



## Examining pain before and after primary total knee replacement (TKR): A retrospective chart review

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### ABSTRACT

**Objective:** The goal of total knee replacement is to improve function and reduce knee pain. The aim of this retrospective chart review was to assess the change in pain intensity from prior to TKR to after TKR at time of discharge from hospital.

**Method:** Consecutive charts of 595 patients who were discharged from the orthopaedic inpatient setting between January 2014 and July 2014 were reviewed.

**Results:** The mean pre-operative pain intensity score was 7/10 (n = 473), and the mean pain intensity score prior to discharge from hospital was 3/10 (n = 548). Four hundred and fifty-six patients had both a pre-operative and pre-discharge pain intensity score documented; for those patients there was a significant change in pain intensity scores from prior to surgery to prior to discharge (p < 0.001).

**Conclusion:** Pain after TKR can be a limiting factor in rehabilitation activities. This retrospective chart review examined the pain intensity scores before and after primary TKR for patients in our facility. We found a significant difference in the pain intensity from before surgery to after surgery. However, further research needs to be conducted to examine the intensity and quality of pain as well as which analgesics patients are consuming after discharge from hospital at 6 weeks and 3 months.

### Introduction

Total knee replacement (TKR) is a painful orthopaedic procedure that requires early rehabilitation for the new joint to function optimally. In order to achieve successful joint range of motion, patients need to continue to mobilize and exercise, even after discharge from the hospital. However, pain can be a limiting factor in a patient's ability to participate in their rehabilitation. Moderate to severe pain on movement and rest has been reported for this patient population while in hospital and after discharge to home (Buvanendran et al., 2010; Ramlall et al., 2010, 2014; Wilson et al., 2016). There is also a risk of the development of chronic pain in this population. Unrelieved moderate to severe pain in the acute post-operative period leads to repeated firing of peripheral nociceptors that can result in the development of chronic pain. The prevalence of chronic pain following TKR ranges between 5% and 44% (Buvanendran et al., 2010; Liu et al., 2012; Wylde et al., 2011). The structures that are most commonly damaged in TKR surgery

that cause pain post-surgery include the skin, joint-lining, soft tissue and bone. However, some people also experience neuropathic pain, although its prevalence post-TKR is uncertain (Drosos et al., 2015). Mechanical pain refers to pain produced by a fractured bone or the pain produced when a patient has to move a newly-inserted total knee prosthesis. Non-mechanical pain, or pain at rest, is usually present 24 h a day and may be worse at night, is marginally affected by activity and can be subdivided into three broad groups: sepsis, neuropathic, and perceived (Cameron et al., 2015).

While in hospital, multimodal analgesia including: spinal anesthetic, peripheral nerve blockade, infiltration of the joint intraoperatively, opioids, NSAIDs, acetaminophen, and gabapentinoids have been shown to reduce post-operative arthroplasty pain (Abdallah et al., 2016; Choi et al., 2016; Sawhney et al., 2016; Wilson et al., 2016). Opioids are prescription analgesics used to manage pain, including pain after total knee replacement (TKR) surgery. Although opioids have a therapeutic effect in managing pain and are

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recommended as part of a multimodal analgesic plan after orthopaedic surgery, they are also associated with misuse and addiction (National Advisory Committee on Prescription Drug Misuse, 2013; Sibbald, 2017). They can also have significant side effects that include constipation, urine retention, somnolence, and impaired balance (Ramlall et al., 2010, 2014). For patients who are consuming opioids prior to surgery there are worse clinical outcomes, including prolonged recovery and increased risk for complications for musculoskeletal patients, especially those who have had TKR (Morris and Mir, 2015; Zywił et al., 2011). Orthopaedic surgeons are the third highest opioid prescribers, surpassed only by primary care providers and internists (Devin et al., 2014). Although patients who undergo orthopaedic surgery are prescribed opioids, they do not use the maximum doses of analgesics prescribed (Ramlall et al., 2010, 2014). In addition, compared to men, women were less satisfied with their pain management (Ramlall et al., 2010, 2014). This may be a result of anatomical, neurochemical or physiological differences between men and women in the pain pathways that transmit pain signals, and/or women may be more sensitive to pain signals (LeResche, 2000).

