Establishing Minimal Clinically Important Differences and Substantial Clinical Benefit Thresholds for Various Objective Gait Metrics after Total Knee Arthroplasty

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INTRODUCTION:

Gait analysis in patients undergoing total knee arthroplasty (TKA) is becoming increasingly important for assessing functional recovery. However, interpretation of the clinical relevance of objective gait metrics remains challenging. While minimal clinically important differences (MCID) have been well established for patient-reported outcome measures, few studies have focused on determining MCID, substantial clinical benefit (SCB) or minimal detectable change (MDC) thresholds for objective gait parameters. This study aimed to calculate these values for gait speed, step counts, step length, double support time, and walking asymmetry in patients undergoing TKA.

METHODS:

A secondary analysis of a longitudinal observational cohort of 1,110 patients who underwent primary TKA between 2019 and 2023 were analyzed. Objective gait metrics were collected via wearables and smartphones from pre-operative to 1-year post-operative. Patients completed the EQ-5D-5L pre-operatively through 1-year post-operative, which was used to calculate anchor-based MCID and SCB of each metric with utilizing ROC-AUC with Youden's Index. Distribution based methods were also applied to calculate MCID, MDC_{80}, MDC_{90}, and MDC_{95}.

RESULTS:

The MCID thresholds were 0.067 m/s for gait speed, 1,227 steps for step count, 0.02 m for step length, 0.5% for double support time, and 1% for walking asymmetry. The corresponding thresholds for substantial clinical benefit (SCB) were 0.067 m/s for gait speed, 1,630 steps for step count, 0.02 m for step length, 4% for double support time, and 3% for walking asymmetry. Distribution-based MDC_{95} values were 0.082 m/s, 1,461 steps, 0.052 m, 0.028%, and 0.156%, respectively. At one year post-operatively, 79% of patients met the MCID threshold for gait speed (0.067 m/s). However, the average change in gait speed across the entire cohort was modest, with a mean (± SD) change of 0.017 ± 0.13 m/s. Patients who achieved the MCID for gait speed had significantly worse preoperative profiles, including lower function, poorer quality of life, and higher levels of pain, compared to those who did not meet the threshold.

DISCUSSION AND CONCLUSION:

This study established thresholds for MCID and SCB across multiple objective gait metrics allowing interpretation of their clinical relevance. These findings suggest that clinically important and substantial changes in gait speed may be smaller in arthroplasty patients than suggested for other populations, while step count change thresholds may be greater than targets for interventions to change behavior in healthy populations. Additional research to determine these metrics collected by other technologies is needed.

Total Knee Arthroplasty	Pre-op average	Post-op average	n	Average Change ± SD	Minimal Detectable Change			Minimal Clinically Important Change		Substantial Clinical Benefit
					MDC_{80}	MDC_{90}	MDC_{95}	Distribution-based	Anchor-based	Anchor-based
Gait speed (m/s)	0.991± 0.145	1.05 ± 0.129	684	0.013± 0.115	0.053	0.0068	0.082	0.057	0.0669	0.0669
Step count (average daily)	5528 ± 2979	5807 ± 3321	1110	279± 2615	954	1222	1461	1318	1227	1630
Step length (m)	0.591 ± 0.066	0.586 ± 0.062	682	-0.005 ± 0.05	0.034	0.044	0.052	0.024	0.0195	0.020
Double support time (%)	0.316 ± 0.017	0.317 ± 0.020	665	0.001± 0.015	0.018	0.023	0.028	0.008	0.005	0.038
Walking asymmetry (%)	0.129 ± 0.156	0.094 ± 0.107	536	-0.034 ± 0.145	0.102	0.130	0.156	0.07	0.01	0.03