Speed-Dependent Changes in Metabolic Cost of Walking 12 and 24 Months after Transfemoral Osseointegration

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Summary

Metabolic outputs were measured among 25 service members with transfemoral amputation (TFA) walking at four speeds before, and 12- and 24-months after osseointegration (OI); overall, metabolic costs were reduced at 24-months after OI for service members with unilateral and bilateral TFA.

Introduction

People with vs. without unilateral TFA have 20-60% greater metabolic cost during walking [1], which is associated with decreased walking capacity and lower quality of life [2]. For those with TFA experiencing socket-related issues, OI is a surgical option that can improve walking capacity through direct skeletal attachment of a prosthesis. While reductions in metabolic costs after OI have been reported, existing work has inconsistently reported metabolic output using a variety of measures across variable timepoints and walking speeds [3-5]. Here, we used indirect calorimetry to evaluate the metabolic costs of walking, at four speeds, in service members with TFA 12- and 24-months after vs. before OI. We hypothesized overall metabolic outputs would be lower after OI, but with speed-dependent changes relative to self-selected walking speed (SSWS).

Methods

Twenty-five service members with TFA (16 unilateral [UTFA], 9 bilateral [BTFA]; 36.4±10.0yr, 178.6±6.7cm, 93.4±15.8kg) completed metabolic testing (Oxycon Mobile, Carefusion; Germany) while walking on a treadmill (Bertec; USA) at four speeds: SSWS, 0.7m/s, 1.0m/s, and 1.3m/s. Metabolic cost of transport (CoT; rate of O_2 consumption per unit distance; J/kg/m) was calculated from the last 2min of each 6min trial, and compared by time and speed using linear mixed models, separately for the UTFA and BTFA cohorts (p<0.05). The six-minute walk test (6MWT) was also performed once at each visit.

Results and Discussion

For the UTFA cohort (Fig. 1A), overall CoT was similar at 12mo (p=0.98) but reduced at 24mo (p<0.001) after OI. For the BTFA cohort (Fig. 1B), overall CoT was reduced at both 12mo (p=0.016) and 24mo (p=0.001) after OI. Reductions in CoT across both cohorts by 24mo indicate that OI can reduce energy expenditure during walking, consistent with other metabolic outcomes (e.g., mean O_2 consumption, heart rate) [2,3]. However, speed-dependent changes in CoT remain for the UTFA cohort; CoT was lower at 1.0m/s (p=0.029) and 1.3m/s (p<0.001), even as SSWS becomes faster 12mo and 24mo after vs. before OI (0.88 and 1.03 vs. 0.82 m/s, respectively). In contrast, the BTFA cohort had the highest CoT at SSWS, despite SWSS becoming faster at 12mo and 24mo after OI (0.64 and 0.72 vs. 0.58m/s, respectively). Mean 6MWT distances for UTFA/BTFA cohorts: 475/325m (before), 464/317m (12mo), and 527/331m (24mo), suggesting improved functional walking capacity alongside reduced CoT at 24 months.

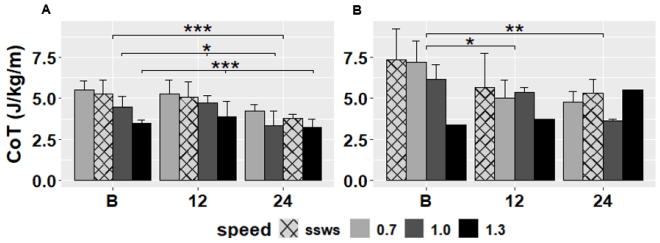

Figure 1: Mean±standard deviation cost of transport (CoT) walking at four speeds before ("B"), 12-, and 24-months after OI in A) UTFA and B) BTFA cohorts.

Conclusions

Overall, lower metabolic outputs after OI in the UTFA and BTFA cohorts suggest that OI can reduce metabolic costs of walking, concurrent to increasing walking capacity (e.g., 6MWT distance), contributing to improved outcomes among service members with UTFA and BTFA [6].

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