A NOVEL AUDITORY BIOFEEDBACK SYSTEM FOR IMPROVING AMPUTEE MOBILITY IN THE HOME AND COMMUNITY

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INTRODUCTION

Everyday mobility of unilateral lower limb amputees can be improved through a standardized prosthetic training and exercise program.[1,2] However, clinical judgement suggests that upon completion of the training program, amputees have a tendency to revert to their habit of asymmetrical walking in the home and community. In order to improve retention and reinforce therapeutic intervention away from the clinic, a novel auditory biofeedback system was developed to assess gait parameters and provide real-time corrective biofeedback[3]. The purpose of this study was to determine the efficacy of the novel auditory biofeedback system in improving gait and mobility of unilateral transfemoral amputees (TFAs) when used at home and in the community.

METHODS

The biofeedback system consisted of inertial measurement units (IMUs) for collecting motion data and iPad for processing data and providing audio feedback. Unilateral TFAs (N=21, mean age 53.5±13.7 years) were randomly divided into four test groups: (1) no exercise & no feedback (controls); (2) exercise only (Ex); (3) feedback only (FB) and (4) exercise with feedback (Ex+FB). At initial visit, subjects were fitted with a Rheo microprocessor knee, were provided gait training and instructed on using the system at home for 4 weeks. The feedback system was designed to detect gait deviations through IMUs, and provide verbal cues to correct these deviations via an iPad. The verbal cues were similar to those provided at the time of gait training in the clinic and reinforced corrective gait patterns. Depending on their group assignment, subjects were given home exercises and/or were asked to practice walking with auditory biofeedback. At the initial and final visits, a self-reported outcome measure (Prosthetic Limb Users Survey of Mobility PLUS-M) and a performance-based outcome measure (Timed Up and Go TUG test), were administered, and stance time was calculated. The effect of auditory biofeedback on changes in these outcome measures was determined.

RESULTS

Table 1 shows the effect size for the average change in self-report, performance-based and biomechanical outcome measures between different groups. Based on Cohen's interpretation of effect size,[4] the combination of exercise and audio feedback had a large effect on SLS time and TUG time, and a medium effect on PLUS-M score, compared to the control group.

	PLUS-M Score	TUG Time	Stance Time
Control vs. Ex+FB	0.73‡	0.85*	1.3*
Control vs. Ex	0.6‡	0.53‡	0.94*
Control vs. FB	0.61‡	1.03*	1.03*

Table 1: Comparison of effect size between groups for selected self-report, performance-based and biomechanical outcome measures. * large effect. ‡ medium effect.

DISCUSSION & CONCLUSION

A large effect size indicates a strong influence of auditory biofeedback on SLS time and TUG time. Upon hearing auditory cues, subjects were able to balance on the prosthetic limb for a longer time, resulting in greater SLS time. The ability to balance on the prosthetic foot increased the walking speed, and subjects were able to complete the TUG test in a shorter amount of time. The corrective biofeedback also had a moderate effect on subject's perception of mobility. Therefore, a Rheo knee, in combination with exercise and auditory feedback can reduce gait deviations and improve functional mobility of unilateral transfemoral amputees.

SIGNIFICANCE

Auditory biofeedback in the form of corrective cues, could be a powerful tool for reinforcing gait training in the home and community, and could be used for long term improvement in gait and mobility of unilateral TFAs.

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