THE EFFECT OF ACHILLES TENDON STRETCHING ON WEIGHTBEARING

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Introduction
The gastrocnemius complex via the Achilles tendon exerts a plantar flexion moment on the foot and ankle. The manifestation of this moment on the forefoot during gait is that of plantar pressure. Stretching is routinely recommended by physicians to provide relief of foot pain, heel pain and plantar fasciitis, as well as being advised prior to sporting activities to minimize injury potential. However, the effect of Achilles stretching on weight bearing has not been studied. Therefore, the following hypotheses are examined for normal subjects: 1) Achilles stretching exercises will, shortly after stretching, result in no increase in passive dorsiflexion of the ankle, and 2) Achilles stretching exercises will, shortly after stretching, result in no change in either the spatial or temporal plantar pressure distribution during gait. This is accomplished by documenting the dorsiflexion range of motion and plantar pressures during gait both prior to and directly after Achilles stretching exercises.

The reliability of the EMED-F system was examined by Hughes, et al in 1991 (1). Using 10 volunteers each taking 75 walks (25 walks at each of 3 speeds), reliability was found to be excellent for three or more walks. In a recent case study Hastings et al (2) included plantar pressure measurements, both in-shoe and barefoot measures, in describing the effects of a tendo-Achilles lengthening and total contact casting in a patient with diabetes mellitus, peripheral neuropathy, neuropathic ulcer, and limited dorsiflexion range of motion. Seven months following TAL in-shoe forefoot peak plantar pressure was reduced by 55% and barefoot pressure decreased by 14%. The amount of dorsiflexion during gait was obtained (email communication: Mary Hastings, MS/PT, ATC, Washington University School of Medicine). The pre-treatment dorsiflexion during gait was 12°; post-treatment was 18°, and six month follow up was 22°.

Armstrong, et al (3) determined the reduction in plantar pressure at the forefoot following percutaneous lengthening of the Achilles tendon in diabetic patients at high risk of foot ulceration. Mean peak pressure on the plantar aspect of the forefoot decreased from 86 ± 9.4 to 63 ± 13.2 N/cm2 at eight weeks postoperatively. Dorsiflexion of the ankle joint increased from 0 ± 3.1° preoperatively to 9 ± 2.3° at eight weeks postoperatively. They conclude that peak pressures on the plantar aspect of the forefoot are significantly reduced following percutaneous lengthening of the Achilles tendon in diabetic patients who are at high risk for ulceration of the foot. Of note, Armstrong, et al (3) performed a power analysis that indicated that a difference of 20 percent between the preoperative and postoperative pressures could be detected with a sample size of ten patients and approximately four passes over the force-plate with a power of 0.90. They used a study design of five steps per patient and an alpha of 0.05.

Methods
Forty-one subjects between age 21-40 years with no history of foot/ankle pathology were studied. Subjects were recruited from relatives and friends of patients and from clinical service patients who had no lower extremity abnormalities or pathology which would adversely affect gait. Subjects who are presently or have recently been performing Achilles stretching exercises were not included. Institutional IRB approval was obtained and informed consent was obtained for each subject by the physical therapist prior to participation in the study.

Passive dorsiflexion was measured using an electrogoniometer while the patient performed a weight-bearing lunge with the knee straight and with the knee bent. An EMED ST pressure platform system was used to record plantar pressures during five gait trials. Subsequently, a bilateral Achilles tendon stretching physical therapy session was performed. Range of motion and plantar pressures testing were again measured post-stretching. Data analysis was then performed using paired T-tests corrected for multiple measures.

Plantar pressure measurements were collected throughout the stance phase: center of pressure, and peak and mean pressures in each of six zones selected using the ability to customize the software. Passive dorsiflexion was measured using an electrogoniometer while the patient performed a weight-bearing lunge with the knee straight and the knee bent. The measurements were performed while maintaining the heel in neutral inversion.

The pre- and post-intervention measurements were compared. Paired-t tests were adjusted for multiple measures to test the dorsiflexion measurements and peak and mean pressures. The temporal aspects are assessed by that time in the gait cycle when heel off occurs and when peak pressure occurs. The temporal aspects are presented as a percent of the gait cycle (GC).

Essential Results
The pre-stretch and post-stretch results are shown in the Table for the entire group. The average increases in dorsiflexion were significant for the knee straight (5.7°, p<0.001) and bent (1.2°, p<0.02). The temporal and pressure parameters were not different. The group was stratified according to the amount of increased dorsiflexion that occurred with the knee straight as a result of the stretching protocol. Twenty-one subjects had less than a 5° increase (subgroup A) and 20 subjects had an increase of ≥5° dorsiflexion (subgroup B). For each of the temporal and pressure parameters there was no difference in the changes between the subgroups, e.g., End Heel Contact occurred 1.6±3.9 %GC earlier after stretch for subgroup A and for subgroup B End Heel Contact occurred 0.2±3.3 %GC earlier after stretch. These changes were no different despite subgroup B having experienced greater stretch. This same analysis yielded no difference for any of the temporal or pressure parameters.

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<tr>
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<th>N = 41</th>
<th>Pre-Stretch</th>
<th>Post-Stretch</th>
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<tbody>
<tr>
<td>Dorsiflexion Knee Straight (deg)</td>
<td>40.3±7.0</td>
<td>46.0±6.5</td>
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<tr>
<td>Dorsiflexion Knee Bent (deg)</td>
<td>47.3±6.9</td>
<td>48.5±6.7</td>
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<tr>
<td>End Heel Contact (%GC)</td>
<td>50.1±8.0</td>
<td>51.0±7.0</td>
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<tr>
<td>Instant of Peak Pressure (%GC)</td>
<td>79.7±6.3</td>
<td>80.4±6.4</td>
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<tr>
<td>Forefoot Peak Pressure (N/cm²)</td>
<td>65.1±27.8</td>
<td>65.9±27.2</td>
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<tr>
<td>Pressure-time Integral (N·cm²)</td>
<td>16.8±6.5</td>
<td>16.9±6.4</td>
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Discussion
Clinical symptoms associated with many common foot disorders is felt by some to be linked to abnormalities in the way that load is distributed across the foot. It should follow, therefore, that the clinical effectiveness of any given intervention is closely linked to the procedure’s ability to alter and, perhaps, normalize the plantar pressure profile during gait. Increased stretch was documented, however, no change in weight-bearing pattern was observed.

Acknowledgements
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References