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The association of pre-operative body pain diagram scores with pain outcomes following total knee arthroplasty

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SUMMARY

Objective: Approximately 20% of total knee arthroplasty (TKA) recipients have suboptimal pain relief. We evaluated the association between pre-surgical widespread body pain and incomplete pain relief following TKA.

Method: This prospective analysis included 241 patients with knee osteoarthritis (OA) undergoing unilateral TKA who completed questionnaires preoperatively and up to 12 months post-operatively. Questionnaires included the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain scale and a body pain diagram. We derived the number of non-index painful body regions from the diagram. We used Poisson regression to determine the association between painful body regions identified preoperatively and both WOMAC pain at follow-up and improvement in pain as defined by the minimal clinically important difference (MCID).

Results: Mean subject age was 66 years (SD 9), and 61% were females. Adjusting for age, sex, co-morbid conditions, baseline pain, pain catastrophizing, and mental health, we found that more widespread body pain was associated with a higher likelihood of reporting 12-month WOMAC pain score >15 (relative risk [RR] per painful body region 1.39, 95% CI 1.18–1.63) and a greater likelihood of failing to achieve the MCID (RR 1.47, 95% CI 1.16–1.86).). Pain catastrophizing was an independent predictor of persistent pain and failure to improve by the MCID (RR 3.57, 95% CI 1.73–7.31).

Conclusions: Pre-operative widespread pain was associated with greater pain at 12-months and failure to reach the MCID. Widespread pain as captured by the pain diagram, along with the pain catastrophizing score, may help identify persons with suboptimal TKA outcome.

Introduction

Research on predictors of poor outcome from total knee arthroplasty (TKA) has shown that individuals with greater pre-operative levels of pain, pain catastrophizing, anxiety and depression, more diffuse body pain, lower educational attainment, and other psychological and social factors tend to have worse surgical outcomes[1–6]. Prior research on identifying at-risk individuals has relied upon validated measures including the Pain Catastrophizing Scale (PCS)[7], the Mental Health Inventory-5 (MHI-5)[8], and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain and physical function subscales[9]. While such measures are useful for research purposes, they may be difficult to administer in a busy clinic. A simple tool that can identify those patients most at risk of poor TKA outcome may be helpful in clinical settings.

We have begun to examine such a tool – a total body pain diagram that captures patient-reported pain in 19 different body sites[10]. In a pre-surgical cohort of subjects with knee osteoarthritis (OA) undergoing elective unilateral TKA, widespread body pain as depicted by the whole body pain diagram was associated cross-sectionally with validated measures of OA-related pain, mental health, and pain catastrophizing[11]. These associations between widespread pain and OA-related pain, mental health, and pain catastrophizing persisted after adjustment for age, sex, and

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comorbid medical conditions. We did not include review of pre-operative knee imaging in our study. It has been established that lower radiographic severity is associated with worse TKR pain outcome[12].

Despite the common use of pain diagrams to depict widespread pain in research involving other musculoskeletal conditions (e.g., chronic low back pain, Ehlers–Danlos disease, and carpal tunnel syndrome)[13–17], the association between widespread pain as depicted by whole body pain diagrams and TKA outcome has received little study[18]. We sought to evaluate the association between pre-surgical pain diagram scores and follow-up WOMAC pain scores up to 12 months post-operatively. Furthermore, we evaluated the association between pre-surgical pain diagram scores and improvement in pain by the estimated minimal clinically important difference (MCID) for WOMAC pain. We hypothesized that those participants who reported more widespread body pain would continue to experience more pain up to 12 months post-operatively and would be less likely to improve by the MCID.

Methods

The Study of Total Knee Arthroplasty Responses (STARs), a prospective cohort study of participants with knee OA undergoing elective unilateral TKA at three clinical sites, was designed to evaluate risk factors for suboptimal TKA outcome. The STARs study enrolled participants at one academic center (NYU Langone Medical Center, New York, NY, USA) and two community orthopedic centers (Orthopaedic Center of the Rockies, Fort Collins, CO, USA, and University of Maryland St. Joseph Medical Center, Towson, MD, USA) from September 2012 to April 2014. Institutional Review Board approval was obtained at all clinical sites and at Brigham and Women's Hospital, Boston, MA, USA.

