The Journal of Arthroplasty xxx (2016) 1–6

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original Article

Preoperative Pain and Function: Profiles of Patients Selected for Total Knee Arthroplasty

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ARTICLE INFO

Article history:
Received 25 November 2015
Received in revised form
12 April 2016
Accepted 14 April 2016
Available online xxx

Keywords:
total knee arthroplasty
pain
function
total joint arthroplasty
cutoff point

ABSTRACT

Background: Total knee arthroplasty (TKA) is an effective treatment to relieve pain and restore function in patients with advanced knee osteoarthritis. TKA utilization is growing rapidly, and the appropriateness of current TKA use is of great interest. We examined patient-reported preoperative pain and function profiles to understand symptom severity at the time of TKA decision.

Methods: Data were from the Function and Outcomes Research for Comparative Effectiveness in Total Joint Replacement. We included patients undergoing primary, unilateral TKAs between 2011 and 2014 for osteoarthritis and had data on the Knee Injury and Osteoarthritis Outcome Score (KOOS) pain and Short-Form 36-item Physical Component Summary (PCS) score. We compared patient profiles across groupings by symptoms: (1) little pain and high function (KOOS $\geq$70, PCS $\geq$40); (2) little pain but poor function (KOOS $\geq$70, PCS <40); (3) high pain but high function (KOOS <70, PCS $\geq$40); and (4) high pain and poor function (KOOS <70, PCS <40).

Results: Of 6936 patients, 77% had high pain and poor function (group 4), 19% had high pain "or" poor function (groups 2-3), and 5% had little pain and high function before TKA (group 1). In group 1, 86% were constantly aware of their knee problem, 48% reported pain daily yet 5% experienced severe or extreme pain on stairs, and 1% pain in bed. Over half had a lot of limitations in vigorous activities. Compared with group 4, group 1 were older, less obese, more educated, and included more men and people reporting being healthy, less disabled, and happy ($P < .05$ for all).

Conclusion: Most patients undergoing TKAs had significant pain and/or poor function. Our results provide critical information given the current debate of potentially inappropriate TKA utilization in the United States.

When knee arthritis pain is severe and frequent and limits mobility and daily activities, a total knee arthroplasty (TKA) remains the most effective treatment to relieve arthritis pain and to improve function [1]. In the United States, the annual rate of TKAs among people aged 65 years or older increased almost 9-fold between 1979 and 2006 [2-4]. In addition, the latest US hospital-discharge data indicate a significant increase in TKA utilization among the younger patients (<65 years) [5]. Among the 719,000 TKAs performed in 2010, close to 50% were performed in those younger than 65 years. While likely multifactorial, the reasons for the increased TKA utilization remain unclear.

Both the increasing demand and associated costs have resulted in a surge in interest regarding the appropriateness of TKA as surgical interventions. Escobar et al [6] determined appropriateness of TKA timing and use based on the patient's age, radiographic evidence of severity and localization of arthritic disease, knee joint mobility and stability, knee pain and function status, and a prior history of surgical and nonsurgical treatments. Using a modified version of Escobar's criteria, a study recently found that close to 30% of TKA patients in the Osteoarthritis Initiative did not meet the "appropriate" surgical intervention criteria [7]. Whether these appropriateness criteria are culturally suitable and appropriate for

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2016.04.015.

The funding sources had no involvement in the study design; data collection, analysis, or interpretation; writing of the report; or submission of the article for publication.

This study is supported by a grant from the Agency for Healthcare Research and Quality P50HS018910 and U.-S. D.T. N. is partly funded by the Arthritis Foundation New Investigator Award and NIAMS K01AR064351.

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http://dx.doi.org/10.1016/j.arth.2016.04.015
0883-5403/

current patients requiring joint arthroplasty remain unclear. It is possible that more relevant appropriateness criteria would balance patient-reported data with clinical data [8].

The purpose of our present study was to ascertain the characteristic of patients selected for TKA in a recently established US nationally representative cohort of total joint arthroplasty patients. Our goals were (1) to examine the distribution of preoperative pain, function, and quality-of-life characteristics at the time of TKA overall and stratified by baseline pain and function groups, with particular interest in the profiles of people with minimal preoperative knee pain and high function; and (2) to determine whether the characteristics differ across groups.

Material and Methods

Population and National Registry

We used data from the Function and Outcomes Research for Comparative Effectiveness in Total Joint Replacement (FORCE-TJR), a national cohort of total joint arthroplasty patients from more than 130 surgeons in 22 sites nationwide. Parallel to the current US surgical practice, most FORCE-TJR patients came from community-based surgeons, including fellowship-trained and general orthopedists in urban and rural locations, as well as teaching and nonteaching hospitals. Further description of the study population and patient-reported outcomes (PROs) measures has been reported previously [9,10]. In brief, the present study included all participants who had unilateral, primary TKAs with the surgical knee as the first surgical joint replaced between April 1, 2011 and May 31, 2014 and with osteoarthritis (OA) as the primary underlying reason for TKA.

