Evaluation of Function, Performance, and Preference as Transfemoral Amputees Transition From Mechanical to Microprocessor Control of the Prosthetic Knee

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Abstract

Objective: To evaluate differences in function, performance, and preference between mechanical and microprocessor prosthetic knee control technologies.
Design: A-B-A-B reversal design.
Setting: Home, community, and laboratory environments.
Participants: Twenty-one unilateral, transfemoral amputees.
Intervention: Mechanical control prosthetic knee versus microprocessor control prosthetic knee (Otto Bock C-Leg).
Main Outcome Measures: Stair rating, hill rating and time, obstacle course time, divided attention task accuracy and time, Amputee Mobility Predictor score, step activity, Prosthesis Evaluation Questionnaire score, Medical Outcomes Study 36-Item Short-Form Health Survey score, self-reported frequency of stumbles and falls, and self-reported concentration required for ambulation.
Results: Stair descent score, hill descent time, and hill sound-side step length showed significant (*P*_.01) improvement with the C-Leg. Users reported a significant (*P*_.05) decrease in frequency of stumbles and falls, frustration with falling, and difficulty in multitasking while using the microprocessor knee. Subject satisfaction with the C-Leg was significantly (*P*_.001) greater than the mechanical control prosthesis.

Conclusion

This study examined the functional ability, performance, and satisfaction of transfemoral amputee subjects during the transition from an established, mechanical control prosthetic knee system into a microprocessor control Otto Bock C-Leg. This transition mirrors the common clinical practice of prescribing a microprocessor control knee after demonstration of proficient and successful use of a mechanical control knee unit. Although anecdotal evidence suggests that microprocessor control of the prosthetic knee may offer increased performance in functional tasks such as stair descent, ramp and hill descent, walking on uneven terrain, a reduction in cognitive demand while walking, and increased safety, empirical evidence for such benefits has been limited. The results shown in this investigation show a statistically significant improvement in subjects' ability to descend stairs; time required to descend a slope; sound-side step length while descending a hill; preference; satisfaction; self-reported frustration with falling; and self-reported frequency of stumbles, semicontrolled falls, and uncontrolled falls while wearing the microprocessor control knee and population trends of 5% or more improvement in a number of other functional categories. The results of this investigation not only highlight measured differences between the microprocessor and mechanical control of a knee component but also offer several new techniques and associated outcome measures for assessing function in the transfemoral amputee population. Because it is in functional areas beyond level walking that the benefits of microprocessor control are most observed, the development and standardized use of tools to assess function in these domains is critical to our understanding of real-world amputee ability, performance, and preference. This research has shown that microprocessor control provides significant benefit over mechanical control of the prosthetic knee. It is hoped that this information encourages and promotes additional research in these and other potential benefits of microprocessor stance phase control in lower-limb prosthetics.

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