FUNCTIONAL AND BIOMECHANICAL DIFFERENCES BETWEEN WEIGHT-ACTIVATED BRAKE (WAB) AND AUTOMATIC STANCE-PHASE LOCK (ASPL) PROSTHETIC KNEE JOINT MECHANISMS

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INTRODUCTION

Lower limb amputations are a major physical disability affecting an estimated 1 in 200 persons [1]. Providing a functional prosthesis is a critical part of the rehabilitation process, facilitating the recovery of mobility function. Despite technological advancements including microprocessor-based knee joint technologies, the majority of individuals with amputation around the world rely on simpler and more affordable mechanical knee joint components. Simple mechanical knee joints include single-axis, polycentric and weight-activated braking (WAB) knee designs, and emerging new technologies such as the automatic stance-phase lock (ASPL) knee mechanism, which has now been commercialized into the All-Terrain Knee by LegWorks[2]. However, limited clinical evidence exists about the performance of these different technologies. The goal of this study was to compare biomechanical and functional aspects of ASPL and WAB knee joint technologies.

METHODS

This prospective study involved ten adults ages 16 to 26 years with unilateral above-knee amputations. Data for the WAB and ASPL knees were collected during two sessions 1 month apart, to allow for acclimation. Instrumented gait analysis of the lower-limbs using an 8 infrared camera optoelectronic system (BTS Bioengineering, Italy) and two force plates (Kistler, Switzerland) provided spatiotemporal, kinematic and kinetic gait parameters obtained during walking trials. Timed walked tests were conducted to determine the walking speed and energy expenditure was estimated from heart rate using the Physiological Cost Index (PCI). Discrete gait parameters were determined and differences between knees were examined using an analysis of variance. Correlation analyses were applied to examine relationships between measures. A 12-month follow-up session was conducted with the ASPL knee and energy expenditure re-measured.

RESULTS

Self-selected and fast walking speeds were the same for both knees. Differences were found in PCI and kinematics at the pelvis. PCI was lower by 27% on average for the ASPL knee joint (All-Terrain Knee) after 1 month, and by 40% ($p<0.05$) after long term acclimation (i.e. 12 months). Pelvic movements including pelvic obliquity and anterior pelvic tilt were found to be lower by 16% each ($p<0.05$) for the ASPL knee compared to WAB knee, and more normal compared to published data for able-bodied individuals. Differences in pelvic tilt range between the two knees were found to be highly and positively correlated with differences in PCI ($r=0.75$, $p<0.05$).

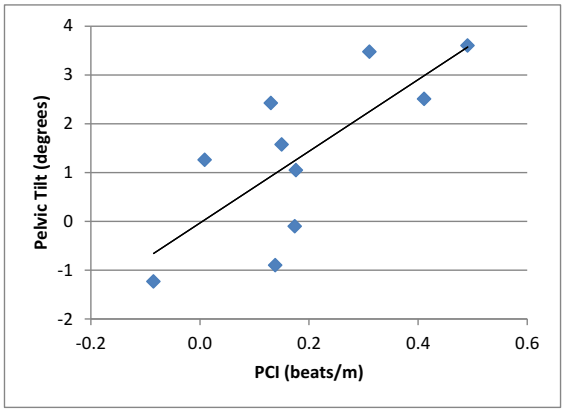

Figure 1. Pearson correlation of differences between WAB and ASPL knees in pelvic tilt and PCI

DISCUSSION

In highly-ambulatory individuals, ASPL knees were found to produce lower pelvic compensatory movements which were highly correlated to decreased energy expenditure during walking. Unlike the WAB mechanism which can restrict swing-phase flexion initiation, the ASPL mechanism is designed to provide stability without inhibiting the stance to swing transition which may explain the measured differences in biomechanical and physiological aspects of gait performance. Like WAB knee joints, ASPL knees offer a simple and affordable option for use in under-resourced health care systems that may be functionally more beneficial and suitable for younger and highly ambulatory individuals.

REFERENCES

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