The Holland Centre/Sunnybrook Health Sciences Centre (HC/SHSC) is an elective joint replacement orthopaedic facility in Toronto, Ontario, Canada. Patients who have TKR are followed-up by the Acute Pain Service (APS) until post-operative day 3 or discharge from hospital. Other team members involved in the pre- and post-operative care include; pharmacists, physiotherapists, occupational therapists, social workers and medical doctors. Patients who had TKR at the facility are followed up by the Acute Pain Service (APS) team from day 0 (day of surgery) until hospital discharge (usually by post-operative day (POD) 3). Immediate post-operative pain is managed using IV PCA (Intravenous Patient Controlled Analgesia), regional nerve blocks (continuous femoral nerve block (CFNB)), and oral analgesics including acetaminophen, an NSAID, controlled release opioids, and gabapentin. Patients return to the outpatient clinic six weeks after surgery. At this six-week follow-up visit, patients often report their pain as being poorly managed, which raises serious concerns for the health care team.

Patient dissatisfaction with outcomes, including pain and function, following TKR can occur as early as 3 months following surgery. This is concerning as dissatisfaction following the procedure is associated with worse outcomes such as prolonged recovery and increased complications (Zywił et al., 2011). Early postoperative assessment and treatment can identify potential and actual adverse outcomes, so intervention to assist with further improvement can be implemented and, subsequently, occur in some cases up to 12 months after surgery (Williams et al., 2013). The reports of ongoing pain at follow-up visits was a concern for our team and it was unclear what the intensity of pain was for these patients prior to TKR surgery and what the intensity of their pain was prior to discharge from hospital after surgery.

The primary aim of this retrospective chart review was to assess the change in pain intensity from prior to surgery to prior to discharge home among patients undergoing primary TKR. Secondary aims included: (1) determining the pain intensity reported by patients one month prior to their pre-surgical screening appointment; (2) determining the pain intensity reported by patients on day of discharge from hospital; (3) examine the characteristics of patients who reported experiencing chronic pain and were using analgesics at home prior to surgery; (4) examining which analgesics were commonly administered post-operatively and (5) listing the medications commonly prescribed on discharge to home. Ideally, the pain intensity reported during the outpatient post-surgical follow-up visit would be examined, however, this was not routinely documented in a systematic way and, therefore, would be difficult to assess. It was determined that an important starting point would be to better understand patients' pre-operative pain and pain prior to discharge from hospital.

## Method

### Sample and setting

This chart review was conducted using a retrospective cross-sectional approach. The study was conducted by reviewing the charts of 595 consecutive patients who were discharged from the orthopaedic inpatient setting at HC/SHSC between January 2014 and July 2014. HC/SHSC is a Centre of Excellence for Orthopaedic Surgery and is a University of Toronto affiliated teaching hospital. Patient charts were included in the review if they underwent primary TKR. Charts were excluded if the patient underwent revision surgery or bilateral TKR. Ethics review approval was obtained from the Ethics Review Board of Sunnybrook Health Sciences Centre prior to the start of this study. All charts were reviewed by the primary author, confidentiality of all patients was maintained by assigning each patient a study number, and all data was securely stored in the hospital.

### Outcome measures

Outcome variables that were collected from the patients' pre-operative assessment forms included demographic variables (age, gender), surgical procedure, medical co-morbidities, history of pain and opioid use. These variables can influence the length of stay (LOS). Post-operative variables that were collected included analgesics consumed post-operatively, LOS, pain intensity on day of discharge, and discharge analgesic prescription.

Pain intensity was determined by reviewing the pre-operative assessment form and pain assessment flowsheets. Pain intensity is measured in our unit using the 11-point numeric rating scale, where 0 is no pain and 10 is the worst pain imaginable. This is routinely documented prior to surgery and while patients are in hospital. The pain intensity in the past month prior to surgery, and post-operative pain expectations were also captured based on documentation in the clinical records. For patients with previously diagnosed chronic pain, their pre-admission medications were also noted. At the same time, care-plans, narrative notes, nursing notes and Medication Administration Records (MARs) were also reviewed. Analgesics consumed were determined by reviewing the Medication Administration Record (MAR). Common discharge medications were also noted, if prescribed.

