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Does Total Knee Arthroplasty Affect Physical Activity Levels? Data from the Osteoarthritis Initiative

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ABSTRACT

Total knee arthroplasty (TKA) is associated with improved patient-reported pain levels, function, and quality of life; however, it is poorly understood whether there is increased physical activity following TKA. Using data from the Osteoarthritis Initiative (OAI), we compare physical activity, as measured using an accelerometer, and patient-reported outcome measures of 60 patients who had already received a TKA with 63 patients who eventually received a TKA during the OAI study. There was no significant difference in activity levels between the two groups as measured by the accelerometer. Total WOMAC, KOOS Quality of Life, KOOS Knee Pain, and KOOS Function scores improved in the post-TKA compared to the pre-TKA group. In both pre-TKA and post-TKA groups, physical activity guidelines were met in only 5% or less.

Total knee arthroplasty (TKA) is well established as the definitive treatment for end-stage knee osteoarthritis (OA) [1–4]. It is associated with improved patient-reported pain levels, increased function, and improved health-related quality of life [5,6]. From a financial perspective, TKA is also one of the most cost-effective procedures considering quality-of-life years gained per amount spent [5,7–12]. However, objective measures of physical activity following TKA are a relatively new area of research which is still poorly understood. Recent research has demonstrated that physical activity, as measured by accelerometry data, may not actually increase following TKA [13], although conflicting results have been reported in the literature [14–16].

Measuring physical activity following TKA is important both as an outcome measure [17] and a public health matter [18,19]. Many patients have high expectations regarding the amount of physical activity they will be able to achieve following TKA [20] and may become frustrated with their outcome if these expectations are not met or addressed. As a recent study by Harding et al demonstrated, very few patients, by 6 months following TKA, achieve activity levels recommended by the American Physical Activity Guidelines [13]. Consequently, inability to increase physical activity also places patients at increased risk of many disease processes, including cardiovascular disease, stroke, and overall mortality [21,22].

Accelerometry has become an important means of objectively measuring patients' physical activity, as it is considered the most accurate means of doing so [23–25]. In contrast to a simple pedometer, accelerometers measure vertical acceleration of the subject, yielding data pertaining to duration, frequency, and intensity of exercise [25–27]. Consequently, accelerometry data provide important information regarding patient exercise which can be interpreted in metabolic equivalent task (MET) units. The utilization of accelerometry data is especially important considering the poor reliability of patient-reported physical activity [13,15,28]. For example, recent research on the physical activity for the elderly (PASE) questionnaire demonstrated several validity and reproducibility shortcomings, especially in women [28].

The primary objective of this study is to evaluate and compare the levels of physical activity using accelerometry data in two groups of patients: those who eventually receive TKA and those who have already received TKA. Secondary objectives include comparing patient-reported outcome measures including: pain, function, and health-related quality of life between these two groups of patients. Our hypothesis is that while patient-reported measures will be different between these groups, and improved in the post-TKA group compared to the pre-TKA group, there will be no difference in physical activity as measured by the accelerometer.

Methods

All data were obtained from the Osteoarthritis Initiative (OAI) database. The OAI is a publicly and privately funded prospective longitudinal observational study that studies the natural progression of osteoarthritis in patients [29]. The 4796 patients included in the OAI study were divided into subcohorts at the beginning of the study, which included

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a progression subcohort of 1389 patients who had clinically significant osteoarthritis at baseline, an incidence subcohort of 3285 patients who were determined to be at high-risk of developing clinically significant osteoarthritis, and a control cohort consisting of 122 patients with no symptoms or risk factors for osteoarthritis. All 4796 patients included in the study were required to attend a baseline visit followed by annual visits to their respective study center, where clinical, radiographic, and biomarker data were collected at each visit.

The OAI study is also a multi-center study that is conducted at four different centers: (1) the Ohio State University, (2) the University of Maryland School of Medicine, (3) the University of Pittsburgh, and (4) Memorial Hospital of Rhode Island in Pawtucket, Rhode Island. All data, including radiographic images and biomarkers, are publically available at http://www.oai.ucsf.edu.

At the 48 month visit of the OAI study, a subset of 2712 OAI participants were invited to join a physical activity ancillary study where participants would wear an ActiGraph GT1M uniaxial accelerometer (ActiGraph; Pensacola, Florida). Of these 2712 OAI participants, 2127 patients consented to participate. All patients were instructed on how to wear and use the accelerometer by trained OAI research staff. Patients were to wear the accelerometer from arising in the morning to retiring at night, except during water activities, for seven consecutive days. Patients were also instructed to maintain a daily log recording time spent in the water and cycling activities (both of which are not recorded accurately with the accelerometer). Upon return of the accelerometers to their respective study centers, data were analyzed to measure valid days of recording, which was defined as greater than or equal to 10 hours of recorded wear-time; 2001 patients provided one or more valid days of recording and 1927 patients provided four to seven valid days of recording.

