

Quantifying Irregularity and Asymmetry in Gait Dynamics for Transmetatarsal Amputation Patients

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INTRODUCTION

As transmetatarsal amputations (TMA) preserve the ankle joint, it is typically favored over more proximal amputations. However, there is a paucity of studies investigating gait in these patients. Thus, this study aims to characterize gait dynamics after nontraumatic TMA among a chronic wound population in order to identify potential gait-related factors that may influence comorbidities and enhance patient outcomes.

METHODS

Between December 2021 and January 2024, adult patients were able to

- 1) Ambulate unassisted
- 2) Without experiencing pain
- 3) Did not have an open wound or did not undergo lower extremity surgery in the preceding 3 months

A single center, cross-sectional study was conducted. Participants completed a 120-second walk test with wearable gait sensors. Demographic, medical and surgical histories were documented. Gait parameters measured included speed (m/s), elevation mid-swing (cm), step duration (s), cadence (steps/min), single limb support (%), double limb support (%), stride length (m), and were compared between the limb of TMA and limb of no surgery.

RESULTS

A total of 8 patients underwent TMA and completed gait testing. The average age is 66.5 (SD=10.9) years, with an average body mass index of 28.6 (SD=7.1), and Charlson Comorbidity Index of 5.3 (SD=1.6). All patients had diabetes mellitus, while 87.5% had neuropathy, 25.0% had peripheral arterial disease, and 37.5% had chronic kidney disease. The analysis revealed a significant difference in stride length between the amputated leg and the non-amputated leg (0.64 [0.15] vs 1.05 [0.40], $p=0.027$). Gait parameters as speed and single limb support (35.20 ± 2.91 vs 34.94 ± 2.89 , $p=0.859$) showed no significant differences.

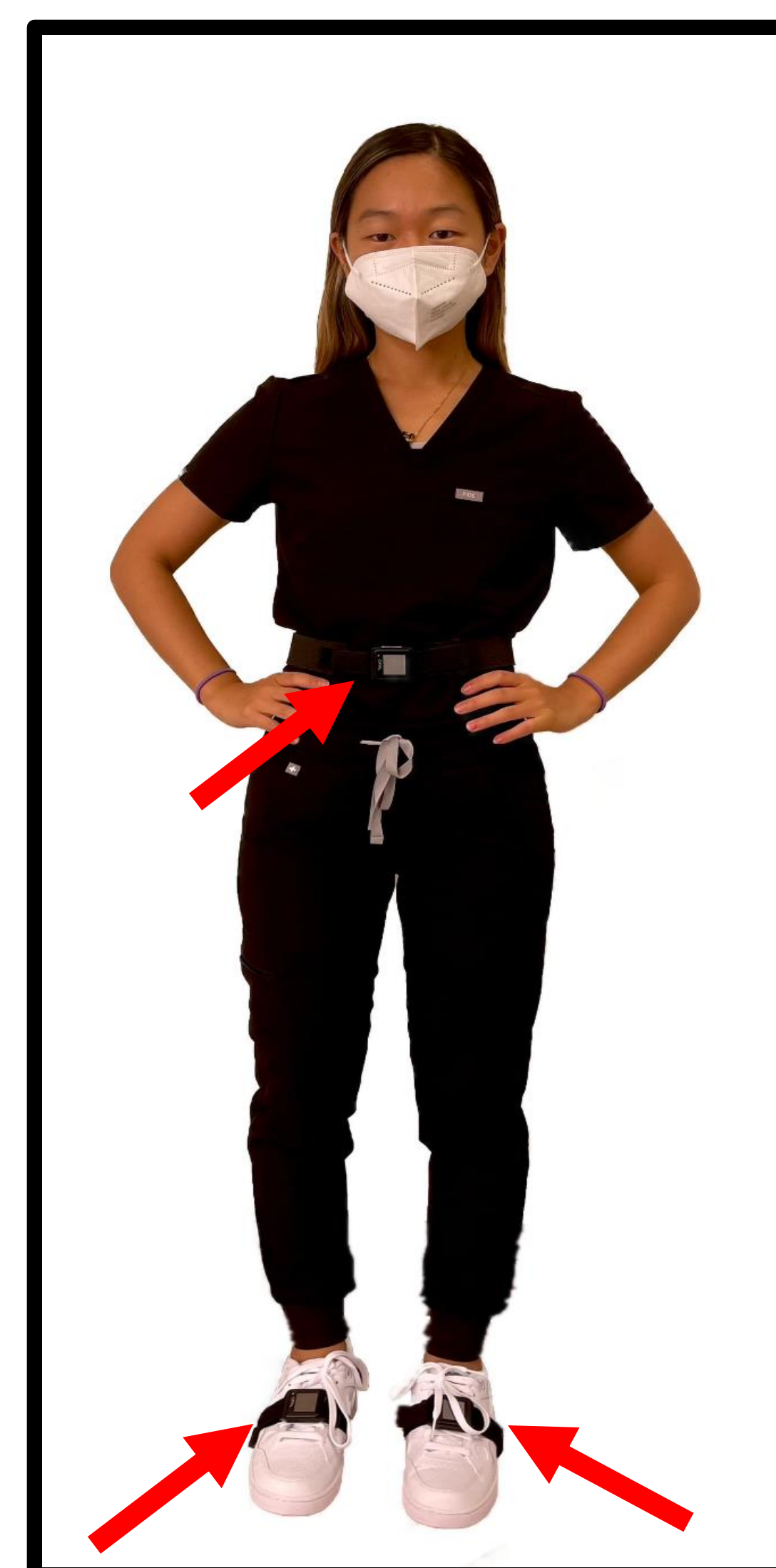


Fig 1. Sensor placement and Romberg test position.

