A new look at the dynamic measurement of foot arch stiffness during gait

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Foot arch stiffness is a modifiable, clinically relevant biomechanical metric. Static arch stiffness is insufficient in representing dynamic arch behavior, while dynamic arch stiffness has only been measured using surrogate variables or at an arbitrary timepoint (mid-stance). We proposed that dynamic arch stiffness instead be assessed using the medial longitudinal arch angle (MLAA) at the time of its maximal deformation, defining medial longitudinal arch stiffness (MLAS). We evaluated (1) the test-retest reliability of MLAS and (2) the effect of walking speed on MLAS.

Subjects (*n*=56) completed 3-5 walking trials each at a self-selected typical speed on a walkway equipped with force plates and a motion-capture system. Reflective markers were placed on the foot, with calcaneal, navicular, and first metatarsal head markers subsequently used for the MLAA calculation. A subset of the subject pool (*n*=21) also completed walking trials at self-selected slow and fast speeds, and eight (*8*) of these subjects returned at a later date for an identical retest.

On average, the timing of peak MLAA deformation (tMLAAmax) occurred at 71.0 ±8.8% of the stance phase, and the MLAS was 8.93 ±4.47deg/kN. The Pearson *r* showed high test-retest reliability for tMLAAmax (0.792, *p*=.019) and MLAS (0.768, *p*=.026). A significant increase in arch stiffness was found with increasing walking speed (*F*=10.686, *p*=.004).

The MLAS measurement proposed here was found to be highly reliable, and tMLAAmax was shown to occur well after mid-stance. The MLAS change corroborates existing evidence suggesting a stiffer arch as walking speed increases.