Functional Assessment in Patients Undergoing Total Knee Arthroplasty: A Systematic Review

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INTRODUCTION: Traditional methods for measuring patient function and satisfaction in patients undergoing total knee arthroplasty (TKA) rely on patient reported outcome measures (PROMs), which are subjective and prone to recall bias. Despite a recent significant rise in the use of objective functional assessments to quantify improvement after TKA, there is heterogeneity and scarcity among the functional assessments described in the literature. To this end, the purpose of this systematic review was to thoroughly investigate and synthesize the unique objective functional assessments utilized for monitoring patients undergoing TKA.

METHODS: This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Eligible English studies of TKA patients that conducted at least one objective functional assessment both preoperatively and postoperatively were identified through a literature search on PubMed/Medline, Embase, and Cochrane Central databases. Studies from the beginning of time to July 1, 2024 were included. Included subgroups for analysis were the following: gait analysis, motion analysis, walking tests, wearables/sensors, and strength tests.

RESULTS SECTION: 314 studies using 21 unique categories of functional assessments were included. The three most common functional assessments included the Timed-Up-and-Go (TUG) test, traditional gait analysis, and the use of a dynamometer to quantify quadriceps strength. The use of functional assessments for patients undergoing TKA has seen a significant rise in recent years, with a variety of gait analyses, wearables, and sensors being utilized to collect a wide range of spatiotemporal, kinetic, and kinematic data.

DISCUSSION: This study highlights the diverse array of functional assessments that can be incorporated into the orthopaedic surgeon's armamentarium to evaluate patients undergoing TKA. The most prevalent assessments, such as TUG test, traditional gait analysis, and dynamometry provide objective insights into patients' pre- and postoperative mobility and functional improvement. Introducing functional assessment measures into the clinical setting provides objective metrics to assess patient outcomes and decrease reliance on subjective survey-based PROMs. Reported benefits in the literature include decreased physical therapy sessions, reduced pain scores, increased activity levels and activity level monitoring, improved patient outcomes, fewer readmissions, less need for in-person clinic visits, and lower post-surgery costs. The future integration of advanced functional technologies, such as markerless motion capture, holds promise for enhancing the accuracy and convenience of gait analysis even in the daily clinic setting.

SIGNIFICANCE/CLINICAL RELEVANCE: Current literature is characterized by significant heterogeneity and a lack of clarity in the assessments used to objectively evaluate functional patient outcomes post-TKA. This study may act as a valuable comprehensive guide for surgeons in an attempt to assess current functional assessment tools and categorizes all of them into 21 distinct categories, providing frequency of use (Figure 1), descriptions with all variables collected, estimated time of use, and relevant advantages and disadvantages (Tables 1-2), enabling surgeons to make informed decisions when selecting the most suitable tools for their clinical setting.

IMAGES AND TABLES:

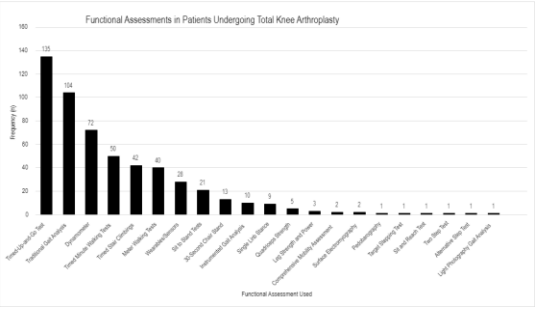

Figure 1. Frequency of functional assessment

Functional Measure	Large Number of Variables Collected	Data Collected during ADL's	Remote Monitoring	High Prevalence in the Literature	Low Cost	Simple Protocol	Time Efficient	No Specialized Equipment
Timed Up and Go Test		✓		✓	✓	✓	✓	✓
Traditional Gait Analysis	✓	✓		✓				
Dynamometer		✓		✓				
Timed Minute Walking Test (2MWT, 6MWT, and 10MWT)		✓		✓	✓	✓	✓	✓
Timed Stair Climbing (Range from 1-50 Steps)		✓		✓	✓	✓	✓	
Meter Walking Test (Range from 4-60 Meters)		✓		✓	✓	✓	✓	✓
Wearables/Sensors	✓	✓	✓	✓				
Sit to Stand Test (i.e. Five Times Sit to Stand Test, Chair Stand Test (CST)/Timed Stand Test (TST))		✓			✓	✓	✓	✓
30-Second Chair Stand		✓			✓	✓	✓	✓
Instrumented Gait Analysis	✓	✓						
Single Limb Stance Test		✓			✓	✓	✓	✓
Quadriceps Strength Tests						✓		
Leg Strength and Power						✓		
Comprehensive Mobility Assessment		✓			✓	✓	✓	✓
Surface Electromyography		✓						
Pedobarography	✓	✓						
Target Stepping Test		✓					✓	
Sit and Reach Test					✓	✓	✓	
Two Step Test		✓			✓	✓	✓	✓
Alternative Step Test		✓			✓	✓	✓	✓
Interrupted-Light Photography Gait Analysis	✓	✓						

Table 1. Advantages of functional assessments

Functional Measure	High Cost	Training Requirements	Time Consuming	Low Prevalence in the Literature	Data Skewed Based on Patient's Fitness Level	Fall Risk	Specialized Equipment or Large Space Requirement	Accuracy Variation
Timed Up and Go Test					✕	✕		
Traditional Gait Analysis	✕	✕	✕			✕	✕	
Dynamometer	✕	✕			✕		✕	
Timed Minute Walking Test (2MWT, 6MWT, and 10MWT)					✕	✕	✕	
Timed Stair Climbing (Range from 1-50 Steps)					✕	✕	✕	
Meter Walking Test (Range from 4-60 Meters)					✕	✕		
Wearables/Sensors	✕	✕				✕	✕	✕
Sit to Stand Test (i.e. Five Times Sit to Stand Test, Chair Stand Test (CST)/Timed Stand Test (TST))					✕	✕		
30-Second Chair Stand					✕	✕		
Instrumented Gait Analysis	✕	✕	✕	✕		✕	✕	
Single Limb Stance Test				✕	✕	✕		
Quadriceps Strength Tests	✕	✕	✕	✕	✕		✕	
Leg Strength and Power	✕	✕	✕	✕	✕		✕	
Comprehensive Mobility Assessment				✕	✕	✕		
Surface Electromyography		✕					✕	✕
Pedobarography	✕	✕	✕	✕		✕	✕	
Target Stepping Test	✕	✕		✕	✕	✕	✕	
Sit and Reach Test				✕	✕		✕	
Two Step Test				✕		✕		
Alternative Step Test				✕	✕	✕		
Interrupted-Light Photography Gait Analysis	✕	✕	✕	✕		✕	✕	

Table 2. Disadvantages of functional assessments