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Predicting Acute Recovery of Physical Function Following Total Knee Joint Arthroplasty

Shawn M. Robbins, BscPT, PhD [a], Ravi Rastogi, BscPT, MSc [b], Terry-Lyne McLaughlin, BScN, MN, NP-Adult [c]

[a] Centre for Interdisciplinary Research in Rehabilitation, Constance Lethbridge Rehabilitation Centre, and School of Physical and Occupational Therapy, McGill University, Montreal, Quebec, Canada
[b] Department of Physiotherapy, London Health Sciences Centre, London, Ontario, Canada
[c] Orthopaedic Surgery, London Health Sciences Centre, London, Ontario, Canada

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ABSTRACT

The objective was to explore predictors of physical function during acute in-patient rehabilitation within a few days after TKA. Physical function status of participants (n = 72) three days after total knee arthroplasty (TKA) was measured using the Timed Up and Go Test (TUG) and the function subscale of the Western Ontario McMaster Universities Index of Osteoarthritis (WOMAC-function). Potential predictors of physical function were measured day one post-TKA. Their relationship with physical function was examined using backward elimination, multiple regression analyses. Older age and increased comorbidity were associated ($R^2 = 0.20$) with worse TUG times. Increased pain severity was associated ($R^2 = 0.08$) with worse WOMAC-function scores. Age, comorbidity, and pain severity should be considered when predicting which patients will struggle with acute recovery post-TKA.

Over 600,000 total knee arthroplasties (TKAs) were performed in the United States in 2008 representing a 134% increase over ten years [1]. The speed of recovery following TKA varies greatly and many factors influence this recovery [2,3]. It is important to identify patients that will have delayed recovery because they require longer hospital stays, incur additional costs, and impact discharge planning. Supplementary resources, including physiotherapy interventions, can be allocated to these patients immediately post-operatively in an attempt to speed their recovery, improve their physical function, and return them home safely in a timely manner.

Previous studies have examined predictors of physical function recovery after TKA in both subacute (1 to 3 months) and long term (>3 months) stages [3–6]. Physical function was assessed using self-report questionnaires and performance based measures such as the Timed Up and Go Test (TUG). Predictors of decreased physical function in subacute and long term stages included low pre-surgical physical function levels, older age, higher body mass index (BMI), high number of co-morbidities, knee extensor weakness on the non-operated and operated sides, and high pain severity [3,6–10]. Psychological variables also related to physical function including helplessness, self-efficacy, pain catastrophizing, coping ability, and surgical expectations [5,11–15]. These previous studies demonstrate that numerous predictors of long term recovery exist which should inform clinical practice. For instance, addressing the psychological factors could result in improved outcomes although research is needed to examine such interventions.

Although it is important to capture long term recovery from TKA, it is equally important to capture recovery in the acute stages (<1 month) especially during in-hospital rehabilitation. Studies examining predictors of success in the acute period use hospital length of stay (LOS), discharge destination, in-hospital complications, and hospital monetary charges as measures of success [2,16–20]. Predictors associated with negative outcomes include older age, higher BMI, women versus men, being single versus being married, multiple co-morbidities, high pain catastrophizing, and low self-report pre-operative mobility [2,16–20]. These studies provide valuable information on predictors of healthcare resource usage. However, the measures used in the acute setting, such as LOS and discharge destination, are not necessarily related to physical function. They are influenced by factors external to patients' physical function status such as institutional policies and characteristics, discharge planning, experience of the physician, and patient income [2,20]. LOS does not capture patients' physical function status and these variables have only demonstrated a minimal relationship in the post-surgical orthopaedic population [21].

Patients should be functioning adequately prior to discharge home. Thus, physical function in the acute recovery stages should be further investigated and predictors indicative of delayed recovery should be determined. Identifying patients with the potential for delayed physical function recovery will assist with discharge planning

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Reprint requests: Shawn M. Robbins, BscPT, PhD, School of Physical and Occupational Therapy, McGill University, Davis House, 3654 Promenade Sir-William-Osler, Montreal, QC, Canada, H3G 1Y5.

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and allow additional resources, such as rehabilitation interventions, to be allocated to these patients to speed the recovery process during in-patient rehabilitation. Thus, the primary objective was to explore predictors of physical function during acute in-patient rehabilitation within a few days after TKA. The secondary objective was to explore the relationship between these predictors and LOS.

Materials and Methods

Participants

Individuals following a TKA were recruited using convenience sampling from the acute in-patient unit of a tertiary healthcare center the day after their surgery (day one post-TKA). Participants were included if they underwent a primary TKA for knee osteoarthritis the previous day and were between 40 and 85 years of age. Exclusion criteria included TKA revision on the operative leg, bilateral TKA on the same day, fracture sustained during surgery, rheumatoid or other inflammatory arthritis, neurological conditions (i.e. Parkinson's Disease, previous stroke), severe cardiovascular conditions (i.e. unstable angina) and an inability to comprehend English. The study was approved by the local institutional ethics board and informed consent was obtained from participants prior to study enrollment.

