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Midfoot Power During Walking and Stair Ascent in Healthy Adults

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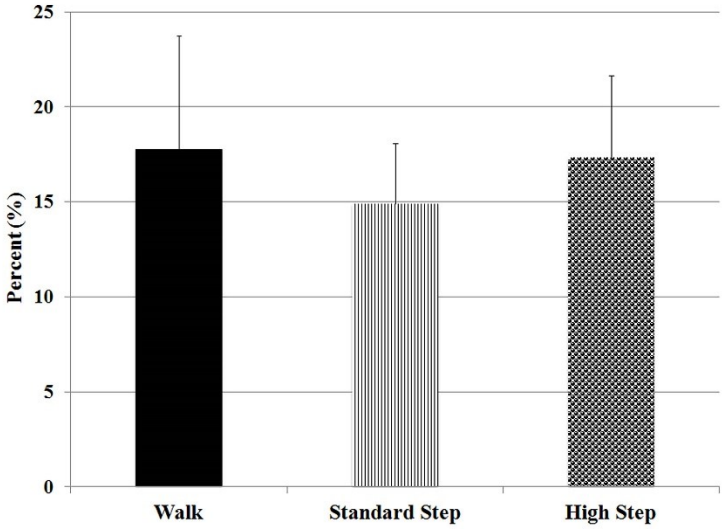
Introduction/Purpose: Intrinsic foot muscles have the capacity to attenuate and reverse arch deformation under loaded conditions. This function is proposed to be an important component in generating the midfoot power and stability requisite for gastroc-soleus muscle action at the ankle during forward propulsion. Synergistic activation of intrinsic foot muscles is proposed to function as a 'foot core' during weightbearing activity that is analogous to the function of the smaller muscles at the spine. If this theory were sound, midfoot power would be expected to increase, potentially in proportion to ankle power, as the muscular demand of a task increases. The purpose of this study was to explore the nature and behavior of midfoot and ankle power during walking and stair ascent in healthy adults.

Methods: Twelve healthy adults [Mean (SD): Age 31.3 (4.9) years; BMI 25.2 (3.4) Kg/m2; 50% female] walked, ascended a standard step, and ascended a high step. An electromagnetic sensor motion capture system and force plate were used to record multi-segment foot motion and ground reaction force data. Subject-specific three segment foot models (tibia, rearfoot, forefoot) were derived. Inverse dynamic calculations were performed to obtain ankle and midfoot positive total power. Positive total power, calculated as the sum of positive power (joint torque x segmental velocity) after heel off, reflects the entire amount of ankle or midfoot push-off power generated for a given task. The proportion of midfoot to ankle positive total power was also calculated. Multiple one-way repeated measures ANOVAs were conducted to evaluate differences in power variables across tasks. Bonferroni adjusted pairwise comparisons were made to assess differences in main effects. Effect sizes between conditions were also examined (Cohen's d).

Results: Significant main effects were found for both ankle and midfoot positive total power [ankle $F = 29.8$ ($p < 0.01$); midfoot $F = 63.1$ ($p < 0.01$)]. Pairwise comparisons revealed that total power significantly increased across each activity at both the ankle (d range: 0.09 - 2.3) and midfoot (d range: 1.4 - 2.9) [all $p < 0.05$]. Interestingly, a main effect was not observed in the proportion of midfoot to ankle total power across activity [$F = 1.2$ ($p = 0.33$)] (Figure 1).

Conclusion: The findings of this study provide preliminary support for the idea of a midfoot 'foot core' system. While increased ankle and midfoot power is required as the muscular demand of activity increases from walking to standard step and high step ascent, the proportion of midfoot to ankle total power remains the same. Study findings may assist practitioner understanding in addressing regional foot muscle imbalances and advancing patients to higher-level functional activities.



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