Assessing the feasibility of using the short physical performance battery to measure function in the immediate postoperative period after total knee replacement

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Abstract

Measurements of physical function after total knee arthroplasty (TKA) are uncertain and require investments for special equipment, space, and staff. Therefore, we evaluated the Short Physical Performance Battery (SPPB) 4 to 6 weeks preoperatively and 2 weeks following TKA as this test battery addresses lower extremity strength, coordination, and balance, without additional special investments. For context, we also employed the Six-Minute Walk test (6MWT) and peak torque knee extension. Our analysis consisted of three women and one man, with average ages of 68.3±3.9 years. Patients showed a decrease in all functional measurements: SPPB (mean change: −4.8±1.9, 44% decrease), 6MWT (−0.37±.21 m/s, 34% decrease), and peak torque (−11.8±8.8°/s, 68% decrease). Our findings suggest the SPPB is feasible and can be integrated easily in daily clinical practice.

Key Words: knee joint; knee replacement arthroplasty; outcome assessment; pain; physical function performance
loss of function and muscle mass continues after surgery, specifically in the elderly, and is characterized by very poor recovery. Several tests are established to evaluate physical function and strength in patients undergoing a TKA, such as the Six-Minute Walk test (6MWT) and peak torque knee extension measurements. However, these tests are elaborate and frequently require special equipment, space, and staff. The purpose of this investigation was to determine the feasibility and acceptability of the Short Physical Performance Battery (SPPB) as a clinically applicable, simple, and objective test to evaluate physical function in older patients undergoing an elective TKA. The SPPB may serve as a brief and more convenient measurement when compared to conventional, more elaborate tests that are difficult to perform in regular practice, such as the 6MWT and peak torque knee extension.

**Materials and Methods**

Four patients were included in the evaluation of the feasibility of the SPPB to measure pre- and immediate postoperative physical function after an elective, unilateral TKA in older patients. Our study was approved by the Institutional Review Board and participants provided written informed consent. We tested the following parameters 4 to 6 weeks preoperatively and 2 weeks postoperatively: the SPPB, the 6MWT, leg strength of the operative leg (peak torque knee extension), and pain score (numerical rating scale). The SPPB includes three objective tests of lower body function: 1) a timed 4-m walk; 2) timed, repetitive chair stands; and 3) a hierarchical test of standing balance. The SPPB summary score is created by adding the three individual test items according to previously established criteria. There is a potential range of 0 to 12, with higher scores indicating better lower body function. A 1-point improvement in the SPPB summary score has been indicated as clinically meaningful and correlated well with increases in overall activity and survival. The 6MWT: Subjects walk back and forth along a 100-ft hallway for 6 minutes after standardized instructions to complete as many laps as possible. The distance covered in 6 minutes is recorded. Strength of the quadriceps extensor muscles (peak torque) was tested using a dynamometer (Biodex, Shirley, NY). The subject was seated on the Biodex seat and strapped in around their shoulders/torso and knees to keep them in position. The operative leg was attached to the knee attachment of the dynamometer with a padded strap at the ankle. Subjects were instructed to perform a sufficient number of submaximal repetitions and then three maximal repetitions. The quadriceps femoris peak torques and corresponding knee angles were measured at a speed of 60°/sec. Each subject performed, with verbal encouragement, three maximal voluntary repetitions. The best peak torque was recorded.

Pain intensity was measured using the numerical rating scale (0–10), with 0 indicating no pain and 10 indicating worst pain. The pain intensity rating was obtained at the beginning of each appointment visit. Anesthetic and postoperative management was similar among patients; all surgeries were performed under a spinal anesthetic and regional anesthesia including a femoral nerve catheter and sciatic nerve single-injection regional anesthetic.

**Results**

Data on four individuals were analyzed (three women/one man). The average age was 68.3±3.9 years and body mass index was 33.3±6. Table 1 reports demographics of the sample. Postoperatively, all patients showed a decrease in all functional measurements: SBBP (mean change: −4.8, 95%CI: −7.7,−1.7, 44% decrease), 6MWT (−0.37 m/s, 95%CI: −0.89,0.16, 34% decrease), and peak torque extension (−11.8°/s, 95%CI: −90.6,67.0, 68% decrease). Patients also showed a 32% increase in pain compared to baseline. Results are summarized in Figure 1.

