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Introduction

Peripheral neuropathy (PN) leads to diminished pain perception and impaired proprioception, causing gait abnormalities that increase fall risk, delayed recovery, and postoperative complications in the perioperative setting. Despite these risks, quantifying gait deficits in complex, comorbid populations remains understudied. This study aims to objectively assess gait impairments in patients with PN using wearable sensors as part of a quality improvement initiative to enhance perioperative safety. By understanding how PN affects mobility, this research seeks to inform anesthesia planning and guide interventions for improving postoperative outcomes in this vulnerable patient group.

AIM STATEMENT: This study aims to assess gait impairments in peripheral neuropathy patients using wearable sensors, enhancing preoperative evaluations, informing anesthesia planning, and improving perioperative safety and outcomes in this vulnerable population.



Fig 2. Sensor placement and Romberg test position. G-Sensor placed across abdomen in lumbar position (red); Opal sensors attached to each foot by velcro straps (blue).

Table 1. Patient Demographics and Objective Gait Parameters by Presence of Neuropathy

	Control (n=95)	Neuropathy (n=95)	P-value
Demographics			
Mean Age (years)	64.1 ± 9.8	64.3 ± 9.7	0.888
Mean BMI (kg/m ²)	29.6 ± 8.9	32.2 ± 8.1	0.045*
Males (n)	63 (66.3%)	63 (66.3%)	-
DMII (n)	30 (31.9%)	70 (73.7%)	<0.001*
Chronic Kidney Disease (n)	10 (10.5%)	24 (25.2%)	0.008*
End Stage Renal Disease (n)	0 (0.0%)	7 (7.37%)	0.007*
Smoking (n)	28 (30.4%)	39 (41.1%)	0.130
Gait Parameters			
Gait Speed (m/s)	0.96 ± 0.23	0.82 ± 0.77	<0.001*
Elevation mid swing (cm)	1.43 ± 0.89	1.58 ± 1.07	0.300
Step duration (s)	0.59 ± 0.06	0.64 ± 0.08	0.009*
Cadence (steps/min)	101.64 ± 9.53	97.36 ± 11.29	0.008*
Single Limb Support (%)	37.08 ± 2.24	35.71 ± 2.53	<0.001*
Double Limb Support (%)	26.18 ± 6.13	28.81 ± 4.53	0.002*
Sway (m/s ²)	0.48 ± 0.57	0.79 ± 0.76	0.003*

Boldface * indicates a statistically significant result with a significance level of $p < 0.05$

Table 2. Multivariable linear regression of gait parameters

	Procedure Performed							
	Peripheral Neuropathy		BMI		DMII		CKD	
Outcome	β [95% CI]	P-value	β [95% CI]	P-value	β [95% CI]	P-value	β [95% CI]	P-value
Treatment Arm	1 [reference]	-	1 [reference]	-	1 [reference]	-	1 [reference]	-
Gait speed (m/s)	-0.1 [-0.2, -0.03]	0.008*	-0.003 [-0.007, 0.009]	0.132	-0.01 [-0.09, 0.06]	0.740	-0.09 [-2, -0.001]	0.046*
Step duration (s)	0.02 [-0.0002, 0.05]	0.052*	-0.003 [-0.001, .001]	0.589	-0.004 [-0.03, 0.02]	0.758	0.03 [0.002, 0.06]	0.035*
Cadence (steps/min)	-4.5 [-8.4, -0.6]	0.025*	0.06 [-1, 0.2]	0.547	1.3 [-2.6, 5.2]	0.515	-5.3 [-9.9, -0.6]	0.025*
Single limb support (%)	-1.3 [-2.2, -0.4]	0.003*	-0.02 [-0.6, 0.02]	0.347	-0.2 [-1.1, 0.72]	0.718	-0.5 [-1.5, 0.6]	0.384
Double limb support (%)	2.9 [1.1, 4.5]	0.001*	0.08 [-0.002, 0.2]	0.058	0.8 [-0.9, 2.5]	0.346	0.5 [-1.5, 2.5]	0.646
Sway (m/s ²)	-0.2 [-0.4, 0.7]	0.172	-0.002 [-0.01, 0.01]	0.754	-0.07 [-0.3, 0.2]	0.554	-0.004 [-0.3, 0.3]	0.976

Abbreviations: DMII = diabetes mellitus type II; CKD = Chronic Kidney Disease
Boldface * indicates a statistically significant result with a significance level of $p < 0.05$

Intervention Description

Adult patients presenting to a tertiary wound care center who could ambulate unassisted and had no pain, open wounds, or recent lower extremity surgery were enrolled. Standardized gait assessments were performed using wearable sensors, including a 120-second walk and a 30-second sway (Romberg) test. Outcomes such as gait speed, cadence, limb support phases, and postural sway were extracted via Motility Lab software. Patients were matched by age (± 5 years) and gender. Multivariable logistic regression adjusted for BMI, type 2 diabetes mellitus (DMII), and chronic kidney disease (CKD).

Post-Intervention Results/ Outcomes

Among 190 age- and gender-matched patients (95 with PN, 95 controls), those with PN exhibited significantly slower gait speed, reduced cadence, decreased single limb support, increased step duration, and greater sway—all of which are associated with heightened fall risk and impaired mobility. Multivariate analysis confirmed PN as an independent predictor of these gait impairments even after controlling for comorbidities.

Peripheral neuropathy significantly alters gait in patients with complex medical histories, posing perioperative risks that may go unrecognized due to the absence of pain. Incorporating gait analysis into preoperative assessment could guide anesthesia teams in mitigating mobility-related complications and improving postoperative outcomes. These findings support quality improvement strategies targeting early PN identification and functional mobility assessments to enhance perioperative safety.

References

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Gait speed and cadence in the control group averaged 0.96±0.23m/s and 101.64±9.53 steps/min, respectively—consistent with normative values reported for independently ambulating older adults. Step duration (0.59±0.06s), single limb support (37.08±2.24%), and double limb support (26.18±6.13) similarly aligned with prior studies of age-matched healthy cohorts. Sway values in controls (0.48±0.57m/s²) provide a perioperative baseline for postural stability. These reference metrics serve as a benchmark for identifying clinically meaningful deviations in patients with peripheral neuropathy and may inform future perioperative risk stratification efforts.