Participants

Participants were English-speaking community-dwelling persons, at least 40 years of age at study entry, undergoing TKA with a primary diagnosis of knee OA. Subjects with inflammatory knee arthritis or other underlying diagnoses leading to TKA were excluded. Staff at each center identified potentially eligible subjects and provided the subjects' contact information to the Brigham and Women's Hospital research coordinator, who in turn contacted all potential subjects to confirm eligibility, explain the study, and ascertain interest in participation. Study subjects were asked to complete questionnaires pre-operatively and at 6 and 12 months post-operatively to capture changes following surgery. Questionnaires included demographic information, co-morbid medical conditions, the whole body pain diagram, WOMAC pain and function sub-scales[9], PCS[7], and the MHI-5[19]. Subjects were reimbursed (USD 25) for returning a questionnaire at each time-point.

While the follow-up data were derived primarily from the one-year questionnaire ($n = 219$), we used data from 6-month questionnaires for 22 subjects in a last value carried forward fashion to maximize sample size and cohort generalizability. To evaluate the validity of the six-month data as a proxy for 1 year outcomes, we compared mean six-month and 24-month WOMAC scores in 18 subjects who provided both six and 24-month data but no 12-month data. These values were similar (mean [SD] WOMAC pain at 6- and 24-months, respectively: 11 [10.8] and 8 [9.3]), supporting the validity of the substitution.

Baseline data

The pre-operative questionnaire included a self-reported body pain diagram completed within 6 weeks of surgery. Subjects were directed to report current pain using checkboxes at nineteen separate pre-defined body sites. Subjects indicated whether they had pain in each of these areas with a 'check.' The number of painful body sites is the sum of the number of sites (0–19) reported by the study subject on the pain diagram. The index joint was removed from this sum and thus the lowest score would be 0 and the highest would be 18. From the number and location of painful areas reported on the body pain diagram, we derived both the total number of painful sites and the number of painful body regions. Similar to our previously reported technique[11], we established eight different body regions but excluded the surgically-treated or index region so as to best capture widespread pain; thus, possible scores ranged from 0 to 7. The eight body regions were defined as follows: right upper extremity (shoulder girdle, upper arm, and lower arm), left upper extremity (shoulder girdle, upper arm, and lower arm), right lower extremity (upper leg and lower leg), left lower extremity (upper leg and lower leg), right hip (hip and buttock), left hip (hip and buttock), back/neck (upper back, lower back, and neck), and chest (abdomen and chest). In our analyses, the index joint was removed from both the body regions and from the painful sites as we anticipated that the vast majority of study participants would experience pain at the index joint. The extent of widespread body pain was analyzed as both a continuous and a categorical variable (0 vs 1–2 vs $\geq$3 painful regions). However, the modeling was performed with the continuous form of the widespread body pain regions because models using the categorical form of the variable demonstrated some instability due to small cell sizes. We assessed pre-operative pain catastrophizing utilizing the 13-item PCS[7] and pre-operative anxiety and depression with the five-item MHI-5[8,19]. Responses to questions were summed and scaled from 0 to 100. PCS scores were dichotomized at 20 with scores of $\geq$20 indicating high catastrophizing based on an assessment of sample distribution and published clinical studies on knee OA[7,13,17,20]. MHI-5 score was dichotomized at 68 with scores <68 indicating poor mental health as previously reported[21]. The WOMAC pain score was calculated as the sum of the responses to the five items, each of which had a five-item scale[9], scaled from 0 to 100 with 100 representing the worst possible score[22]. Baseline WOMAC pain was categorized as 0–39, 40–69, and $\geq$70.

Outcome measures

The outcome measures for this analysis included a (1) dichotomized variable for the final WOMAC pain score at follow-up; and (2) the determination of estimated MCID (yes/no) based on pre- and post-surgical WOMAC pain scores. A dichotomous outcome variable for WOMAC pain at follow-up was created using a threshold of 15. This cut-point implies at least mild pain on 3 of 5 items or at least moderate pain on at least one item, representing persistence of pain and suggesting a suboptimal outcome. The MCID was calculated based on the methodology used by Escobar and Riddle[22] which takes baseline WOMAC pain into account in determining MCID. Thus, higher or worse baseline scores require a larger gain in pain scores in order to meet the MCID.

Statistical analysis

Descriptive statistics of baseline demographic, clinical, psychosocial measures, and OA-related pain and function measured at both baseline and at follow-up were either summarized as medians (twenty fifth and seventy fifth percentiles) or means (standard deviation) for continuous variables based on normality or as percentages for categorical variables. Similar methods were used for WOMAC pain measured at follow-up and for the difference between baseline and follow-up WOMAC pain. Participants were first