Subthreshold Vibration Does Not Affect Walking Performance of Transtibial Amputees

Ian Sloan1, Jenny A. Kent1, Shane R. Wurdeman2, Adam L. Jacobsen3, Kota Z. Takahashi1, Nicholas Stergiou1, 4

1Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE USA
2Department of Clinical and Scientific Affairs, Hangar Clinic, Houston, TX USA
3Veterans Affairs Medical Center, Omaha, NE USA
4College of Public Health, University of Nebraska Medical Center, Omaha, NE USA

INTRODUCTION

- Amputation below the knee causes a person to lose important pathways of sensation to central nervous system [1].
- The goal of this work is to find if a stochastic resonance pattern will help to improve walking performance of residual limb in transtibial amputees when applied as subthreshold vibration to the affected side.
- The choice to work with pink signal is based off its prevalence in natural processes. [2]

STOCHASTIC RESONANCE

<table>
<thead>
<tr>
<th>Signal below perception threshold</th>
<th>Above perception threshold – underlying signal is detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak Stimulus</td>
<td>Noise Added Stimulus</td>
</tr>
</tbody>
</table>

Figure 1: The differences between normal signal and stimulus with added noise.

- It has been shown that stochastic resonance (Figure 1) has improved sensation in elderly adults with neuropathy. [3]

Purpose: We specifically anticipated that stochastic resonance would enable an amputee to have better control of their prosthesis.

METHODS

- All subjects attended the Biomechanics Research Building for this biomechanical analysis
- Three different vibration conditions were applied: no vibration, pink noise, and white noise.
- All vibrations were applied to the mid-thigh of the affected limb.
- Participants walked across the gait laboratory floor at self-selected pace.
- At least 10 traverses were completed.
- Motion data were captured at 100Hz using Cortex; kinematic data processed in Visual 3D.
- A 1-way Repeated Measures ANOVA was used to compare variables across all three conditions; α=0.05.

RESULTS AND DISCUSSION

Figure 2: Step length and width variability of both prosthetic and sound leg.

- No significant differences found across conditions. (Figure 2)
- Vibration of thigh doesn’t improve walking performance.
- From the variables that were choose, there is high variability among participants, reflecting heterogeneity of group.

CONCLUSION

- Vibration of residual limb did not improve overall control of prosthesis from the measures that were analyzed.
- Will look into more possibilities: longer duration of vibration or testing outside laboratory setting in form of an intervention/training.

REFERENCES


ACKNOWLEDGEMENTS

This work was supported by the Center for Research in Human Movement Variability of the University of Nebraska at Omaha, NIH (P20GM109090), and NIH (R15HD08682).