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Understanding the Relationship Between 3-Month and 2-Year Pain and Function Scores After Total Knee Arthroplasty for Osteoarthritis

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ABSTRACT

Background: Research to understand predictors of poor outcomes after total knee arthroplasty (TKA) has largely focused on presurgery factors. We examined whether pain and function 3-month postsurgery were predictive of longer-term outcomes ascertained 2 years after TKA.
Methods: Western Ontario McMaster University Osteoarthritis Index pain and physical function scores (scaled 0-20 and 0-68; higher = worse) were recorded pre-TKA and 3, 12, and 24 months post-TKA. A sequential series of regression models was used to examine the relative contribution of baseline score and baseline to 3-month and 3 to 12-month change score to explaining variability (R^2) in 2-year pain and function scores, with consideration for presurgery covariates.
Results: Data from 560 patients were analyzed. Mean pain and function scores improved significantly presurgery to 2 years postsurgery; 10-4 and 33-16 ($P < .001$), respectively. Considerable variability in 2-year scores was observed. Overall, 80.3% and 79.9% of changes in pain and function scores over the 2 years occurred within the first 3 months. Change over these 3 months explained the greatest proportion of variability in 2-year scores, 16% and 23% for pain and function, respectively. The influences of these early changes were similar to those of baseline status.
Conclusion: Changes in patient-reported pain and function occurring within the first 3 months post-TKA strongly determine pain and function status at 2 years. Research to identify pre-/intra-/early postoperative factors associated with change in this early postoperative period that may be amenable to modification or used to better inform education and decision-making is warranted.

Osteoarthritis (OA) is a highly prevalent chronic joint disease associated with pain and disability, with the knees among the most commonly affected joints [1–3]. Effective conservative therapies for OA pain remain limited [4,5], and when medical management fails, total knee arthroplasty (TKA) becomes the preferred option for alleviating pain and improving function for those with end-stage disease. TKAs are among the most often performed elective, in-patient, surgical procedures in Canada and the United States [6,7], and projection estimates suggest an increase from 700,000 cases annually to 3.5 million TKA procedures by the year 2030 in the United States alone [6,8].

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Despite an increasing patient willingness to undergo TKA for symptomatic knee OA [9], up to 30% still report dissatisfaction or little to no improvement in pain and function 1-2 years after surgery [10–13]. In a report based on a Canadian registry, 28% reported dissatisfaction with pain relief climbing stairs and 15% for walking on flat ground 1 year after TKA, for example [11]. In addition to the individual burden associated with ongoing symptoms [10,12,13], there are system impacts. A 2012 European study, for instance, reported over £5000 (estimated over $8000 USD 2017) in health care costs associated with investigating and managing a single patient with persistent pain after TKA over a period of almost 24 months postoperatively [14]. These costs were associated with repeated physician appointments, investigations, and therapeutic interventions.

Understanding what contributes to poorer pain and function scores after TKA has long been of interest, and many studies have focused on presurgery patient factors as predictors of 1- and 2-year post-TKA pain and function [15–17]. Presurgery pain and function status are among the strongest and most consistent predictors of 1- and 2-year post-TKA pain and function; additional factors include age, sex, higher body mass index (BMI), and general health status measures [16,18,19].

Despite the focus in TKA research studies on outcomes assessed at 1-2 years postsurgery, many orthopedic surgeons believe that the majority of improvement occurs by 3 months postsurgery and that 3-month postoperative outcomes are strongly correlated with "peak recovery" obtained subsequently. Although some studies have peripherally noted this [19–22], the degree to which change during this early period contributes to the overall variability in outcome scores has been little studied [18]. This early period is often marked by follow-up clinical appointments with the surgeons and physiotherapists and therefore offers a potential opportunity for intervention to potentially alter longer-term postsurgery outcomes. The objective of this study was to explore the extent to which changes in pain and function after TKA from baseline to 3 months and 3 months to 1 year explain variability in pain and function scores at 2 years after surgery, taking into account presurgery patient factors.

