Seminars in Arthritis and Rheumatism 45 (2016) 547–555

Contents lists available at ScienceDirect

Seminars in Arthritis and Rheumatism

journal homepage: www.elsevier.com/locate/semarthrit

Improvement following total knee replacement surgery: Exploring preoperative symptoms and change in preoperative symptoms

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ARTICLE INFO

Keywords:
osteoarthritis
knee
joint replacement surgery
improvement
postoperative outcomes

ABSTRACT

Objective: To determine whether changes in preoperative osteoarthritis (OA) symptoms are associated with improvement after total knee replacement (TKR) and to identify predictors of clinically significant improvement.

Methods: Data on Osteoarthritis Initiative participants who were annually assessed and underwent TKR were included. T0 was the assessment prior to TKR while T−1 was the assessment prior to that. T+2 was the second assessment after TKR. We compiled data on the Western Ontario and McMaster Universities OA Index (WOMAC), OA-related symptoms, and radiographic severity. We defined clinically significant improvement as improvement in WOMAC total score ≥ to the minimal important difference (MID) (0.5 SD of mean change) between T0 and T+2 and also considered other definitions of improvement. Logistic regression models were performed to evaluate the relationship between improvement and preoperative measures.

Results: Improved ($n = 211$) compared to unimproved ($n = 58$) patients had greater worsening of their WOMAC pain ($p = 0.002$) and disability ($p < 0.001$) from T−1 to T0. Preoperative measures as predictors of improvement included higher WOMAC disability (OR = 1.08, $p < 0.001$), presence of chronic OA symptoms in the surgical knee (OR = 5.77, $p = 0.033$), absence of OA-related symptoms in the contralateral knee (OR = 9.25, $p < 0.001$), exposure to frequent knee bending (OR = 3.46, $p = 0.040$), and having a Kellgren–Lawrence x-ray grade of ≥2 in the contralateral knee (OR = 4.71, $p = 0.010$).

Conclusions: More than 75% of participants had improvement after TKR. Improved patients were more likely to have escalation of OA pain and disability prior to surgery than unimproved patients. Other preoperative measures predicted improvement after TKR.

Introduction

Knee osteoarthritis (OA) is a highly prevalent and disabling disease [1,2]. When conservative (e.g., pharmacologic and non-pharmacologic) therapies no longer provide adequate relief and functional improvement, the Osteoarthritis Research Society International (OARSI) and others recommend total knee replacement (TKR) surgery [3]. There is no consensus on the criteria for the timing of TKR, and there has been a dramatic increase in the numbers of TKRs performed in the US [4].

Well-validated and patient-reported health-related quality of life (HRQL) instruments have been used to evaluate TKR outcomes and its appropriateness [5–13]. The instruments represent individual responses to the physical, mental, and social effects of illness on daily living [14,15]. Among HRQL instruments used to gauge TKR surgery outcomes, the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) and the Short Form-36 (SF-36) are most frequently used [5–12]. Although there has been an attempt to define appropriateness for TKR [16], these criteria have not been widely accepted and there is wide variability in the clinical status of patients undergoing TKR [13]. Furthermore, the linkage between fulfilling these criteria and improvement after TKR is unknown.

There are different approaches to measuring patients' responses to treatments using these HRQL instruments. The minimal important difference (MID) approach defines clinical improvement based on overall improvement of the WOMAC score [17]. The OARSI/Outcome Measures in Rheumatology (OMERACT) approach defines improvement based on absolute and relative changes in WOMAC scores [18]. The patient acceptable symptom

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http://dx.doi.org/10.1016/j.semarthrit.2015.10.002

state (PASS) is an approach based on achieving a certain WOMAC score that represents a satisfactory state of well-being [19]. Essentially, outcomes in TKR can be conceptualized based on change in outcome score over time or on achieving an outcome score at a specific point in time [20]. In other words, the metric of success from joint replacement can be measured based on the amount of improvement from different levels of disability or achieving a final status of a target in terms of the level of functioning, irrespective of the prior level of disability [21].

Regardless of the definition of improvement, the determinants of clinical improvement following joint replacement are largely understudied. Yet, this critical information can provide guidance for providers and patients in making informed decisions on proceeding with TKR surgery or not. Hawker et al. [8] found 4 preoperative variables that discriminately predicted having a good outcome following joint arthroplasty based on the MID criterion. Patients with greater pain and disability, less comorbidity, OA instead of inflammatory arthritis, and fewer troublesome joints were found to be most likely to experience good outcome [8]. The trajectory of patients' pre-surgical changes in symptoms or disability was not examined, however. Riddle et al. [9] found an escalation of pain and worsening function ~2.5 years prior to surgery among patients who underwent TKR, but did not examine whether the trajectory of pre-TKR changes in OA-related symptoms and disability influenced improvement in TKR outcomes.