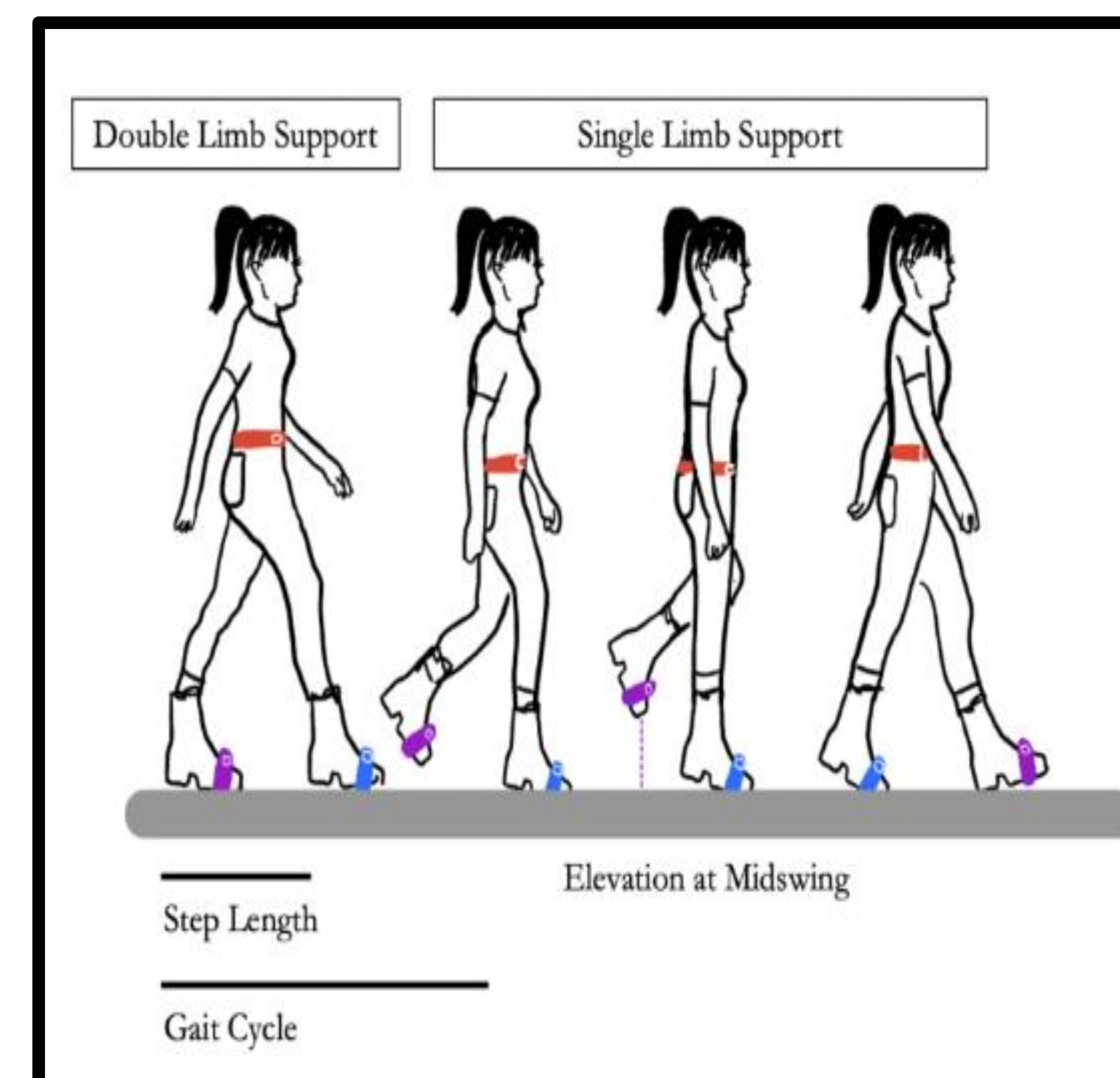


Fig 2. Depiction of spatiotemporal gait parameters. G-Sensor placed across abdomen in lumbar position (red); Opal sensors attached to each foot by velcro straps (blue and purple).

Table 1. Amp Leg vs Non Amp Leg, analysis of Gait Characteristics of those with TMA

	Average	Amp	Non Amp	P-Value
Gait Speed, m/s	0.85 ± 0.20	0.86 ± 0.21	0.84 ± 0.20	0.795
Elevation Mid-Swing, cm	2.16 ± 1.04	2.22 ± 1.13	2.10 ± 1.01	0.831
Step Duration, s	0.63 ± 0.07	0.63 ± 0.07	0.62 ± 0.08	0.797
Cadence, steps/min	96.64 ± 10.63	96.64 ± 10.93	96.65 ± 11.06	0.999
Single Limb Support, %	35.07 ± 2.80	35.20 ± 2.91	34.94 ± 2.89	0.859
Double Limb Support, %	28.42 [8.08]	28.42 [8.00]	28.40 [8.06]	1.000
Stride Length	0.74 [0.47]	0.64 [0.15]	1.05 [0.40]	0.027

CONCLUSION

In the TMA population, gait symmetry was maintained, and limb support was balanced. However, stride length varied due to the TMA limb's shorter foot generating less push-off force while walking. TMA is an effective limb-lengthening amputation that promotes functional gait outcomes and should be considered before opting for more proximal amputations. Regular follow-up on patients' lower extremity function is essential to preserve their quality of life, prevent further reductions in stride length, and reduce the risk of falls or imbalance gait.