INTRODUCTION

Plantar fasciitis is a common lower extremity injury caused by mechanical overload that affects 10% of all runners. Despite its commonality, research results investigating the etiology of the condition and the most efficacious treatment have been equivocal [1]. A potential limitation of previous research assessing the mechanical changes associated with plantar fasciitis may be the modeling of the foot as a single segment. Previous studies on healthy adults have demonstrated the importance of using a multi-segment foot model during gait to identify midfoot and forefoot motion [2,3]. To date no study has investigated running kinematics in individuals with plantar fasciitis using a multi-segment foot model.

Clinical symptoms have historically been used for diagnosing plantar fasciitis. Recently, however, sonography has provided a more definitive measure for diagnosis [4,5]. In non-athletic populations, plantar fasciitis has been associated with a hypoechoic appearance and an adaptive thickening of the plantar fascia [4]. No studies have investigated the thickness of the plantar fascia in runners with plantar fasciitis.

The primary purpose of this study was to compare running kinematics between runners with plantar fasciitis and uninjured runners using a six-segment foot model. The secondary purpose was to investigate differences in plantar fascia thickness between the two groups.

METHODS

Fifteen runners (7 f, 8 m) with plantar fasciitis (age: 30 ± 8.74 yrs, height: 170.60 ± 8.25 cm; mass: 67.98 ± 8.20 kg) and 15 age, gender and mileage matched uninjured runners (age: 29.33 ± 6.53 yrs, height: 170.52 ± 7.78 cm, mass: 68.07 ± 9.99 kg) were recruited. Data collection consisted of a running gait analysis and ultrasound imaging.

A six foot segment model was used for this study [6]. Participants completed 10 running trials at 4.0 (±10%) m/s. 3D positions of the technical and anatomical marker clusters were collected at 200 Hz with a 10-camera Eagle system (Motion Analysis). A force plate (AMTI) sampling at 1000 Hz was used to identify initial contact and toe-off. A custom written Matlab program was used to filter the data, reconstruct the 3D position of each segment using the calibrated anatomical system technique with a single value decomposition optimization procedure, and compute joint angles between adjacent segments (Figure 1). Prior to completing the running trials, an anatomical calibration procedure was performed to identify anatomical landmarks and define local coordinate systems within each segment (Figure 1).

Stance phase was separated into 4 subphases, and MANOVAs (α ≤ 0.05) were performed to assess between-subject ROM differences for six functional articulations (rearfoot complex, calcaneocuboid, and calcaneonavicular complex, medial and lateral forefoot, and 1st metatarsophalangeal complex).

Ultrasound images were captured following a protocol similar to that reported by Rathleff [7]. The proximal attachment of each participant’s plantar fascia was imaged using a 4.0 cm wide transducer head and 12 MHz transducer (Vivid-i, General Electric Healthcare) and a scan depth of 2.5 cm. Imaging of the plantar fascia consisted of real time scanning of longitudinal sonographic images. The thickness at the proximal insertion was measured on three successful images within 0.5 mm of each other. Independent t-tests (α ≤ 0.05) were conducted to investigate differences in plantar fascia thickness.
RESULTS AND DISCUSSION

Results revealed calcaneocuboid eversion ROM during early stance (p = 0.003) (Table 1), and plantar fascia thickness (p = 0.007) were significantly greater in the plantar fasciitis group. The increased eversion excursion of the calcaneocuboid in the plantar fasciitis group may suggest decreased lateral midfoot stability. Additionally, the increased thickness of the plantar fascia in the plantar fasciitis group (4.64 ± 1.07 mm) over the limb-matched control group (mean: 3.75 ± 0.54 mm) was consistent with previous findings [4,5].

The results of the study enhanced understanding of the effects of plantar fasciitis on running gait mechanics. Previous studies have only analyzed rearfoot kinematics. However, additional study on the influence of extrinsic and intrinsic foot musculature is warranted before conclusions regarding the effect of plantar fasciitis on running gait can be drawn.

REFERENCES


ACKNOWLEDGEMENTS

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Table 1: Mean (SD) sagittal, frontal, and transverse plane ROM for the calcaneocuboid joint during phase 1

<table>
<thead>
<tr>
<th>Plane</th>
<th>Plantar Fasciitis</th>
<th>Control</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagittal Plane</td>
<td>Dorsiflexion</td>
<td>4.44 (3.74)</td>
<td>4.91 (2.73)</td>
</tr>
<tr>
<td>Frontal Plane</td>
<td>Eversion</td>
<td>3.63 (2.73)</td>
<td>1.16 (1.14)</td>
</tr>
<tr>
<td>Transverse Plane</td>
<td>Adduction</td>
<td>3.63 (1.89)</td>
<td>3.28 (2.14)</td>
</tr>
</tbody>
</table>

*Significantly different from control group (p < 0.05)