### Statistical analysis

Statistical analysis was performed with SAS<sup>®</sup> version 9.4 (SAS Institute, Cary, NC, USA). Demographic and baseline data were analyzed using descriptive statistics including frequencies and means. Change in mean pain intensity scores was analyzed using paired t-tests with  $p < 0.05$  considered significant for the primary outcome of change in pain intensity scores.

## Results

The mean age of patients ( $n = 595$ ) included in the chart review was 70 (SD 9.76; range 35–95) years old. The majority of patients were female ( $n = 391$ , 65%), underwent a right TKR ( $n = 318$ , 53%) and reported pain from osteoarthritis (OA) and rheumatoid arthritis (RA) ( $n = 551$ , 92.6%). Other co-morbid medical conditions reported by patients included: diabetes, gout, fibromyalgia, osteoporosis, renal insufficiency, coronary artery disease, anxiety, avascular necrosis, myasthenia gravis, cancer, obesity, osteopenia, osteonecrosis, anemia, constipation, deep vein thrombosis (DVT), diabetes, depression, anxiety, gastroesophageal reflux disease (GERD), chronic obstructive pulmonary disease (COPD), sciatica, stroke, sleep apnea and hypertension.

**Table 1**  
Pre-operative pain and pain at discharge

|  | Mean pain intensity (0–10) | Pain 0-3/10 | Pain 4-6/10 | Pain 7-10/10 |
|--|----------------------------|-------------|-------------|--------------|
| Pre-op pain (n = 473)                              | 7                          | 26 (5.5%)   | 123 (26%)   | 324 (68%)    |
| Pain at discharge (post-operative day 3) (n = 548) | 3                          | 385 (70%)   | 142 (26%)   | 21 (3.8%)    |

*Pain intensity*

The pain intensity in the past month prior to surgery was captured from the chart for 473 patients, with the mean pre-operative pain intensity score 7 out of 10. The majority of patients (n = 324, 68%) reported severe pain (between 7 and 10 out of 10) (Table 1). On POD 3, or prior to discharge, pain intensity scores were documented and captured for 548 patients, with a mean pain intensity score of 3 out of 10. The majority of patients (n = 385, 70%) reported none or mild pain (between 0 and 3 out of 10).

Four hundred and fifty-six patients had a pain intensity score documented both prior to surgery and prior to discharge to home after TKR. There was a significant change in mean pain intensity from prior to surgery to prior to discharge home following TKR (p < 0.001). There was no difference in the change in pain intensity scores based on age (p = 0.33), or based on side of surgery (right or left, p = 0.91).

*Post-operative analgesics*

All patients were given scheduled post-operative analgesics and were followed up by the Acute Pain Service (APS) team and pharmacists up to the time of discharge. Patients received a combination of peripheral nerve blocks, intravenous and/or oral opioids, a non-steroidal anti-inflammatory drug (NSAID), acetaminophen, and gabapentin or pregabalin (Table 2). Patients were monitored and analgesics re-assessed as needed.

Prescriptions for analgesics are provided to patients prior to discharge home. These prescriptions are supplied by the patient's local pharmacy and are intended to be used at home so patients can continue to manage their pain and participate in their rehabilitation activities. Table 3 summarizes the standard analgesic discharge prescription for use over a 2–3week period or when needed.