A sample size calculation estimated 80 participants would be required for the study [22]. A previous study found that the overall explained variance in the TUG and the variance accounted for by contra-lateral knee extensor strength were 49.5 and 4.4% respectively one year post-TKA [3]. To be conservative, these values were rounded down to 40% and 4% for the current sample size calculation. With seven predictors and a significant level of $P = 0.05$, 68 participants would be required. A 15% drop out rate was also applied and this increased the sample size estimate to 78 participants, which were rounded to 80 participants.

Predictor Variables

The potential predictors chosen for this study have shown a previous relationship to physical function or LOS post-TKA and could be captured during the initial post-operative physiotherapy assessment. Thus, potential predictors were measured day one post-TKA or were available in medical charts (e.g. pre-operative BMI).

Demographic Variables

Age, gender, and BMI (BMI = weight/height^2) were recorded from medical charts. Weight and height were measured during pre-operative screening appointments a few weeks prior to TKA as part of the usual standard of care. Age, gender, and BMI have previously demonstrated a relationship to physical function 6 to 24 months post-TKA [3,6,7].

Pain Severity

Pain severity on day one post-TKA was measured using the Numeric Pain Rating Scale (NPRS) [23]. Participants were asked to rate their pain on a scale from 0 ("No Pain") to 10 ("Pain as bad as it can be"). Pain severity has been shown to be a predictor of physical function performance post-TKA [9].

Co-Morbidity

Participants completed the Self-Administered Comorbidity Questionnaire on day one post-TKA [24]. This questionnaire lists 13 medical conditions with room to add additional conditions. Participants identify if they have the condition, if they are presently receiving treatment for the condition and if the condition limits their activity. Higher scores represent increased co-morbidities. The number of co-morbidities has previously predicted self-report physical function six months post-TKA [7].

Pain Catastrophizing

Participants completed the Pain Catastrophizing Scale on day one post-TKA [25]. This measure includes 13 items each rated on a five point scale (0: not at all, 4: all the time). The maximum score is 52 and higher scores represent severe levels of pain catastrophizing. This scale has previously predicted self-report physical function one year post-TKA [15].

Strength

Knee extensor isometric strength of the non-operative leg was measured using a hand-held dynamometer (Lafayette manual muscle test model 01163, Lafayette, IN) on day one post-TKA [26,27]. Participants were positioned in supine with their knee in 60° of flexion supported by a bolster. The dynamometer was placed 1 cm proximal to the superior border of the medial malleolus. The investigator placed one hand on the participant's thigh to stabilize the limb and the other hand on the dynamometer perpendicular to the participant's lower leg. The participants were asked to contract their knee extensors and push into the hand-held dynamometer for five seconds by using a standard phrase: "Keep pushing as hard as you can, push, push, push, now relax" [26]. Participants were given a practice trial to become accustomed to the testing protocol and then the test was repeated three times. The maximum value from the three trials normalized to body mass represented the non-operative knee extensor isometric strength (N/kg). Strength measures were not collected on the operative side due to limitations in strength secondary to pain and swelling from the TKA. Knee extensor strength from the non-operative limb has previously shown to predict TUG scores at one month and one and two years post-TKA [3,28].

Dependent Variables

Timed Up and Go Test

Physical function performance on day three post-TKA was measured using the TUG. Participants began seated in a standard chair (seat height 49.5 cm, seat width 51 cm) with armrests (height from floor 68.5 cm). Standard instructions included: "When I say 1, 2, 3 go, please stand up from the chair, walk with your assistive device at a comfortable pace to the line, return to the chair and sit down." The line was 3 m from the chair and they used the gait aid they planned to use upon discharge (e.g. standard walker or standard crutches) which was recorded. The participants were timed to the nearest 1/10 s using a digital stopwatch. The TUG was completed twice and an average score calculated. This procedure has previously demonstrated good test–retest reliability (intraclass correlation coefficient = 0.80) in patients following orthopaedic surgery [21].

Western Ontario McMaster Universities Index of Osteoarthritis Physical Function Subscale

Self-report physical function on day three post-TKA was captured using the function subscale of the Western Ontario McMaster Universities Index of Osteoarthritis (WOMAC-function). The subscale consists of 17 items each representing a functional task (i.e. descending stairs) with a five point scale rating the difficulty of the activity (0: no difficulty, 4: extreme difficulty). The WOMAC-function score is calculated by summing the item scores (minimum = 0, maximum = 68) with higher scores representing increased difficulty performing functional tasks. The WOMAC-function has previously demonstrated reliability and construct validity with other self-report physical function outcome measures [29,30].

Length of Stay

LOS on the acute in-patient unit was recorded. Day one represented the day after TKA surgery. Upon discharge from the acute in-patient unit, participants either returned home, were