Leg Muscle Activities and Center of Pressure Changes of Healthy Individuals during Single Leg Stance

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Summary

In this study, we compared surface electromyography (sEMG) activity and center of pressure (COP) changes in 15 children, 28 young adults, and 32 elderly individuals during a single-leg stance. The Brain Motor Control Assessment (BMCA) protocol was applied to identify differences, and the results, considering COP changes, were found to be reasonable.

Introduction

The single-leg stance (SLS) test is commonly used as a simple and effective measurement tool for elderly individuals. However, relying solely on duration may not provide a comprehensive assessment of neurologically intact participants. In this study, we analyzed both EMG and COP path length data. The BMCA technique offers a straightforward approach that eliminates the need for additional procedures, such as determining maximum voluntary contraction for normalization. Instead, it involves multi-muscle EMG measurements from agonist, antagonist, and synergistic muscles during a specific motion, with data collected from both ipsilateral and/or contralateral muscles.

Methods

All participants provided written consent (IRB no. DHCIRB-2022-06-0008). A total of 75 neurologically intact individuals (15 children, 27 young adults, and 32 elderly adults) followed the standard single-leg stance (SLS) protocol established by the Korean Balance Ability Data Center. Surface electromyography (sEMG) measurements were recorded from both legs during the SLS test, utilizing a total of 14 sEMG channels: rectus abdominis, rectus femoris, tibialis anterior, peroneus, biceps femoris, gastrocnemius, and soleus on both legs. A prototype sEMG profile was created using data from all participants while they were positioned on the force plate (Bertec, USA). The sEMG system employed was the Ultium EMG sensor system (Noraxon USA), with a gain of 1000, a bandwidth of 10-500 Hz, and a sampling rate of 2000 samples per second per channel.

The SLS test window for each subject was set to a minimum of 20 seconds. COP path length also measured from the force plate. EMG data were normalized using both the sampling rate and the total magnitude of EMG for each participant. Multi-muscle sEMG patterns were compared during SLS. The entire EMG assessment followed the BMCA protocol [1-3]. In short, a prototype vector was created using data from 15 young adults, incorporating seven response elements for each side. Finally, a similarity index and total EMG activity were calculated. We also compared the COP, SI, and magnitude.

Results and Discussion

The similarity index (SI) revealed consistent patterns across groups. Young adults exhibited the highest SI (0.93 ± 0.02), followed by elderly adults (0.91 ± 0.05), and children, who had the lowest SI (0.90 ± 0.07). In terms of magnitude, elderly adults showed the greatest values (80.1 ± 40.0), followed by children (68.5 ± 28.3), and young adults (51.3 ± 13.3). (See Fig. 1 for SI and magnitude values across 14 muscles.)

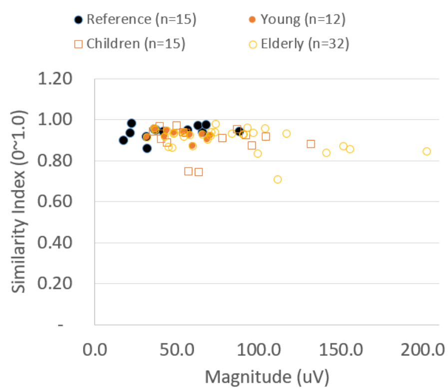

Figure 1: Similarity index (SI) and magnitude of all participants. There were no significant differences among four groups.

We observed the shortest COP path length in young adults (1058.8 ± 249.4), followed by children (1097 ± 259.6), and the longest in elderly adults (1501 ± 558.7). Both EMG magnitude and COP path length exhibited similar patterns.

Conclusions

The similarity index (SI) and magnitude as well as COP path length could provide valuable additional insights.

References

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