STABILITY OF SUPERIOR SEGMENTS DURING GAIT IN OLDER ADULTS

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INTRODUCTION

The ability to maintain steady motion diminishes with age (Cromwell et al., 2002; Kang and Dingwell, 2008). Active control of trunk motion is believed to enable stable walking (Winter et al., 1993). Head movement is always tightly controlled during various tasks, and this control may not function as well in older adults (Cromwell et al., 2002). Acceleration amplitudes from shocks from walking are absorbed as they move up from the feet to the head (Ratcliffe and Holt, 1997). The nervous system may therefore prioritize the stability of the superior segments during walking. We tested whether superior segments exhibited less dynamic instability than inferior segments, and whether these stability relationships between segments are altered with age. We hypothesized that increased control of superior segments would be reflected in decreased local instability and that the deterioration of this control with normal aging would lead to increased local instability.

METHODS AND PROCEDURES

Eighteen healthy older adults (age 72±6) and 17 height- and weight-matched young adults (23±3), with no orthopedic or neurological conditions, participated with informed consent. Each walked for 5 minutes on a Woodway treadmill at their preferred speed (PWS) (Kang and Dingwell, 2008). VICON was used to measure the motion of trunk, pelvis, thigh, shank, and foot segments using a custom market set. Custom MATLAB routines were used to determine dynamic stability for the trunk, pelvis, thigh, shank, and foot segments separately. Local dynamic stability was quantified as local divergence exponents that estimate the sensitivity of gait pattern to small intrinsic perturbations, using established algorithms (Dingwell et al, 2007). The effects of the small perturbations over 0-1 strides (λ^*_S), and 4-10 strides (λ^*_L) were quantified. Differences between the two age groups and the five body segments were compared using ANOVA (SPSS 14).

RESULTS

The preferred walking speeds of our healthy older adults were no different than our young adults (1.29 ± 0.13 m/s, $p = 0.86$). Superior segments were less sensitive to small local perturbations ($p < 0.0001$; Fig. 1). Older adults exhibited higher local divergence exponents ($p < 0.001$; Fig. 1) than the young adults, and thus were less stable across all segments. Segment × age interaction effect was also present ($p < 0.02$), where the age-differences were stronger at superior segments for (λ^*_S).

DISCUSSION

The trunk segment was less sensitive to local perturbations. The larger mass of the trunk may make it less sensitive to perturbations. The trunk segment is often involved in other motor tasks during gait, and therefore may require additional stability during gait to allow other activities.

Older adults exhibited greater instability in all segments, despite walking at the same preferred speeds as young adults. This may indicate diminished control of body segment motion even in healthy older adults, although this difference may not be obvious from their gait speed. This age-related difference was larger in the stability of superior segments. Measuring dynamic stability of trunk motion during gait may be more indicative of future gait disorder and falls in older adults than measures based on lower extremity movements.

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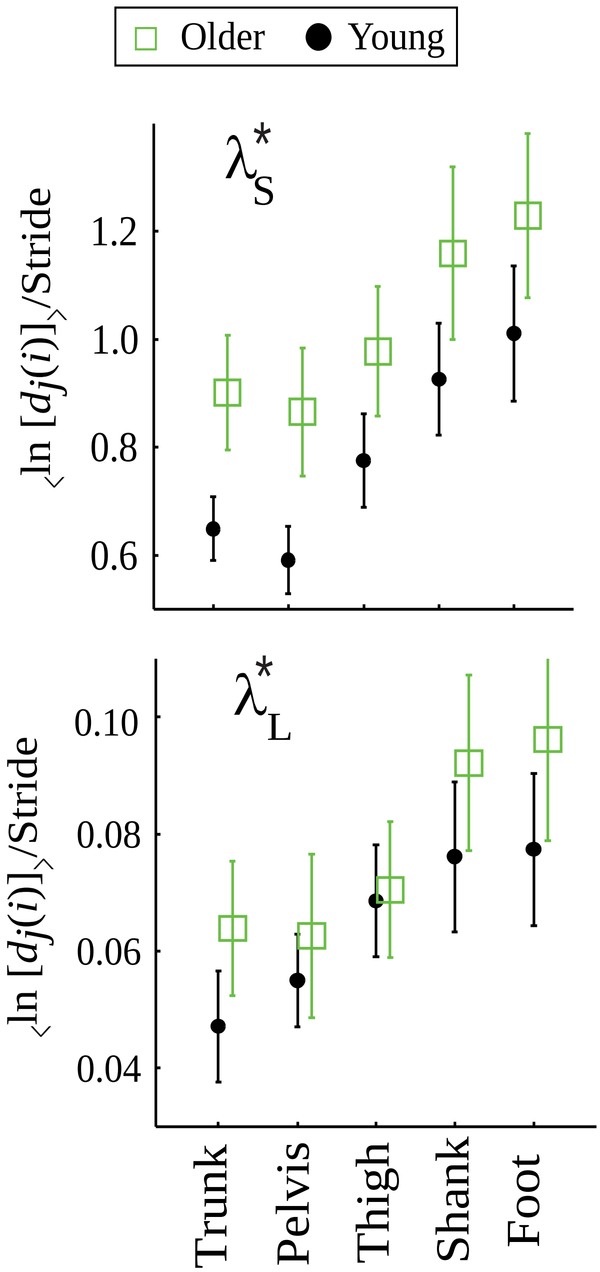

Figure 1. Local Divergence Exponents vs. Age and Body Segment.