**Discussion**

The purpose of the study was to evaluate the feasibility and acceptability of the SPPB as a clinically applicable, simple, and objective test to evaluate physical function in older patients undergoing an elective TKA. Our pilot study demonstrated that the completion of the SPPB was feasible and acceptable prior to and within 2 weeks following the TKA procedure. There was no special investment necessary for the SPPB. Additionally, preliminary findings suggest across all measurements a clinically significant decline in physical function and strength of the lower extremity and an increase in pain postoperatively following elective total knee replacement surgery. With the increase in the aging population, the need for knee joint replacement surgery will continue to grow. The targeted benefits of TKA include reducing pain and increasing mobility and function. Studies comparing patients who underwent a TKA to healthy

| Table 1. Sample demographics | N = 4 |
|-------------------------------|------|
| **Measurement**               |      |
| Age, mean year ± SD           | 68.3±3.9 |
| Gender, n                     |      |
| Female                        | 3    |
| Male                          | 1    |
| Ethnicity, n                  |      |
| Hispanic                      | 1    |
| Non-Hispanic                  | 3    |
| Race, n                       |      |
| White                         | 3    |
| Black/African-American        | 1    |
| Highest level of education, n  |      |
| College graduate              | 3    |
| Some college, but not degree completion | 1 |
age-matched control subjects demonstrated that patients who underwent a TKA remained weaker in quadricep strength throughout study periods beyond 3 years. Identifying brief and easy to administer physical functioning measurements that can be adapted in the clinic to evaluate decline or progress will improve patient management and outcomes following TKA. As anticipated, our pilot study demonstrated a significant decline in objective physical parameters in the postoperative period. The SPPB has been studied across a wide range of populations; however, it is not typically included in the evaluation of physical performance following TKA. As a postoperative functional outcome measurement, the SPPB has mainly been investigated and used in patients undergoing cardiac or pulmonary surgery. A low SPPB score has been associated with adverse surgical outcomes. In patients undergoing mitral valve replacement surgery, a SPPB score below 12 was a predictor of unplanned readmissions. A SPPB score below 10 was associated with higher postoperative pulmonary complications in elderly patients undergoing lung resection. Przkora et al. demonstrated the utility of the SPPB in ambulatory patients undergoing pain procedures for degenerative spine disease. Our findings suggest that the collection of the SPPB in the perioperative setting in patients following lower extremity joint replacement surgery is feasible and acceptable. Patients had a mean SPPB of 10.75±0.5 prior to surgery, which declined to a mean of 6±1.4 postoperatively, a 44% decrease (3 to 4 points). The decrease in the SPPB in the postoperative period also occurred in conjunction with declines in the 6MWT and knee extension. Future investigations with a larger sample size are needed to confirm the sensitivity of the SPPB to meaningful clinical changes in patients undergoing TKA and comparative utility with recognized standard of care instruments. In conclusion, our pilot study indicates that completing the SPPB presurgically

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**Fig 1.** Pre- and post-values for Short Physical Performance Battery (SPPB), Six-Minute Walk Test (6MWT), peak torque extension, and pain score. Solid horizontal lines represent mean values, dots represent individual patient values, and error bars represent 95% confidence intervals.
and within a 2-week postoperative period is feasible and acceptable. Given the importance of monitoring the physical function of patients undergoing TKA following the surgical procedure to optimize physical function, the SPPB might serve as a simple and easy to administer tool in the clinical setting to monitor patient progress and refer for necessary services as needed.

List of acronyms

OA – osteoarthritis
TKA – total knee arthroplasty
SPPB – Short Physical Performance Battery
6MWT – Six-Minute Walk test

Authors contributions

All authors made substantial contributions to the conception, design, and analysis and interpretation of data for this work. All authors contributed substantially to the drafting and critical revision of the manuscript, provided final approval of the version submitted, and agree to be held accountable for all aspects of the work.

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Conflict of Interest

The author declares no competing interests.

Ethical Publication Statement

We confirm that we have read the Journal's position on the issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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