The Effect of Achilles Tendon Stretching on Weightbearing

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Introduction

The gastrocsoleus complex via the Achilles tendon exerts a plantar flexion moment on the foot and ankle that is manifested at the forefoot during gait through plantar pressure. Stretching is routinely recommended to provide relief of forefoot pain, heel pain and plantar fasciitis, as well as to minimize injury potential. However, the effect of Achilles stretching on weight bearing has not been studied. Therefore, the following hypotheses were examined for normal subjects; 1) Achilles stretching exercises will, shortly after stretching, result in no increase in passive dorsiflexion (DF), and 2) Achilles stretching exercises will, shortly after stretching, result in no change in either the plantar pressure distribution or temporal parameters during gait. This was accomplished by documenting the DF 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] and found to be excellent for three or more walks. In a recent case study, Hastings et al [2] included plantar pressure measurements, in describing the effects of a tendo-Achilles lengthening (TAL) and total contact casting in a patient with diabetes mellitus, peripheral neuropathy, neuropathic ulcer, and limited DF motion. Seven months following TAL peak plantar pressure was decreased. The DF during gait increased by 10° at six month follow-up. Armstrong, et al [3] documented 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 to 63 N/cm2 and DF increased 9º at eight weeks postoperatively. 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 pressure platform with a power of 0.90.

Statement of Clinical Significance

Surgical lengthening of the gastrocnemius complex (including recession of the gastrocnemius, and lengthening of the Achilles tendon) and stretching of the gastrocnemius complex has been used to provide relief of forefoot pain, heel pain and plantar fasciitis in neurologically intact individuals. This study will examine the effect of Achilles stretching on weight bearing and plantar pressures in normal individuals following a stretching program. If Achilles stretching is effective in decreasing plantar pressures and altering temporal parameters, then we will have documented a rationale for including stretching as an intervention.

Methodology

Forty-one subjects between age 21- 40 years with no history of foot/ankle or lower extremity abnormalities or pathology that would adversely affect gait pathology were studied. Subjects who were currently or had recently been performing Achilles stretching exercises were not included. Institutional IRB approval was obtained and informed consent was obtained for each subject.

Passive DF was measured using an electrogoniometer while the patient performed a weight-bearing lunge with the knee straight and with the knee bent. The measurements were performed while maintaining the heel in neutral inversion. An EMED ST pressure platform

system was used to record stance plantar pressures during five gait trials. Subsequently, a bilateral Achilles tendon stretching physical therapy session was performed. Range of motion and plantar pressures were again measured post-stretching.

Plantar pressure measurements included center of pressure, and peak and mean pressures into zones (heel, mid foot, forefoot, great toe, lesser toes). The temporal aspects of the plantar pressure recordings included instants of peak pressure and heel off, both as a percent of the gait cycle (GC). The pre- and post-intervention measurements were compared. Paired-t tests were adjusted for multiple measures to test the DF measurements and peak and mean pressures and temporal measures.

Results

The pre-stretch and post-stretch results are shown in the Table for all subjects.

N =41	Pre=Stretch	Post-Stretch
Dorsiflexion Knee Straight (deg)	40.3±7.0	46.0±6.5
Dorsiflexion Knee Bent (deg)	47.3±6.9	48.5±6.7
End Heel Contact (%GC)	50.1±8.0	51.0±7.0
Instant of Peak Pressure (%GC)	79.7±6.3	80.4±6.4
Forefoot Peak Pressure (N/cm^2)	65.1±27.8	65.9±27.2
Pressure-time Integral ($N\text{-}s/cm^2$)	16.8±6.5	16.9±6.4

The average increases in DF were significant for the knee straight (5.7°, $p<0.001$) and bent (1.2°, $p<0.02$). The pressure and temporal parameters were not different for any of the zones. The group was then stratified according to the amount of increased DF that occurred with the knee straight as a result of the stretching protocol. Twenty-one subjects had less than a 5° DF increase (subgroup A) and 20 subjects had an increase of ≥5° DF (subgroup B). For each of the pressure and temporal 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 sub-group 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.

Discussion

Clinical symptoms associated with many common foot disorders are 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 an intervention might be 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. The time to the end of heel contact, a indication of the dorsiflexion utilized during stance was not increased. A limitation of the study was the lack of documentation of actual PF used when walking.

References

1. Hughes, J. et al. Clin Biomechanics. 6(1): 14-18, 1991.
2. Hastings MK, et al J Orthop Sports Phys Ther 30(2):85-90, 2000.
3. Armstrong, D.G. et al. J Foot Ankle Surg. 37(4): 303-307, 1998.

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