*Characteristics of patients with chronic pain*

Patients who had a documented history of chronic pain during their pre-surgical assessment were identified during the chart review (n = 24; 4%). The majority of patients who were identified as having chronic pain were female (n = 16). Patients took a range of 1–4 different analgesics regularly to manage their pain. Only 2 patients indicated they did not take an opioid (consumed a combination of NSAID, pregabalin and acetaminophen or NSAID only), and 1 patient reported using marijuana to help manage pain. The majority of patients reported consuming a combination of analgesic classes (more than 1 type of analgesic) to manage their pain (n = 23), known as multimodal analgesia. Only 2 female patients were consuming the same combination

**Table 2**  
Medications received post-operatively

| Medication  | Scheduled Dose  |
|---|---|
| IV Patient Controlled Analgesia (PCA) Hydromorphone                               | 0.1–0.3 mg every 5 min prn (patient administered) stopped on POD 2 or earlier   |
| Continuous Femoral Nerve Block (CFNB; a continuous infusion of 0.15% ropivacaine) | 5 ml - 8 ml/h; stopped on POD 2 at 0600.  |
| Hydromorphone Controlled Release po   | 3 mg or 6 mg po bid or tid  |
| Celecoxib po  | 200 mg po tid or bid  |
| Gabapentin po   | 100 mg or 200 mg po tid or bid  |
| Acetaminophen po  | 1000 mg qid   |
| Hydromorphone po  | 1–2 mg q 2hr prn after IV opioids stopped (dose adjusted based on patient need) |

**Table 3**  
Standard discharge analgesic prescription

|  |
|--|
| (1) Hydromorphone 1 mg–4 mg po q2-4hr when needed (120 tablets)                              |
| (2) oxycodone 5 mg with acetaminophen 325 mg 1–2 tablets po q4-6hr when needed (100 tablets) |
| (3) Celecoxib 100 mg–200 mg po tid or bid for 2 weeks  |
| (4) Acetaminophen 500 mg–1000 mg po q6h when needed for 2 weeks                              |

of pre-operative analgesics (an NSAID, acetaminophen and oxycodone combination product (Percocet®)). The commonly consumed pre-operative analgesics are reported in Table 4.

The mean pain intensity score for patients who reported chronic pain prior to surgery was 7.9. (range 5–10). While post-operatively, prior to discharge home, the mean pain intensity score decreased to 4 (range 0–8). The mean pain intensity scores prior to discharge from hospital were higher in men who had right TKR as compared to other chronic pain sufferers (Table 5).

**Discussion**

Prior to total knee replacement surgery many patients report experiencing pain. Following TKR early mobilization is required for successful joint function. However, pain can be a limiting factor to participating in rehabilitation activities. This retrospective chart review examined pain intensity scores before and after primary TKR for patients in our facility. We found a statistically significant difference in pain intensity from before surgery to after surgery. Patients who reported chronic pain prior to surgery also had a decrease in pain intensity scores after surgery. Although pain intensity was reduced post-operatively, over 29% of patients reported moderate to severe pain prior to discharge home. Our team feels that this is an opportunity to explore innovative ways that will further enhance the patient experience, in particular in the area of pain management.

From a clinical practice perspective, the results are useful for a number of reasons. First, it is unethical for patients to continue to suffer from pain and one of the main reasons why patients undergo TKR is to reduce the experience of daily pain. Second, the significant decrease in pain is a reflection of the importance of inter-professional collaboration in ensuring a patient-centred approach to pain management, including pre-operative education and post-operative care. The practice in our hospital mirrors what has been reported in the literature regarding the importance of pre-operative rehabilitation in preparing patients for surgery (Wang et al., 2015). During the pre-op visit, patients have the opportunity to speak with team members, not only to address their questions on pain management, but also their functional abilities. Part

**Table 4**  
Pre-op opioids used by patients diagnosed with chronic pain

| Analgesics class | Controlled Release Opioid (including fentanyl) or buprenorphine patch) | Immediate release opioid | Combination opioid (opioid with acetaminophen) | NSAID | Acetaminophen | Gabapentin/Pregabalin | Muscle relaxant | Anti-depressant |
|------------------|--|--------------------------|--|-------|---------------|-----------------------|-----------------|-----------------|
| Female (n = 16)  | 8  | 3                        | 8  | 6     | 2             | 3                     | 3               | 1               |
| Male (n = 8)     | 6  | 1                        | 2  | 2     | 2             | 2                     | 1               | 1               |

