A Novel Smart Implantable Device Demonstrates Early Gait Decline as a Marker of Periprosthetic Joint Infection After Total Knee Arthroplasty

Malcolm W Sinclair, Patrick M Aubin, Fred D Cushner, William John Long

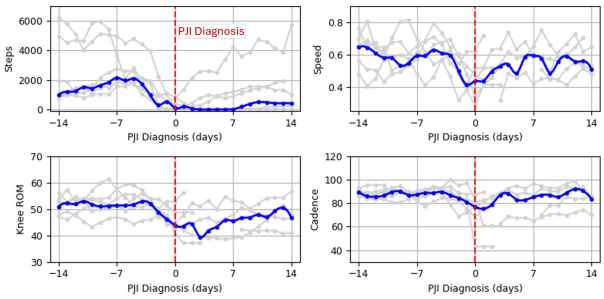
INTRODUCTION: Timely detection of periprosthetic joint infection (PJI) remains difficult with no current tools available to aid in early detection. In this retrospective study, we analyzed pre- and post-diagnostic gait parameters in 12 patients who developed a PJI after implantation with a smart implantable device (SID). Given the critical importance of early detection for successful infection eradication and implant retention, this study aimed to evaluate whether pre-diagnostic functional gait decline could serve as an early, objective indicator of evolving PJI.

METHODS:

A retrospective case study was conducted using a de-identified longitudinal commercial claims dataset of 6,394 patients who received a smart implantable device (SID) during total knee arthroplasty (TKA) between October 2021 and January 2025. Of the 29 patients diagnosed with periprosthetic joint infection (PJI), 12 met the following inclusion criteria: (1) PJI diagnosis confirmed by ICD-10 code, (2) onset of PJI between postoperative day 8 and day 364, (3) retention of the TKA/SID implant following diagnosis (i.e., no explantation), and (4) complete SID gait data available both before and after diagnosis. For each patient, three-day moving averages were calculated for step count, walking speed, cadence, and functional knee range of motion (ROM) from 14 days before to 14 days after the PJI diagnosis. Percentage changes from baseline were assessed at the following timepoints relative to the date of PJI diagnosis: -7, -3, -1 (pre-diagnosis), 0 (day of diagnosis), and +1, +3, and +7 days (post-diagnosis).

RESULTS: Two distinct subgroups of PJI patients were identified based on the temporal impact of infection on gait parameters. Group 1 (n=6) demonstrated significant functional decline, while Group 2 (n=6) exhibited minimal or no change. In Group 1, step count emerged as the most sensitive early indicator, declining from baseline by 54% at 3 days prior and 75% at 1 day prior to diagnosis. Walking speed, cadence, and knee range of motion (based on 3-day moving averages) also declined by 1 day before diagnosis (Table 1). Post-diagnosis, step count remained depressed, while walking speed, cadence, and knee ROM returned to near-baseline levels within 7 days (Table 1, Figure 2).

DISCUSSION AND CONCLUSION: This observational study is limited by its small sample size (N=12). The clinical presentation of periprosthetic joint infection (PJI) can range from fulminant to indolent—a heterogeneous pattern that was also reflected in the objective gait metrics collected around the time of diagnosis. Two distinct gait trajectories emerged: half of the patients (Group 1, n=6) demonstrated marked changes in gait parameters preceding diagnosis, while the other half (Group 2, n=6) showed no detectable changes. In Group 1, step count proved to be the most sensitive indicator, declining earliest (3 days prior) and most significantly (75% reduction one day prior to diagnosis). Other parameters—walking speed, cadence, and knee range of motion—also declined (7–30%) but with a later onset, typically one day before diagnosis. No objective gait changes were observed in Group 2. These preliminary findings support the hypothesis that rapid, objective functional decline captured through sensor-enabled devices may offer a novel, non-invasive method for early PJI detection in certain patients. Larger studies are needed to validate these findings and inform postoperative monitoring protocols.



Group 1: Significant Decline (N=6)
Days Prior to Periprosthetic Joint Infection Diagnosis

	-7 (baseline)		-3 days		-1 day		0 (diagnosis)		+1 day		+3 days		+7 days	
	median	%Δ	median	%Δ	median	%Δ	median	%Δ	median	%Δ	median	%Δ	median	%Δ
Steps	2154	0	984	-54	528.7	-75	97	-91	192.3	-91	2.3	-100	27.3	-99
Speed	0.59	0	0.6	0	0.41	-30	0.44	-27	0.44	-26	0.53	-11	0.59	0
Cadence	87	0	87	-1	81	-7	77	-12	75	-14	87	-1	85	-3
Knee	51.4	0	52.1	1	46.2	-10	43.8	-15	43.5	-15	39.4	-23	45.5	-11