Analyzing the Differences in Postural Stability in Patients with Minor Lower Extremity Amputations

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INTRODUCTION: Amputations of the lower extremity (LE) significantly impact quality of life (QoL). After LE amputation, many patients experience difficulty with mobility, and, importantly, often struggle to adequately support themselves while standing. Struggles in postural stability exist for patients at all levels of LE amputations, including minor amputations. Understanding the impact of different levels of minor LE amputations on postural stability and QoL is important to guide surgical decision making. Thus, this study compares postural stability parameters in patients with digit, ray, and transmetatarsal (TMA) amputations.

METHODS: From December 2021 to March 2024, adult patients (≥18 years) who were 1) able to stand up unassisted, 2) were not experiencing pain, and 3) had not undergone an LE procedure in the past three months were eligible for study participation. Using wearable gait sensors, patients completed a standardized sway test, similar to the Romberg Test, to assess postural stability. This test involved the patients standing up straight with their feet together and their eyes closed for 30 seconds. Three sway parameters were used to determine postural stability. These were sway area, mean velocity, and root mean square (RMS). Sensor data was collected and analyzed using Motility Lab software. Statistical significance was defined as $p < 0.05$.

RESULTS: A total of 30 patients were included in the study. These participants comprised 13 (43.33%) digit, 8 (26.67%) ray, and 9 (30%) TMA amputees. Between the digit, ray, and TMA groups, the mean age (64.31 ± 15.85, 66.75 ± 9.36, 68.78 ± 10.46 years respectively), body mass index (BMI; 30.19 ± 6.66, 28.65 ± 4.98, 31.84 ± 4.97 kg/m2 respectively), and Charlson Comorbidity Index (CCI; 5.08 ± 2.90, 6.125 ± 1.64, 5.67 ± 2.45 respectively) did not differ significantly ($p = 0.725$, $p = 0.533$, $p = 0.639$ respectively). We observed a significant difference ($p=0.024$) in the rate of Diabetes Mellitus II (DM II) between the three groups: digit (30.77%), ray (62.50%) and TMA (88.89%). Between the digit, ray, and TMA groups, there were no significant differences in sway area (0.13 ± 0.11, 0.37 ± 0.46, 0.78 ± 1.61 m2/s4 respectively; $p= 0.274$), mean velocity (0.27 ± 0.16, 0.32 ± 0.19, 0.48 ± 0.54 m/s respectively; $p = 0.351$) or RMS (0.16 ± 0.07, 0.23 ± 0.10, 0.28 ± 0.25 m/s2 respectively; $p = 0.187$).

DISCUSSION AND CONCLUSION: Our results indicate comparable postural sway and stability between patients with different levels of minor LE amputations. While significance is limited by our small sample size, the trend of our data may suggest that postural stability declines with increasing levels of amputation. One other limitation is that there is a significant difference between the rates of DM II of the three groups and this may have an effect on the outcome of the sway trial. Nonetheless, our results are valuable to guide further research to determine the outcomes of all LE amputation levels on postural stability.