BIOMECHANICAL ADAPTATIONS OF STEPPING GAIT IN RECENT LOWER LIMB AMPUTEES: A LONGITUDINAL STUDY

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Introduction

Stepping to and from a new level is a complex motor task that requires an individual to raise and lower their centre of mass (COM) safely during gait. Previous research has not investigated the re-learning of these tasks in recent transtibial amputees following discharge from rehabilitation, as individuals adapt to new biomechanical constraints [Vrieling, 2009], therefore, this was the aim of the current study. Understanding how recent lower limb amputees adapt to these motor tasks could have important implications for patients and therapists involved in rehabilitation.

Methods

Seven male unilateral transtibial amputees (age 56.1±14.9 years, height 1.82±0.08m, mass 91.7±11.4kg) attended standardised data collection sessions at one, three and six months following discharge from rehabilitation. Passive reflective markers were attached to selected landmarks on the lower limb. Participants were required to walk at a self-selected speed towards and step onto a raised surface, which resembled the dimensions of a street kerb. Participants then continued to walk, turn 180° and then walked off the walkway allowing for continuous gait while stepping onto and from a new level to be recorded. Kinematic (100Hz) and kinetic (1000Hz) data were processed and modelled in Visual 3D (C-Motion, Inc, Germantown, US). All variables were normalised to the gait cycle with lead limb preference being noted for each trial. Group mean data were analysed using a linear mixed model (IBM SPSS, UK).

Results

Participants increased walking velocity over time during both stepping up and stepping down, this effect being significant in the latter ($p=0.04$). Participants displayed a preference to lead with the intact limb when stepping up and the affected limb when stepping down, however, preferences diminished at six months post-discharge. During stepping down, knee range of motion (ROM) during single limb support ($p=0.05$) and decay rate ($p=0.01$) were greater when trailing with the intact limb. In addition, power absorption at the ankle A1 ($p=0.01$) and power generation at the ankle A2 and ($p=0.04$) and knee K2 ($p=0.05$) during stance were greater when trailing with the intact limb. When stepping up, knee ($p=0.01$) and hip ($p=0.04$) ROM during single limb stance were greater when leading with the intact limb. Power generation at the ankle A2 ($p=0.02$) and knee K2 ($p<0.01$) during stance were greater with an intact lead limb strategy.

Discussion

Results indicated that participants' ability to perform stepping gait improved between one and six months post-discharge, as reflected by increases in walking velocity. When stepping down, results from the current study suggested that participants were more comfortable lowering their COM during stance phase using the intact limb which was reflected in lead limb preferences. This strategy has been reported previously in stair descent [Alimusaj, 2009] although this preference diminished over time which suggested an improvement in affected limb function when acting as the trail limb. During stepping up, participants tended to select the intact limb as the lead limb given its apparent ability to raise and progress the whole body COM more effectively, with particular reference to power generation at the knee. However, this preference also diminished over time, perhaps reflecting increases in the power generation capability of the affected limb. Novel results from both tasks highlight the integral role of the intact limb for successful stepping gait in the early stages following rehabilitation.

References

Alimusaj *et al,* Gait Posture, 30:356-363, 2009
Vrieling *et al,* Clin Rehabil, 23:659-671, 2009