Control of the Centre of Mass during different stair descent strategies in the Elderly

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Introduction

The elderly are at an increased risk of falls and trips during stair descent due to the increased musculoskeletal demand imposed by this task (Reeves *et al.* 2008). Reduced functional capacity, muscle recruitment, coordination or strength may limit the ability to adjust the limb to safely control the body in instances of unexpected instability (Buckley *et al.* 2013). The aim of this study was to determine how the elderly controlled their centre of mass (CoM) during different stair descent strategies.

Methods

Eleven elderly participants descended a four step custom built instrumented staircase at a self-selected speed. Two step configurations were tested: 1) a standard rise height of 170mm using a step over step strategy (STD SoS) and 2) a rise height of 255mm using step over step, (INC SoS), step by step (INC SbS) and side step (INC SS) strategies. The going stayed constant at 280mm. Centre of pressure (CoP) and whole body model accelerations and A/P displacement were captured at 1080Hz and 120Hz respectively. Data were analysed using a repeated measures GLM. Significance was accepted at $p<0.05$.

Results

Significantly reduced CoP-CoM A/P separation during the landing phase was evident in STD SoS compared to INC SoS and INC SbS (6.1vs10.6 and 10.7cm, $p<0.05$). INC SS resulted in significantly greater separation during mid-stance compared to STD SoS, INC SbS, INC SS (10.4vs-4.3,-2.2,-2.5cm, $p<0.01$). During toe off, INC SbS resulted in a larger A/P acceleration compared to STD SoS and INC SoS (0.8vs-0.7 and -1.0m/s/s, $p<0.01$) with a reduced CoP-CoM separation compared to INC SoS and INC SS (2.5vs10.0 and 6.2cm, $p<0.02$).

Discussion

The capability of the elderly to control their CoM during stair descent can fluctuate. During the landing phase a greater posterior 'lean' towards the staircase occurs with increased step rise, which could reduce the eccentric muscle action necessary to control lowering of the CoM. This lean was maintained by the SS strategy during mid-stance suggesting that this approach provides a mechanism for a safer single limb support. However, this strategy resulted in a simultaneous rapid CoM acceleration (1m/s/s) and large CoP-CoM separation (10cm) prior to toe off, indicating an unstable and potentially dangerous transition into swing. Whilst the INC SbS strategy also resulted in a large peak acceleration, a smaller CoP-CoM separation (1.2cm) occurred at a slower rate (0.07m/s/s) during this transition. This INC SbS strategy could offer increased CoM control, stability and support during stair descent.

References

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