FUNCTIONAL METATARSAL LENGTH IN PATIENTS WITH MIDFOOT ARTHRITIS

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Introduction

• Arthritis: One of the leading causes of disability
  *(MWWR, 2006)*

• Midfoot Arthritis: High potential for chronic secondary disability
Incidence and Prevalence

- Athletic population

- Minor twisting injuries

- Midfoot Injuries
  - Secondary to motor vehicle trauma.

(Smith et al. 2005)
Morton’s Foot Structure

• Patients with midfoot arthritis have a Morton’s foot structure
  \((\text{Davitt et al. 2005})\)

• Postulated to result in:
  – 1\textsuperscript{st} metatarsal hypermobility
  – Overloading of the 2\textsuperscript{nd} metatarsal
  \((\text{Morton DJ, 1928})\)
Purpose

• To examine functional first metatarsal length in patients with midfoot arthritis

• To compare regional plantar loading and first metatarsal mobility during walking in patients with midfoot arthritis compared to asymptomatic control subjects
Subjects

- 30 patients
  - Age: 62 (55 - 71) years
  - BMI: 30.4 (19.9 - 38.1)
  - 28 female

- 20 control subjects
  - Matched in age, gender and BMI
Patient Presentation

• Clinical:
  – Pain on dorsum, localized to TMT region
  – Aggravated by walking
  – Stair descent

• Radiographic:
  – Joint space reduction
  – Osteophytes
  – ‘Dorsal bossing’
1. Radiographic Measures

- Ratio of first to second metatarsal length

  $(Davitt \ et\ al,\ 2005)$

  $1 = \text{Same length}$
  $>1 = 1^{\text{st}} \text{ metatarsal longer}$
  $<1 = 1^{\text{st}} \text{ metatarsal shorter}$

- Single tester:
  $(\text{ICC}(2,k) = 0.92)$
2. Plantar Loading

• Data Acquisition
  – Barefoot
  – EMED™

• Data Analysis
  – “Masks”
  – Heel, Midfoot, Metatarsals 1-5, Great Toe
  – Dependent Variables:
    • Pressure time integral

http://novel.de/productinfo/systems-emed.htm
3. Kinematic Data Collection

- Electromagnetic sensors (18 mm x 8 mm x 8 mm) placed over proximal phalanx and first metatarsal
- Anatomically based local coordinate systems for each segment
  
  \[(Tome \ et \ al. \ 2004, \ Rao \ et \ al. \ 2009)\]

- Reference trial: Subtalar Neutral
  
  \[(Houck \ et \ al. \ 2008)\]
Kinematic Dependent Variables

- 1\textsuperscript{st} metatarsal plantarflexion
- 1\textsuperscript{st} Metatarsophalangeal dorsiflexion
Statistical Analysis

• Descriptive statistics were used to summarize radiographic measures.
• Independent $t$-tests were used to assess differences in regional plantar loading and first metatarsal mobility during walking between the two groups.
## Results: 1. Radiographs

Ratio of first to second metatarsal length

<table>
<thead>
<tr>
<th>Mean (SD)</th>
<th>Current study</th>
<th>Davitt et al. 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFA</td>
<td>82 (3)</td>
<td>77 (4)</td>
</tr>
<tr>
<td>Control</td>
<td>82 (5)</td>
<td></td>
</tr>
</tbody>
</table>


Patients with midfoot arthritis sustained significantly higher pressure time integral at the heel, midfoot, and first metatarsal, compared to matched control subjects.
Decreased Peak First Metatarsophalangeal (MTP) joint dorsiflexion and First Metatarsal Range of Motion during walking was noted in patients with midfoot arthritis.
Conclusions and Discussion:

- **Shorter first metatarsal** in patients with midfoot arthritis.

- **Decreased first metatarsal motion** and **increased heel, midfoot and first metatarsal regional plantar loading** in patients with midfoot arthritis.
  - In contrast to first metatarsal hypermobility and attendant overloading of the second metatarsal head expected in a Morton’s foot structure.

- These findings may reflect potential mechanisms that contribute to the evolution of symptoms in patients with midfoot arthritis.
Acknowledgements

AOFAS Research Grant
Arthritis Foundation
Chapter Grant and Post-doctoral Fellowship