In our study, we studied two sets of patients taken from the accelerometry OAI study: "pre-TKA patients" and "post-TKA patients." There was no overlap of patients between these two groups; as accelerometry data were only collected during the 48-month visit of the OAI study, these patient groups represent those who had TKA before accelerometry data collection (post-TKA patients) and those who had TKA after accelerometry data collection (pre-TKA patients). The **pre-TKA patients** included those who had not had a total knee arthroplasty prior to the 48 month visit where accelerometry data were collected, though did have an adjudicated TKA at an OAI visit any time after the 48 month visit where accelerometer data were collected (the OAI study currently has data up to an 84 month visit). Patients were included if they had an adjudicated TKA at any point following the accelerometry data collection and had 4 to 7 days of valid accelerometry recording — this inclusion criteria were based on previous studies which demonstrated that at least 3 to 5 days of wear-time is necessary to accurately predict overall physical activity for the patient [26]. The **post-TKA patients** included those who did have a TKA during the OAI study prior to the 48 month visit where accelerometry data were collected. Patients were included in this second group if they had an adjudicated TKA prior to accelerometry data collection and had 4 to 7 days of valid recording. Only patients with total knee arthroplasty were included in our study; those with partial knee arthroplasties were excluded.

Accelerometry data for both patient sets were analyzed using cut-points, which divide activity counts (units of accelerometry data that integrate vertical acceleration and deceleration) per minute into different physical activity intensity levels. Previously established cut-points in the literature have been designed to estimate the intensity of physical activity in terms of energy expenditure measured in MET units, with light activity corresponding to 1.5 to <3 METs, moderate activity to 3 to 6 METs, and vigorous activity to ≥6 METs [30–32]. In our study, we utilized "cut-points" published by Troiano et al, which were applied to the general adult population from the National Health and Nutrition Examination Study [30]. The final data for each patient are reported as minutes of activity above light, moderate, or vigorous activity threshold cut-points.

To better evaluate each patient's physical activity, we also compared each patient's accelerometry data to the 2008 Physical Activity Guidelines for Americans set forth by the United States Department of Health and Human Services (DHHS). The DHHS guidelines recommend 150 moderate intensity bout minutes (minutes are accumulated in 10 minute bouts) along with 75 vigorous bout minutes spread out across the week. We also compared accelerometry data to the 2008 DHHS guidelines of adults with arthritis, which recommends 150 moderate-to-vigorous bout minutes spread out across the week.

As coexisting comorbidities could serve as confounding factors in this study, the Charlson Comorbidity Index was used to assess the level of comorbidity in each patient. The Charlson Comorbidity Index is a method of assessing and categorizing the amount of comorbidities in a given patient [33]. Contributing factors to the index are conditions such as heart failure, COPD, strokes, or diabetes. Patients from both the pre-TKA and post-TKA groups were stratified using this index into groups with either no comorbidities or at least 1 comorbidity. A similar stratification was performed for symptoms of hip pain. Patients were separated into two groups based on the presence or absence of any hip pain for more than half the days in a given month within the year previous to accelerometry data collection. For each of these stratifications, accelerometry data were compared across pre-TKA and post-TKA groups.

For each patient included in the study, self-reported outcome measures of knee function, knee pain, and overall quality of life were gathered from the 48-month visit (the same visit where the accelerometer data were collected on). Self-reported outcome measures included Western Ontario and McMaster osteoarthritis index (WOMAC) scores, Knee Injury and Osteoarthritis Outcome Score (KOOS), and Global Assessment score. As the WOMAC score, as well as some of the KOOS subsets, focuses on only one knee, such unilateral scores were combined by summing the scores from each knee together. The combined score was utilized as to have greater correspondence with physical activity and ambulation, which were pertinent to this study. The Global Assessment score asks the patient on a scale of 0 to 10, "Considering all ways knee pain and arthritis affect you, how are you doing today?".

Patient-reported physical activity was also measured using the PASE questionnaire, which was filled out by patients during the 48 month visit.

The accelerometry data of pre-TKA patients and post-TKA patients were compared using SPSS Statistics (Version 22; SPSS Inc., Chicago, Illinois). Patients' accelerometry data as well as self-reported function/pain scores were compared using an independent samples T-test with Levene's test to assess for equal variances among patient data. The percentage of patients achieving DHHS guidelines for physical activity were compared between pre-TKA and post-TKA groups using a Pearson's chi-squared test.

Results

Based on our inclusion and exclusion criteria, there were 63 patients included in the pre-TKA group and 60 patients in the post-TKA group. Baseline characteristics of each of these groups can be seen in Table 1. The mean age of patients in pre-TKA and post-TKA groups was 68.4 (SD: 8.2) and 67.3 (SD: 8.7), respectively. The mean BMI in pre-TKA and post-TKA groups was 29.2 (SD: 4.8) and 31.1 (SD: 5.3), respectively. For the pre-TKA group, 34.9% of patients had at least 1 medical comorbidity, while in the post-TKA group, 48.3% of patients had at least 1 comorbidity ($P = 0.123$). In the pre-TKA group, 27.0% had hip pain for the majority of the days in a month within the previous year compared to 25.0% in the post-TKA group. All baseline characteristics of both study groups can be found in Table 1.

For the pre-TKA patients, there was an average of 552.6 days (SD: 358.9) between the time of accelerometry data collection and TKA. For the post-TKA patients, there was an average of 624.8 days (SD: 420.6) between TKA and accelerometry data collection.