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Preoperative Predictors of Pain Following Total Knee Arthroplasty

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ABSTRACT

Total knee arthroplasty has provided dramatic improvements in function and pain for the majority of patients with knee arthritis, yet a significant proportion of patients remain dissatisfied with their results. We performed a prospective analysis of 215 patients undergoing TKA who underwent a comprehensive array of evaluations to discover whether any preoperative assessment could predict high pain scores and functional limitations postoperatively. Patients with severe pain with a simple knee range-of-motion test prior to TKA had a 10 times higher likelihood of moderate to severe pain at 6 months. A simple test of pain intensity with active flexion and extension preoperatively was a significant predictor of postoperative pain at 6 months after surgery. Strategies to address this particular patient group may improve satisfaction rates of TKA.

Condylar-type total knee replacement has been performed in the United States for four decades. Implants, surgical techniques and instrumentation have been continuously developed to provide durable results at 20-year follow-up and more [1–5]. Improvements in the development of kinematically functioning designs, user-friendly instruments, peri-operative pain management and accelerated post-operative rehabilitation regimens have been implemented since the beginnings of the operation [6–10]. Although significant improvements in pain and function related to end-stage arthritis of the knee has occurred in millions of patients who have undergone total knee arthroplasty procedures, many studies suggest that an important proportion of total knee replacement recipients are dissatisfied with the procedure and have not had their expectations met [11–14]. Recent reports have demonstrated only 70–88% satisfaction rates following TKA in regards to improvement in function and decrease in pain [11,15–18], and persistent moderate to severe pain in ten to thirty percent of patients at 1–7 years of follow-up [11,19–21]. These studies have led certain agencies and payors to question whether this commonly performed yet expensive operation should be reimbursed in patients with such reported levels of dissatisfaction as their outcome [22].

Several investigators have begun to prospectively evaluate patients who are considering or undergoing total knee replacement using validated outcome and performance assessments to determine factors that contribute to better or worse outcomes and to affirm the effectiveness of the procedure [23–27]. Our multidisciplinary research group became interested in this area of investigation five years ago with the intent of a critical evaluation of pain and function pre- and postoperatively in total knee arthroplasty. The group hoped to develop a systematic assessment that could then be utilized to determine whether specific pain management interventions could be effective in reducing short and long term (6–12 months) pain and improve short and long term function following TKA. The purpose of the present investigation was to analyze patient characteristics including pain and function preoperatively with a combination of validated sensory tests, psychological questionnaires and pain rating assessments and to determine whether these evaluations could predict pain relief and return to function after knee replacement surgery.

The authors attempted to answer the following questions:

What is the distribution of pain intensity ratings before and six months following TKA?
Does pain intensity rating during functional assessment of the knee preoperatively predict pain intensity six months post-total knee arthroplasty?
Do high patient scores on scales of psychological state prior to TKA, such as depression, anxiety and pain catastrophizing, predict pain intensity ratings after total knee?

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We have previously reported factors predicting high pain on postoperative day 2 (in-hospital) and analgesic medication intake following TKA in this study group [28].

Patients and Methods

Patients

This was a prospective cohort study involving patients recruited to a larger randomized controlled trial studying the effectiveness of TENS on pain and function after total knee arthroplasty.

Two hundred fifteen patients underwent a comprehensive multi-faceted evaluation during their TKA preoperative visit. Postoperative assessments were performed at the 6-month clinic visit (n = 193). All patients provided informed consent and the study was approved by the University of Iowa and VA institutional review boards.

Inclusion criteria were:

1) patients ≥30 years
2) diagnosis of knee osteoarthritis
3) spoke English
4) indicated for a primary, unilateral TKA at the University of Iowa Hospitals and Clinics or at the Iowa City VA Medical Center.

Patients were excluded if they had used the investigational device (TENS unit) in the past, could not use the device, had significant chronic pain at a secondary site such as opposite knee, ipsilateral hip or back, had a central or peripheral neurological disorder, were non-ambulatory or could not provide informed consent.

Three hundred forty-three eligible patients were approached, 100 declined to participate and 15 did not complete the required preoperative testing. Postoperatively, 13 subjects were excluded due to surgical complications leaving 215 patients in the final cohort.

Twenty-two patients did not complete a 6-month visit despite attempts at contact from the study team. Analysis of preoperative variables revealed that missing patients at the postoperative evaluation were not different than tested patients, except more were male. Thus, uni- and multivariate analysis would not have been any different with their inclusion, except that these results may generalize more to female patients.