**Table 5**  
Pain intensity for patients with chronic pain by side of procedure

| Procedure | Sex             | Age range | Pre-op pain Mean (range) | Pain at discharge from hospital (POD3) |
|-----------|-----------------|-----------|--------------------------|--|
| Right TKR | Male (n = 5)    | 35–68     | 6.4 (5–10)               | 3.8 (0–7)                              |
|           | Female (n = 5)  | 53–81     | 6.6 (7–10)               | 3.4 (1–6)                              |
| Left TKR  | Male (n = 3)    | 56–66     | 9 (8–10)                 | 3.3 (2–8)                              |
|           | Female (n = 11) | 53–81     | 7.3 (6–10)               | 3.4 (1–8)                              |

of their pre-operative visit includes meeting team members from anesthesiology, rheumatology, and internal medicine when discussions take regarding drug reconciliation and/or pain management post-operatively. Patients also meet members of their rehabilitation team to learn the value of exercise, setting up their home prior to surgery, and making the necessary pre-operative arrangements with the community physiotherapist to further enhance their functioning after the surgery. Social workers are also vital team members most especially when psychosocial issues arise pre- and post-operatively. The role of the APS has also been instrumental in ensuring that patients' pain experiences are being addressed appropriately. After discharge, patients are also given hospital contact information should questions arise during their recovery phase.

Limitations of this study are related to the retrospective nature of the study design and the single-hospital setting. Chart review data is only as thorough as the information documented. We only identified 24 patients who reported chronic pain prior to surgery. This is a small number and it is unclear if this is a true reflection of this group of patients. We were also unable to determine how much pain patients had during their follow up visits as this was not consistently documented. It would be valuable to have a better understanding of how much pain patients had and how they are managing their pain at their 6 week or 3 months follow up visits. The data obtained in this study is from a Canadian multicultural urban setting, where English is a second language for many patients (Ramlall et al., 2014). It is unclear if pain reporting was influenced by language barriers.

**Conclusions and future research**

The aim of a TKR is to improve function and to reduce pain. This study provides some information regarding the pain experienced before and after TKR. It also provides information regarding the common discharge opioids that are prescribed following TKR. The primary aim of this retrospective chart review was to assess the change in pain intensity from prior to surgery to prior to discharge home following TKR among patients undergoing primary TKR. There was a significant change in pain intensity from prior to surgery compared to after surgery, with pain intensity being lower after TKR. We were also able to highlight the importance of an inter-professional collaboration to pain management which can further enhance a patient-centred care approach to patients undergoing joint replacement surgery. However, there is a need for more information about the intensity and quality of pain as well as which analgesics patients are consuming after discharge from hospital at 6 weeks and 3 months.

**Conflicts of interest**

No conflict.

**Financial disclosure**

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## Ethics statement

This study underwent review and received approval by the Health Science Research Ethics Board at Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijotn.2019.04.001>.