Measures

Within 3 months before the date of surgery, participants completed PROs related to preoperative pain, function, and quality of life, as well as patient demographics such as age, gender, race, education attainment, and medical status including body mass index and comorbidities.

We assessed knee pain and function using the Knee Injury and Osteoarthritis Outcome Score (KOOS). KOOS is a self-administered knee-specific questionnaire containing 42 items that yields 5 separate subscales assessing domains of patient's pain (including frequency), symptoms (including stiffness, swelling, and clicking), activities of daily living for physical function, sport and recreation function, and knee-related quality of life [11,12]. For the overall KOOS, each item was scored from 0 to 4, and scores for all items were summed, transformed, and normalized to a scale of 0-100, with 100 representing the best result (eg, no pain; full function). A separate score was then calculated and normalized for each of the 5 subscales, with a scale of 0-100. For each subscale, if less than 50% of items were missing data in a subscale, then a valid subscale was calculated based on the developer's instructions [13]. If more than 50% of the items within a subscale were omitted, the response was considered invalid, and no subscale score was calculated [13]. In addition, we derived participants' Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC) scores based on their responses to the appropriate items from the KOOS.

We also assessed function using the Short-Form 36-items (SF-36), version 2. The SF-36 is a multipurpose self-administered questionnaire with 36 items that yields 8 subscales covering general health, physical function, social function, bodily pain, vitality, physical, mental, and emotional health, as well as 2 measures of summary scores for the physical and mental components [14-16]. Using proprietary methods, each subscale and summary measure were scored and summed, transformed, and normalized with a mean of 50 and 1 standard deviation (SD) of 10, reflecting that of the general population. The SF-36 subscales and summary scores ranged from 0 to 100, with higher scores indicating better outcomes. Scores above 50 are better, whereas scores below 50 are worse than the general population average [17,18]. Thus, a PCS function score of 40 indicates that function is 1 SD below the population average.

Method of Analysis

For the purpose of examining preoperative patient symptom profiles, we used the KOOS pain subscale score and the SF-36 Physical Component Summary score (PCS). The SF-36 is a generic health questionnaire used extensively in populations with OA, especially those undergoing knee arthroplasties [19]. The PCS and the Mental Component Summary equivalence can also be derived from the shorter version SF-12 [20]. Thus, we chose the PCS as a measure of physical function for possible comparisons across studies where SF-36 or SF-12 may be used. Furthermore, the SF-36 PCS is a commonly used global measure of physical function; thus, we use PCS as the primary TKA function outcome for comparability. The SF-36 pain subscale, however, is not joint specific; thus, we use the KOOS pain subscale as our primary TKA pain outcome measure given it is specific to the surgical knee.

Moreover, there are currently no established gold standards with regard to cut points for pain and function thresholds that would require TKA intervention [21]. Although population-based normative scores for the SF-36 are well established [17,18], that of KOOS subscales are less so [22,23]. Thus, we applied the population-based cut point of 40 for PCS, representing 1 SD below the population norm of average function. For KOOS, we took the midpoint of 2 preoperative KOOS pain scores: American patients undergoing anterior cruciate ligament reconstruction [24], with a mean KOOS Pain score of 80; and Swedish patients undergoing arthroscopic partial meniscectomy [25], with a mean KOOS Pain score of 60. Our KOOS Pain score cut point of 70 also approximates the mean preoperative KOOS Pain score plus 2 SDs in Swedish patients awaiting TKAs [12]. In addition to the normalized score of 100 in KOOS that indicates no pain symptom [13], in a correspondence between our team and the developer of KOOS (Ewa Roos, March 17, 2015), a KOOS score of 70 to <100 indicates minimal pain, 50 to <70 moderate pain, 25 to <50 severe pain, and 0 to <25 extreme pain. For our main analysis, we classified patients as having high vs little pain if KOOS Pain <70 vs $\geq$70, and poor vs high physical function (SF-36 PCS <40 vs $\geq$40). We then classified patients into 4 groups: (1) little pain and high function; (2) little pain but poor function; (3) high pain but high function; and (4) high pain and poor function.

Descriptive statistics including patient demographic and clinical characteristics of the 4 groups were calculated and compared. We also compared items from each of the KOOS and SF-36 subscales to explore possible differences by the 4 groups that may add insights into reasons for TKA. For continuous variables, we calculated means and SDs, as well as the medians and interquartile range. We checked for normality using histograms and examined the mean, median, and SD distributions, and used the skewness/kurtosis test for normality. For normal distributions, we compared means across the 4 groups and used analysis of variance to determine statistical differences in the means, and for non-normal distributions, we used the Kruskal-Wallis rank test. For discrete variables, we calculated proportions and used chi-square tests to determine statistical differences in proportions among the 4 study groups. We used a two-tailed P value of <.05 as indication of statistical significance.