All patients received a cemented modern condylar-type total knee arthroplasty with patellar resurfacing. Operative anesthesia included spinal anesthesia with bupivacaine or general anesthesia with propofol followed by isoflurane or sevoflurane if a spinal was contraindicated or refused by the patient. Intraoperative and early postoperative analgesia included single-shot spinal analgesia using preservative free morphine or single-shot femoral block analgesia using ropivacaine.

Preoperative evaluations

Pain Intensity rating. Patients were asked to rate the pain in their operative knee on a vertical, 21-point (0–20) numerical rating scale (NRS) where 0 was no pain and 20 was the most intense pain.

Pain intensity at rest was measured prior to any range-of-motion, limb manipulation or other study procedure.

The range-of-motion pain test (pain intensity with range-of-motion) was scored during active extension, then flexion of the operative knee. For active extension: a rolled towel was placed under the ankle of the surgical leg and subjects actively extended their leg as much as possible by pressing their knee toward the examination table. Pain intensity was rated by the patient when maximum extension was reached. For active flexion, patients were supine and flexed the study knee as far as possible while keeping their foot flat on the examination table. Again, patients were asked to rate the intensity of pain in the surgical knee at maximum flexion.

A 0–20 numerical rating scale (NRS) has established validity and reliability for assessing acute and postoperative pain [29–31]. It correlates highly with the Visual Analogue Scale (VAS) [32–34] and has been shown to be easier to use across all age groups [35–38].

Quantitative Sensory Testing. Three quantitative sensory tests were used to measure pain sensitivity to mechanical and thermal stimuli:

Cutaneous mechanical pain sensitivity was measured with von Frey Pain intensities (VFPI). A standardized monofilament is pressed at a right angle to the skin's surface with a standard force sufficient to bend the filament. Patients were asked to rate the pain intensity caused by this force on the 0–20 NRS [39].

Cutaneous thermal pain sensitivity was measured by heat pain threshold (HPT). A Neurosensory Analyzer with a 16 × 16 mm thermode placed at an initial temperature of 34 °C is increased at a rate of 1 °C/s to a maximum 52 °C. Patients were instructed to press a button when the heat sensation is first perceived as painful. If the temperature reached 52 °C, this was recorded as the threshold [40–43].

Deep mechanical pain sensitivity was measured with pressure pain thresholds (PPT). A hand-held pressure algometer with a 1 cm^2 digital probe was applied perpendicularly to the skin at 40kPa/s and the patient was asked to press a button when the applied pressure was first perceived as pain. Measurements were performed in three locations medial to the center of the patella approximating the area of the incision. The average of the three scores was used as the final value [40–42].

Psychological Variables. Anxiety, depression, and pain catastrophizing were measured during the preoperative clinic visit using the Trait Anxiety Form of the State Trait Anxiety Inventory (STAI) [44], the Geriatric Depression Scale (GDS) [45], and the Pain Catastrophizing Scale (PCS) [46], respectively.

The Trait Anxiety Scale (STAI Form Y-2) consists of twenty statements that assess how respondents generally respond to perceived threats in the environment rated on a 4-point scale. This instrument has been used in prior TKA and THA outcome studies [47].

The GDS is a five-item screening tool for depression in the older population. Subjects are considered to screen positive for depression if they answer positive to two or more questions [48–50].

The PCS is a 13-item survey designed to measure the tendency for catastrophizing in response to pain by measuring: rumination, magnification, and helplessness. Subjects rate their thoughts regarding pain using a 5-point scale. The PCS has been demonstrated to be a significant predictor of pain after TKA [27,51,52].

Data Collection Protocol. At the preoperative TKA work-up clinic visit, all consented patients completed demographics forms and the psychological questionnaires (STAI, GDS, PCS). Pain intensity at rest was measured and then the three quantitative sensory tests were performed on the surgical knee. The range-of-motion pain test was then performed.

At the standard 6-month clinic visit, patients were reassessed for pain in their total knee arthroplasty, prior to the encounter with their surgeon. Patients' pain intensity was measured at rest and with the extension and flexion range-of-motion test on an examination table and scored on the 0–20 NRS.

Statistical Analysis. Descriptive statistics were used to describe preoperative and postoperative pain variables using percentages for categorical variables, and mean ± S.D. for continuous variables. Pain with the range-of-motion pain test was determined by averaging the pain intensity ratings during active extension and active flexion. These scores were then coded as low, moderate, or severe pain using cutoff points established in previous literature [25]. Low pain = 0–7 out of 20, moderate pain = 8–14 out of 20, and severe pain = 15–20. For each candidate explanatory variable, a generalized logit model for