How do Differences in Achilles’ Tendon Moment Arm Lengths Affect Muscle-Tendon Dynamics?

Eric C. Bennett, Esthevan Machado, Colton P. Quinn, and Jared R. Fletcher

Department of Health and Physical Education, Mount Royal University. Calgary AB Canada.

INTRODUCTION

➢ The Impact of the Achilles Tendon Moment Arm (AT_{MA}) on the energy cost of running (E_{run}) has been disputed:

Short AT_{MA}

➢ reduces E_{run} by:
  ➢ Reducing muscle fascicle shortening velocity for a given joint rotation
  ➢ Reducing active muscle volume
  ➢ Reducing muscle energy cost
  ➢ Higher tendon strain energy storage
  ➢ Increases E_{run} by:
  ➢ Increased muscle forces for a given joint moment.

Long AT_{MA}

➢ reduces E_{run} by:
  ➢ Reduced fascicle force for a given joint moment
  ➢ Increases E_{run} by:
  ➢ Higher shortening velocity for a given joint rotation.
  ➢ Reduced AT energy storage

METHODS

Table 1. Subject Characteristics

<table>
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<tr>
<th>N</th>
<th>Age (yrs)</th>
<th>Height (m)</th>
<th>Mass (m)</th>
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<tr>
<td>19</td>
<td>24±3</td>
<td>177±7</td>
<td>75±11</td>
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Participants were classified based on AT_{MA} length: ‘LONG’ (n=9, 36.6±2.5mm) and ‘SHORT’ (n=10, 29.5±1.8mm) from the bimodal distribution of AT_{MA} (p<0.001) (Figure 1)

RESULTS

➢ LONG AT_{MA} was significantly related with a reduced muscle energy cost (r^{2}=0.13, p=0.02) (Figure 3).

➢ Muscle forces were not significantly different during stance phase (Figure 4)

➢ Fascicle length change, and fascicle force were not significantly different during stance (Figure 5)

➢ Shortening velocity was significantly higher in LONG (0.02±0.19 L·s^{-1}) compared to SHORT (0.04±0.06 L·s^{-1}) at 5% of stance (p=0.03, d=1.097) (Figure 6)

➢ There was a large effect size for 60% of stance (p=0.51, d=0.966) (Figure 6)

CONCLUSIONS

➢ LONG AT_{MA} was associated with a lower muscle energy cost, but we did not see differences in force between groups.

➢ The reduced muscle energy cost can be attributed to the lower shortening velocities between groups.

➢ Runners with short AT must have had a reduced plantarflexion moment, as a result of a reduced forefoot length.

ACKNOWLEDGMENTS

Supported by NSERC’s Undergraduate Student Research Award