COMPARING WALKING SPEED DURING SLOPE AND LEVEL WALKING BEFORE AND 24 MONTHS AFTER TRANSFEMORAL OSSEOINTEGRATION

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Summary

Service members with unilateral transfemoral amputation (TFA) completed upslope, downslope, and level walking before and 24 months after osseointegration (OI) while temporal-spatial data was collected. Relative to pre-OI, post-OI speeds were similar during upslope and downslope walking, though 0.1 m/s slower during level walking.

Introduction

Individuals with TFA and OI (the direct skeletal attachment of a prosthesis) vs. socket-suspended prostheses have higher mobility scores, walk up to 44% faster over level ground, and otherwise exhibit temporal-spatial metrics more similar to individuals without lower limb loss [1-3]. While walking on slopes vs. level ground presents a more challenging terrain for individuals with TFA [4], the effects of OI on slope walking have not been thoroughly studied. Thus, the aim of this work was to compare temporal-spatial outcomes, primarily self-selected center of mass speed, during slope and level walking among Service members with TFA, before and 24-months after OI. We hypothesized that self-selected walking speeds would increase after vs. before OI for all modes.

Methods

Six male Service members (mean±SD age: 40.8±13.7yr, mass: 91.0±18.2kg, height: 178.7±8.8cm) with unilateral TFA completed a full-body biomechanical analysis while walking at a self-selected speed up and down a 10° slope, and on level ground, before OI (B) and again 24 months after OI (24M). Walking speed was calculated by dividing stride length by stride time on the prosthetic side. Stride width was also extracted for the prosthetic side. Paired t-tests ($p<0.05$) compared outcomes at B and 24M, separately for each mode.

Results and Discussion

For both upslope and downslope walking, there were no differences from B to 24M in walking speed ($p>0.49$), stride length ($p>0.30$), or stride width ($p>0.17$). For level walking, walking speed decreased (1.30 to 1.20 m/s, $p=0.02$), stride width increased (5.01 to 5.51 cm, $p<0.01$), while stride length was not different ($p=0.06$) from B to 24M.

Our data does not support the hypothesis that walking speed would increase from B to 24M for all modes. However, our participants exhibited faster speeds at 24M (1.2m/s) compared to a civilian TFA population during level walking (1.05 m/s) and comparable speeds during upslope (1.1 to 0.98 m/s) and downslope walking (0.95 to 0.95 m/s) [5]. The faster level walking speed could be attributed to young and active military, as speed at B (1.3m/s) was comparable even to uninjured individuals (1.4 m/s) [5]. There were also greater differences in speed between 24M and uninjured individuals during downslope walking (0.95 to 1.44 m/s), compared to upslope (1.1 to 1.24 m/s) and level walking (1.2 to 1.4 m/s) [5]. Of note, similar stride lengths and widths from B to 24M suggest participants did not need to use shorter or wider gait for loading or balance compensation. These temporal-spatial outcomes collectively demonstrate that individuals with OI vs. socket-suspended prostheses can achieve faster or comparable speeds for level walking, though sloped walking (particularly downslope) presents a greater challenge. While we do not report a worsening of gait outcomes after OI, these data alongside relatively large improvements in patient-reported outcomes [6] emphasize the importance of a comprehensive approach for more fully characterizing OI, particularly within unique patient populations like young service members with traumatic lower limb loss.

Conclusions

Service members with TFA walked at similar speeds on slopes and level ground (within 0.1 m/s) after vs. before OI, highlighting a potential disconnect between biomechanical and patient-reported outcomes. Evaluating performance-based outcomes outside of laboratory environments could help bridge this gap.

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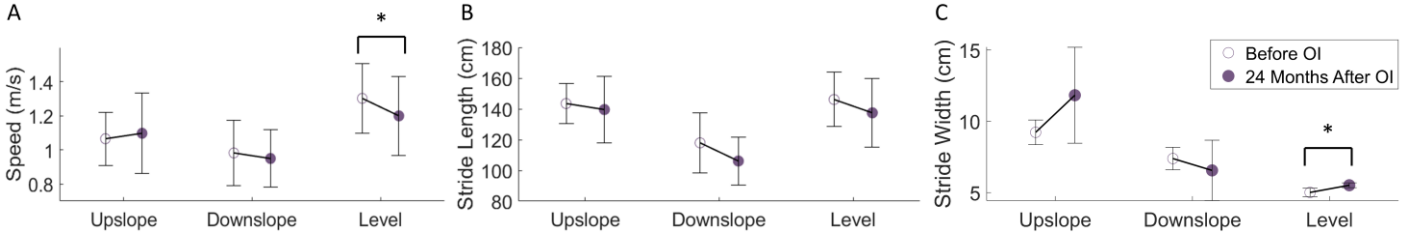

Figure 1: Average (A) walking speed, (B) stride length, and (C) stride width before (open circle) and 24-month (filled circle) after OI, for upslope, downslope, and level walking. Error bars represent ±1 standard deviation. Significant differences are indicated with a (*).