Dual Task Gait Analysis in Prosthesis Users

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INTRODUCTION

Performing two tasks concurrently, such as walking and talking, is common in daily life. Attempting to perform two activities at once is referred to as *dual tasking* and relies on cognitive executive function to achieve successful performance. The interference caused by a secondary task while walking (dual task cost) has been examined in multiple studies in the elderly and persons with neurological impairments. The results indicate that a dual task paradigm is useful for identifying gait anomalies not identifiable during normal walking and for predicting falls (Springer, 2006).

Since such studies have not been carried out in prosthesis users, our objective was to compare the effects of dual tasking on gait between lower limb prosthesis users and healthy controls. It was hypothesized that prosthesis users will exhibit greater variability in gait than controls. This approach may be useful to improve understanding of motor control in prosthesis users, assess fall risk, and have consideration for prosthetic alignment.

METHOD

Subjects: We recruited 21 prosthesis users (15 men; mean age 46±14 years; 14±2 years of education; 14 below knee and 7 above knee amputees) and 13 age- and education-matched healthy controls (8 men; mean age 46±18 years; 15±2 years of education). Consent was obtained prior to participation.

Method: Gait, cognitive function, cognitive processing, and executive function were evaluated at baseline. To assess gait, subjects walked at their self-selected speed 6 times over a 7.6m electronic walkway (GAITRite®), which recorded temporal and spatial foot fall data over the middle 4.4m. Cognitive function was evaluated using the Modified Mini-Mental Status Exam. Processing speed and executive function were tested using Trail-Making forms A and B.

Protocol: Backwards spelling (SPL), serial subtraction (SUB), and sorting through keys (KEY) were used for dual tasking. The subjects were told to walk at a comfortable pace while performing these tasks and no instruction on prioritization was given. In a random order, each task was presented in a block of 6 passes on the walkway. Afterwards, the subjects walked at their self-selected normal, slow, and fast speeds (6 passes each). At the end, they were asked to rate the difficulty of each task on a 7-point Likert scale.

Data Analysis: Footfall data from the GAITRite® system were processed using MatLAB® (Mathworks Inc.). For each subject, a linear fit was performed for different gait variables against velocity for all self-selected, non-dual task walking speeds. For the variables found to have a significant relationship with velocity, the linear formula was used to calculate the predicted value for the self-selected speeds and the three dual tasks. The difference between the predicted value and the actual value for each data point was calculated as the residual. The variability of gait was calculated as the standard deviation of residuals. The ANOVA interaction between the group (prosthetic/non-prosthetic side vs. control) and condition (baseline vs. dual task) factors was used to determine if gait variability (SD of residuals) during dual tasking was significantly greater in prosthesis users compared to controls ($p<0.05$).

RESULTS

The prosthesis users showed significantly greater variability than controls in stride length, cadence, step length, and step time for all dual tasks on the prosthetic side. The non-prosthetic side showed significantly greater variability for these variables as well, but not for every dual task. Figure 1 illustrates the variability data for stride length.

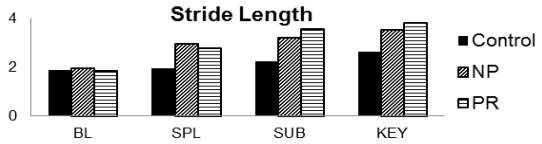

Figure 1. SD of residuals for stride length. There was a significant interaction for both legs for all three tasks. NP – Non-Prosthetic Side; PR – Prosthetic Side

DISCUSSION

The increased variability of the prosthesis users under dual task conditions suggests that the use of a prosthetic device increases dual task cost. This implies that prosthesis users must allocate more cognitive resources to walking than matched controls. Such findings are relevant to understanding everyday gait in prosthesis users, since performing a secondary task while walking is a common occurrence.

CONCLUSION

Further studies should be conducted to determine how these results relate to everyday function of prosthesis users, including fall risk and prosthetic alignment.

CLINICAL APPLICATIONS

Dual task analysis may prove to be a useful tool in predicting fall risk and assessing prosthetic alignment.

REFERENCES

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