IMPROVEMENTS IN WALKING PERFORMANCE WHEN USING A POWERED ANKLE PROSTHESIS

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INTRODUCTION

Powered ankle prostheses show promise in increasing preferred walking speed, and reducing energetic cost and some gait asymmetries in persons with transtibial amputations (Herr and Grabowski 2012, Ferris 2013). Successful translation of these benefits from lab to clinic may depend on the ability of prosthetist to replicate the device tuning procedure. It is unknown whether a powered ankle prosthesis with a typical clinical tuning would produce similar improvements in walking performance as those demonstrated in laboratory studies. Therefore, the purpose of this study was to characterize improvements in level walking performance for people using a powered ankle prosthesis that was tuned to approximate the work of an intact human ankle.

METHOD

Subjects: Five (5) males (age 49 ± 12 yrs, BMI 27.8 ± 4.2 kg/m^2, K3+ functional levels) with unilateral traumatic transtibial amputations and 5 age-matched healthy controls participated in this study. Two participants were regular users of the powered prosthesis. The remaining participants were fitted with the BiOM ankle (BiOM, Inc. Bedford, MA) by a manufacturer-certified prosthetist, who matched prosthetic ankle work to that of the average intact human ankle over a range of speeds. At least 30 minutes of accommodation was given prior to testing.

Procedures & Data Analysis: Participants used the BiOM and their own dynamic response prosthesis (DR). Preferred walking speed was measured during overground walking. Metabolic cost of transport (COT) was measured during a 3-minute fixed-speed treadmill walking trial.

RESULTS

Participants' preferred walking speed increased by 4.8% when using the BiOM (+0.06 ± 0.06 m/s). Three participants had decreased COT when using the BiOM (-0.027 ± 0.023 J/N·m) **(Fig. 1)** while the remaining 2 increased (+0.024 ± 0.006 J/N·m). There were no significant differences in stride length or temporal-spatial symmetry ($p > 0.084$).

DISCUSSION

The modest gains in preferred walking speed and energy expenditure in the present study compared with previous work may depend on both the tuning of the device's power delivery parameters as well as the functional level of users. The 10 available tuning parameters allow for a potentially complex tuning by clinicians with extensive training and device experience and may explain the discrepancy in results compared to Herr and Grabowski (2012). The participants in Ferris et al. (2013) were active-duty military personnel and likely higher-functioning than the population sampled in the present study, which may explain the improvements in step symmetry not replicated here. Development of an iterative, repeatable tuning algorithm may improve the translation of benefits to users. Assessments of traversing slopes and varied terrain may also reveal clinically meaningful benefits in walking performance.

CONCLUSION

When tuned by a certified prosthetist in accordance with manufacturer recommendations, the powered ankle prosthesis prompted only modest improvements in walking performance compared to previous studies.

CLINICAL APPLICATIONS

These results highlight the important role that tuning of powered devices may play in delivering proposed benefits to users. The benefits of powered devices may also depend on the functional status of users.

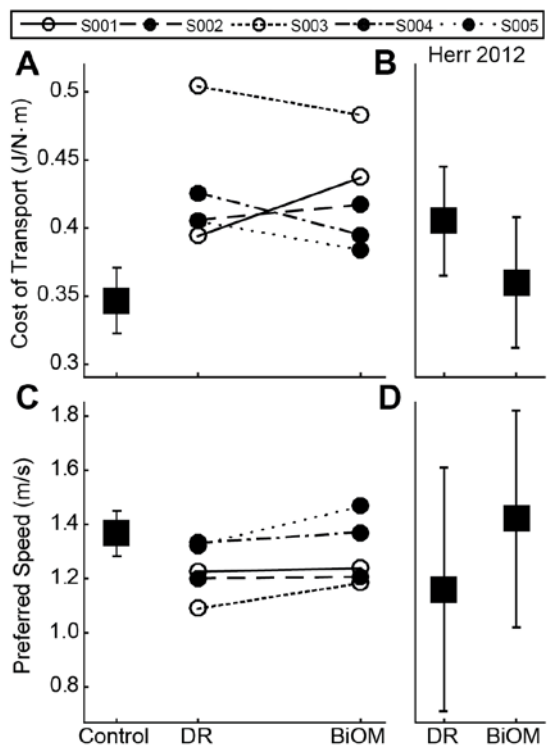

Figure 1. Average COT (A) and preferred walking speed (C) in DR and BiOM ankle prosthesis. Data from control subjects and from (Herr 2012) (B, D) are shown for comparison. Error bars represent ±1 SD. 'O' indicates regular BiOM users.

REFERENCES

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