The Osteoarthritis Initiative (OAI) dataset provides an excellent opportunity to address the limitations of previous studies [9,22,23]. The OAI is a prospective longitudinal cohort study of persons with, or at high risk of developing, knee OA. Its study design allows observation of participants' WOMAC and other HRQL measure scores years prior to and after TKR. These self-reported measures are also less susceptible to response bias, as participants' responses do not directly determine their providers' decision to offer TKR surgery or not. As participants were recruited from 4 clinical centers nationwide, data results should also have better generalizability in comparison to studies that recruit research subjects from only a single site.

The objectives of this study were to evaluate OA-related outcomes up to 2 years after TKR surgery in individuals with knee OA, and to determine whether changes in preoperative HRQL measures were associated with improvement in OA-related pain and disability after surgery. We also evaluated the specific predictors of various definitions of clinically significant improvement following TKR. We hypothesized that significant worsening in preoperative pain, disability, and other OA-related symptoms would be associated with improvement after TKR.

Methods

Participants

Data were obtained from the publicly available OAI database (http://oai.epi-ucsf.org/datarelease/) gathered April 2014. Subjects 45–79 years of age were recruited from 4 OAI Clinical Centers [University of Maryland School of Medicine and the Johns Hopkins University (Baltimore, MD), Ohio State University (Columbus, OH), University of Pittsburgh (Pittsburgh, PA), and Memorial Hospital of Rhode Island (Pawtucket, RI)], and they were assessed annually. The institutional review boards at each of the sites approved the study, and all participants gave informed consent.

For this study, we examined OAI data from participants who underwent TKR surgery (verified by chart review or by x-ray) from the 12-month visit to the 72-month visit. The annual OAI visit just prior to TKR will be hereafter referred to as "T0." The annual OAI visit after TKR was reported will be referred to as "T+1"; this may occur anytime from 1 day to 1 year after T0. "T+2" will be the participant visit 1 year following the T+1 visit. "T−1" is the annual OAI visit 1 year prior to the T0 visit. Only those with T0 and T+2 WOMAC data were included in the study. We excluded those who had partial knee replacement (i.e., unicompartmental), those who had a history of inflammatory arthritis (e.g., rheumatoid arthritis), and those who died prior to T+2. Those with a reported TKR at the 12-month visit were also excluded; they could not contribute data to the T−1 measures, as T0 was their OAI baseline visit.

Study measures

Clinical assessment

Health-related quality of life was assessed using the Short Form Health Survey (SF-12), from which the physical and mental component scores were calculated [24]. Depressive symptoms were assessed using the validated Center for Epidemiologic Studies Depression Scale (CES-D) [25]. Comorbidity was measured using the Katz-modified Charlson Comorbidity Index Questionnaire [26].

OA-related measures

OA-related disease severity was determined using the 24-item WOMAC, a reliable and validated measure that consists of 3 subscales, with higher scores indicating increased pain, stiffness, and disability [27]. The total and subscale scores were normalized to the 0–100 scale.

The Knee Injury and Osteoarthritis Outcome Score (KOOS), a reliable and validated measure, is a 42-item questionnaire that encompasses pain, other symptoms, function in sports and recreation, and knee-related quality of life [28]. Scores range from 0 to 100, with 0 representing extreme problems and 100 representing no problems.

We also determined participant-reported frequent knee-bending activities on most days during the previous 30 days. Frequent knee-bending activities included (1) kneeling for ≥30 min, (2) squatting for ≥30 min, or getting in and out of a squatting position ≥10 times, (3) climbing ≥10 flights of stairs, and (4) lifting or moving objects weighing ≥25 pounds. Those who performed ≥1 of these activities were classified as frequent knee benders.

Pain severity of the knee in the past 7 days was measured using a numerical rating scale (range: 0–10). The presence of pain, aching, or stiffness of the surgically replaced (i.e., index) knee, contralateral knee, and both hips was also determined by asking participants if they had had any of these symptoms in the joints for most days of the month in at least 1 month in the past year.

Performance measures

Functional performance was assessed using the timed 20-m walk and the chair stand test. The timed 20-m walk is a standard outcome measure for OA [29]. The chair stand test measures the time required for 5 repetitions to rise from a chair and sit down.

Radiographic measures

The radiologic severity of knee OA prior to surgery in both knees was assessed using the Kellgren–Lawrence (K–L) scoring system [30].

To deal with T0 missing data which were not assessed annually in OAI (e.g., demographics), data from previous waves were carried forward.

Definitions of improved vs. unimproved

For this study, we first defined improved participants as those with an overall improvement in knee WOMAC total score ≥ to the