TRANSFEMORAL AMPUTATION ALTERS PELVIS-TRUNK COORDINATION DURING WALKING: IMPLICATIONS FOR LOW BACK PAIN

Elizabeth M. Russell, Jennifer M. Aldridge Whitehead, Jason M. Wilken

Center for the Intrepid, Brooke Army Medical Center, Fort Sam Houston, TX, U.S.A.

E-mail: erussell.kin@gmail.com

INTRODUCTION

Low back pain (LBP) is common in individuals with transfemoral amputations (TFA) and their rates of pain are greater than in the general population [1]. The increased incidence of LBP is likely the result of altered gait mechanics from prosthetic use. Using continuous relative phase (CRP), Seay et al. [2] found that sufferers of LBP had greater synchronous, in-phase pelvis and trunk rotations in the frontal plane during walking than controls. Lamoth et al. [3] found that individuals with LBP never achieved the same degree of axial out-of-phase coordination as control subjects. LBP patients also have less ability to switch coordination patterns when exposed to perturbations, such as increases in walking speed [2,3,5].

The variability of CRP can also provide information on LBP. A movement with low variability is perceived as “safer” due to its predictability, but repetition may create an overuse situation [4]. Although the literature varies [2], Selles et al. [5] found lower pelvis-trunk coordination variability in patients with LBP relative to controls.

The purpose of this study was to determine if individuals with TFA, with and without LBP, demonstrate pelvis-trunk coordination consistent with populations with LBP. A secondary purpose was to determine if coordination modulates with walking speed.

METHODS

Seven TFA with LBP (TFA-LBP), nine TFA with no pain (TFA-NP), and twelve control subjects participated. TFA-NP indicated a response on a Prosthetics Evaluation Questionnaire of LBP frequency as “never” or “only once or twice” in the past 4 weeks. TFA-LBP indicated a LBP frequency ranging from “one time per week” to “all the time”.

Overground gait was analyzed with three-dimensional motion capture (Motion Analysis, 120 Hz) as participants walked at slow, moderate and fast speeds corresponding to Froude numbers of 0.10, 0.16, and 0.23, respectively. Trunk and pelvis segment angles were calculated during eight strides initiated with the prosthetic limb in both TFA groups, and right limb in the control group. CRP and CRP variability were calculated as per Hamill et al. [4].

A repeated-measures ANOVA tested for significant main effects of group and speed. Paired t-tests and Tukeys post hoc tests identified pair-wise differences. Criterion for statistical significance was set at p<0.05.

RESULTS AND DISCUSSION

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (yrs)</th>
<th>Height (m)</th>
<th>Mass (kg)</th>
<th>Months ambulating</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFA-LBP</td>
<td>32.1* (5.2)</td>
<td>1.80 (0.06)</td>
<td>90.6* (10.9)</td>
<td>23 (21)</td>
</tr>
<tr>
<td>TFA-NP</td>
<td>28.4 (6.4)</td>
<td>1.79 (0.07)</td>
<td>82.4 (8.0)</td>
<td>43 (20)</td>
</tr>
<tr>
<td>Control</td>
<td>25.1 (3.1)</td>
<td>1.79 (0.06)</td>
<td>79.5 (10.0)</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1: Mean (standard deviation) subject characteristics. * indicates a significant difference from the control group. There were no significant differences between patient groups.

The TFA groups exhibited significantly different CRP values relative to the control group in the sagittal (p<0.001) and frontal (p=0.001) planes (Fig 1). Both TFA groups also responded in a manner similar to non-amputees with LBP [2].
Although the greatest pelvis and trunk ranges of motion typically occur in the transverse plane during walking to control angular momentum, transverse CRP were not significantly different among groups.

Transverse CRP, in particular, was expected to increase with speed, but this was only found in the TFA groups ($p_{interactions} = 0.018$). Both TFA groups demonstrate an apparent phase transition between the lowest speeds. The speed differences may not have been sufficiently challenging to require adaptation by the control group but both TFA groups transitioned at lower levels of perturbation.

CRP variability was not significantly different among groups, with the exception of lower values in the TFA groups relative to the controls in the frontal plane at the slowest speed ($p=0.014$ and $p=0.001$ for TFA-NP and TFA-LBP, respectively, relative to controls).

**SUMMARY/CONCLUSIONS**

Individuals with TFA demonstrated some coordination patterns that were different from able-bodied individuals, but consistent with persons with LBP. The patient groups were able to control transverse plane rotations to the same extent as non-amputees, but may do so by neglecting optimal coordination in the sagittal and frontal planes. Interestingly, individuals with TFA with and without LBP were not significantly different.

Although a cause and effect relationship between CRP and future development of LBP has yet to be determined, the results of this study add to the literature attempting to characterize biomechanical parameters of LBP in high-risk populations.

**REFERENCES**


**ACKNOWLEDGEMENTS**

Funding for this study was provided by the U.S. Army Telemedicine & Advanced Technology Research Center and The Center for Rehabilitation Sciences Research.

The view(s) expressed herein are those of the author(s) and do not reflect the official policy or position of Brooke Army Medical Center, U.S. Army Medical Department, U.S. Army Office of the Surgeon General, Department of the Army, Department of Defense or the U.S. Government.