## References

- Abdallah, F.W., Madjdpour, C., Brull, R., 2016. Is sciatic nerve block advantageous when combined with femoral nerve block for postoperative analgesia following total knee arthroplasty? A meta-analysis. *Can. J. Anesth.* 63, 552–568.
- Buvanendran, A., Kroin, J.S., Della Vale, C.J., Kari, M., Moric, M., Tuman, K.J., 2010. Perioperative oral pregabalin reduces chronic pain after total knee arthroplasty: a prospective randomized trial. *Anesth. Analg.* 110, 199–207.
- Cameron, H.U., Wadey, V.M.R., Silverman, F., 2015. The post-operative painful knee—Clinical and societal causation. *Semin. Arthroplasty* 26 (4), 251–254.
- Choi, S., O'Hare, T., Gollish, J., Paul, J., Kreder, H., Thorpe, K.E., Katz, J.D., Mamdani, M., Moisiuk, P., McCartney, C.J., 2016. Optimizing pain and rehabilitation after knee arthroplasty: a two-center, randomized trial. *Anesth. Analg.* 123 (5), 1316–1324.
- Devin, C.J., Lee, D.S., Armaghani, S.J., Bible, J., Shau, D.N., Martin, P.R., Ehrenfeld, J.M., 2014. Approach to pain management in chronic opioid users undergoing orthopaedic surgery. *J. Am. Acad. Orthop. Surg.* 22 (10), 614–622.
- Drosos, G.I., Triantafilidou, T., Ververidis, A., Agelopoulos, C., Vogiatzaki, T., Kazakos, K., 2015. Persistent post-surgical pain and neuropathic pain after total knee replacement. *World J. Orthoped.* 6 (7), 528–536.
- LeResche, L., 2000. Epidemiologic perspectives on sex difference in pain. In: Fillingim, R.B. (Ed.), *Sex, Gender, and Pain*. IASP Press, pp. 233–250.
- Liu, S.S., Buvanendran, A., Rathmell, J.P., Sawhney, M., Bae, J.J., Moric, M., Perros, S., Pope, A.J., Poultides, L., Della Valle, C.J., Shin, N.S., McCartney, C.J.L., Ma, Y., Shah, M., Wood, M.J., Manion, S.C., Sculco, T.P., 2012. A cross-sectional survey on prevalence and risk factors for persistent postsurgical pain 1 Year after total hip and knee replacement. *Reg. Anesth. Pain Med.* 37 (4), 415–422.
- Morris, B.J., Mir, H.R., 2015. The opioid epidemic: impact on orthopedic surgery. *J. Am. Acad. Orthop. Surg.* 23 (5), 267–271.
- National Advisory Committee on Prescription Drug Misuse, 2013. *First Do No Harm: Responding to Canada's Prescribing Drug Crisis*. Canadian Centre on Substance Abuse, Ottawa Retrieved from: <http://www.ccsa.ca/Resource%20Library/Canada-Strategy-Prescription-Drug-Misuse-Report-en.pdf>.
- Ramlall, Y., Ramlall, S., Sawhney, M., 2014. Post-discharge pain experience following primary total hip or knee arthroplasty in patients whose primary language is not English. *Int. J. Orthop. Trauma Nurs.* 18 (2), 60–67.
- Ramlall, Y., Ramlall, S., Archibald, D., Robinson Pereira, S., Sawhney, M., 2010. Post-discharge pain management following elective primary total hip and total knee arthroplasty on patients discharged to home on pod 5 or earlier from an acute care facility. *Int. J. Orthop. Trauma Nurs.* 14 (4), 185–192.
- Sawhney, M., Mehdian, H., Kashin, B., Ip, G., Bent, M., Choy, J., McPherson, M., Bowry, R., 2016. Pain following unilateral total knee arthroplasty: A prospective randomized controlled trial examining the analgesic effectiveness of a combined adductor-canal peripheral nerve block with periarticular infiltration vs adductor-canal block alone vs periarticular infiltration alone. *Anesth. Analgesia* 122 (6), 2040–2046.
- Sibbald, B., 2017. Physicians combat opioid crisis. *Can. Med. Assoc. J.* 189 (1), E44–E45.
- Wang, L., Lee, M., Zhang, Z., Moodie, J., Cheng, D., Martin, J., 2015. Does preoperative rehabilitation for patients planning to undergo joint replacement surgery improve outcomes? A systematic review and meta-analysis of randomised controlled trials. In: *British Medical Journal Open*, . <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4746481/pdf/bmjopen-2015-009857.pdf>.
- Williams, D.P., O'Brien, S., Doran, E., Price, A.J., Beard, D.J., Murray, D.W., Beverland, D.E., 2013. Early postoperative predictors of satisfaction following total knee replacement. *Knee* 20 (6), 442–446.
- Wilson, R., Watt-Watson, J., Hodnett, E., Tranmer, J., 2016. A randomized controlled trial of an individualized preoperative education intervention for symptom management after total knee arthroplasty. *Orthop. Nurs.* 35 (1), 20–28.
- Wylde, V., Hewlett, S., Learmonth, I.D., Dieppe, P., 2011. Persistent pain after joint replacement: prevalence, sensory qualities, and postoperative determinants. *Pain* 152, 566–572.
- Zywiel, M.G., Stroh, A., Lee, S.Y., Bonutti, P.M., Mont, M., 2011. Chronic opioid use prior to total knee arthroplasty. *J. Bone Jt. Surg.* 93, 1988 Inc.