 2009b)

- Distortion grid
  - (Kedgley, 2009b)
Sample images

Calibration Frame Image

Distortion Grid Image
Experimental Set-up Recreation
Final Set-up
Final Step - Matching
Foot Anatomy

(Norden & Frankel, 2001)
Foot Motion

- Occurs in 3 anatomical planes
  - Extension/flexion in **sagittal** plane
  - Adduction/abduction in **transverse** plane
  - Inversion/eversion in **frontal** plane

(Hamill & Knutzen, 2003)
Medial Longitudinal Arch (MLA)

- Concave arch along medial aspect of foot
  - Head of the first metatarsal to calcaneal tuberosity
- Function
  - Shock absorption of vertical loads

(http://podiatryboards.web.officelive.com/footbones.aspx)
MLA Angle Measurement

- Based on Tome et al. (2006)
- Markerless RSA eliminates skin motion artefact
Orthotics

• Restrict and support medial column of foot
• Conservative treatment for musculoskeletal disorders

*Pes planus* (low arch)  *Pes cavus* (high arch)
Study Purpose

• Compare medial longitudinal arch angle
  ▫ 3 foot types:
    • Normal
    • *Pes cavus* (high arch)
    • *Pes planus* (low arch)
  ▫ 4 different orthotics
    • Foam box & plaster casting
      • **Soft** (plastazote)
      • **Hard** (subortholen)
Hypotheses

- *Planus* participants show the largest BF angle
- Orthotics decrease the angle of all foot types
- No significant differences between casting methods
Methods - Static

- Participants stood on wooden platform
Methods - Dynamic

- 15 subjects (mean age 27.5)
  - 5 each foot type: normal, pes cavus, pes planus
- Dynamic gait along platform
Methods

- Neutral cushioning running shoes
  - New Balance Model 882
Methods

- Foam box & plaster casting methods
  - Soft (plastazote) & hard (subortholen) materials
Static - Barefoot *pes cavus*
Dynamic - Barefoot *pes planus*
Results (TO BE ADDED)
Results (TO BE COMPLETED)

- Discovered significantly longer vector MTMP/L for pes cavus (p<0.05)

<table>
<thead>
<tr>
<th></th>
<th>MTMH/L</th>
<th>SD</th>
<th>MTMP/L</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0.389</td>
<td>0.012</td>
<td>0.445</td>
<td>0.080</td>
</tr>
<tr>
<td>Planus</td>
<td>0.382</td>
<td>0.020</td>
<td>0.451</td>
<td>0.035</td>
</tr>
<tr>
<td>Cavus</td>
<td>0.399</td>
<td>0.014</td>
<td>0.591</td>
<td>0.049</td>
</tr>
</tbody>
</table>
Discussion - Static (NOT COMPLETE)

- Largest mean angle – planus (hypothesized)
- Smallest mean angle – normal
  - Cavus foot structure:
    - Oversupinated, weight support on lateral side causing rearfoot inversion (Xiong et al., 2010)
Discussion - Dynamic (NOT COMPLETE)

- Pes planus group
  - Smallest angle – Foam hard orthotic
- Normal group
  - Mean increase for all devices
Summary

• Static comparison
  ▫ STN statistically significant

• Dynamic orthotics
  ▫ Largest decrease with foam casted hard orthotic
Limitations

• Small sample size per foot type

• Post-processing time is lengthy

• Somewhat invasive – radiation exposure

• Fluoroscope size and shape (9-inch and C-arm)
Strengths

• Tantalum beads not required (standard RSA)

• Dynamic data collection

• Markerless RSA eliminates skin motion artifact

• First reported study to look at skeletal kinematics of the medial longitudinal arch
Future Directions

• Improve manual matching procedure
  ▫ Edge detection algorithm

• Increase sample size
  ▫ Focus ONE foot type

• Investigate *pes cavus* foot structure
  ▫ NTMP length
Significance

• Provides \textit{in-vivo} investigation of skeletal kinematics of the foot
• Findings suggest there is more to understand about the MLA and the effect orthotics have
• STN showed significant difference
Acknowledgements

• Colin Dombroski
• Kristen Bushey
  ▫ Co-investigator
• Tom Jenkyn
  ▫ Supervisor
• Ian Jones
  ▫ WOBL Manager
• John Henry
  ▫ X-ray technician
References


Questions