Materials and Methods

Patients with end-stage knee OA (Kellgren-Lawrence grades 3 and 4) scheduled to undergo elective, primary TKA for OA were recruited from a single, academic hospital in Toronto, Canada from 2008-2012. Eligibility criteria included ages 35 years and older and ability to read and understand English. Individuals with a diagnosis of inflammatory arthritis or post-traumatic OA were excluded. The study was approved by the University Health Network Research Ethics Board, and written informed consent was obtained from all study participants.

Participants completed a self-report questionnaire 2 weeks before surgery, eliciting age, sex, height, and weight, from which BMI (kg/m^2) was calculated, and included a list of 14 medical conditions for which individuals responded yes or no to each (Self-Administered Comorbidity Questionnaire [23]). A comorbidity count was derived for analytical purposes, with a potential range of 0-14.

Knee symptoms were assessed using the Western Ontario McMaster University Osteoarthritis Index (WOMAC) pain and function subscales. The WOMAC index is among the most commonly used self-reported pain and function measures in lower-extremity OA, with demonstrated validity and responsiveness [24,25]. Possible scores range from 0-20 for the pain scale and 0-68 for the functional limitation scale, with higher scores indicating worse symptoms. The WOMAC questionnaire was completed 2 weeks before surgery, and 3, 12, and 24 months after surgery.

Table 1
Sample Description.

	Overall Sample (N = 560)
Mean age, y (SD; range)	67.7 y (9.2; 38-88)
Female	61.5%
Body mass index, kg/m^2	
Mean (SD; range)	30.2 (6.4; 18.6-59.2)
Normal (18.5 ≤ BMI < 25)	19.7%
Overweight (25 ≤ BMI < 30)	35.1%
Obese (BMI ≥ 30)	45.2%
Mean comorbidity count (SD; range)	1.6 (1.3; 0-7)
Mean WOMAC pain (SD) (/20)	
Presurgery	9.9 (3.8)
3 mo postsurgery	5.2 (3.8)
1 y postsurgery	4.0 (3.7)
2 y postsurgery	3.9 (3.8)
Mean WOMAC function (SD) (/68)	
Presurgery	33.4 (12.6)
3 mo postsurgery	18.7 (12.2)
1 y postsurgery	15.9 (12.5)
2 y postsurgery	15.6 (12.8)

BMI, body mass index; SD, standard deviation; WOMAC, Western Ontario McMaster University Osteoarthritis Index.

Statistical Analysis

The baseline characteristics of the sample were described, and mean pain and function scores were estimated at each study time point. Pain and function change scores between consecutive time points were determined, and mean differences were statistically tested by way of paired *t* test. For each individual, the amount of change in their pain and function scores between consecutive time points was divided by their overall change over the 2 years to determine the proportion of overall change by time period. In addition, baseline status, 2-year status, and change over the 2-year period for pain and function scores were estimated by tertile of baseline pain and function scores. Tertile 1 represents the lower third of the sample with lower (better) baseline pain/function scores, whereas tertile 3 represents the upper third with the higher (worse) baseline pain/function scores.

To examine the relative contribution of factors to explaining variability in pain and function scores at 2 years after surgery, a sequential series of least squares multivariable linear regression models were estimated, separately for pain and function outcomes. Initially, age, sex (female vs male), BMI, and comorbidity count were considered (model 1). Subsequently added to the model were presurgery pain/function score (model 2), change in pain/function

Table 2
Mean Individual Pain and Function Score Differences[a] Between Study Time Points.

	Baseline to 3 mo	3 mo-1 y	1-2 y	Baseline to 2 y
WOMAC Pain (/20)				
Mean difference	4.7	1.2	0.1	6.0
95% CI	4.33, 5.04	0.88, 1.49	−0.19, 0.37	5.59, 6.33
Paired *t* test *P* value	<.001	<.001	.522	<.001
WOMAC function (/68)				
Mean difference	14.7	2.9	0.3	17.8
95% CI	13.57, 15.80	2.02, 3.75	−0.56, 1.07	16.62, 18.90
Paired *t* test *P* value	<.001	<.001	.542	<.001

CI, confidence interval; WOMAC, Western Ontario McMaster University Osteoarthritis Index.

[a] Positive values reflect improvement in scores.