Perioperative Pain Management and Anesthesia

A Critical Component to Rapid Recovery Total Joint Arthroplasty

Matthew W. Russo, MD, Nancy L. Parks, MS*, William G. Hamilton, MD

KEYWORDS

• Pain management • Arthroplasty • Multimodal • Periarticular injection • Regional anesthesia

KEY POINTS

- Proactive, multimodal pain management in the setting of total joint arthroplasty allows for earlier mobilization and leads to enhanced rapid recovery and patient satisfaction.
- Minimizing opioid use is the hallmark of multimodal pain management, improving the targeting of all pain pathways while decreasing perioperative nausea and enhancing rapid participation with postoperative rehabilitation.
- Combined use of local periarticular anesthetic infiltration with avoidance of excessive soft tissue dissection and appropriate use of regional anesthesia improves patient satisfaction and pain control following total joint arthroplasty.
- Failure to control pain following total joint arthroplasty increases medical costs and risk of venous thromboembolism while prolonging overall recovery and length of stay.

INTRODUCTION

Adequate pain control is a prerequisite of rapid recovery total joint arthroplasty. Patient satisfaction is often linked to appropriate perioperative pain management. The involvement of the anesthesia team in the rapid recovery protocol is critical, with contributions to multimodal analgesia owed to enhanced regional anesthesia and neuraxial techniques. The arthroplasty surgeon and anesthesiologist should aim to capitalize on the most current techniques to achieve successful multimodal pain management.

MULTIMODAL PAIN MANAGEMENT

The philosophy of multimodal pain management in the setting of total joint replacement refers to the use of multiple types of medications delivered through many different routes with the goal of targeting all pain pathways simultaneously (Fig. 1). This strategy reduces the undesired side effects of narcotic medications including nausea, vomiting, sedation, ileus, respiratory depression, and pruritus. The result is improved patient satisfaction and earlier mobilization.

Disclosure Statement: Authors of this work participate in consulting for DePuy. The research institute where this work was compiled receives grant funding for research from Biomet and from Inova Healthcare System.
Research Department, Anderson Orthopaedic Research Institute, PO Box 7088, Alexandria, VA 22307, USA
* Corresponding author.
E-mail address: nparks@aori.org

Orthop Clin N Am 48 (2017) 401–405
http://dx.doi.org/10.1016/j.ocl.2017.06.006

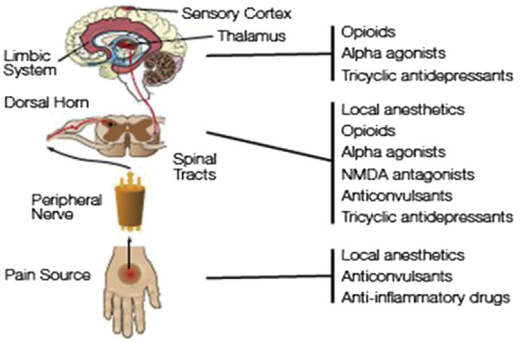

Fig. 1. Medications delivered through many different routes target multiple pain pathways. NMDA, *N*-methyl-D-aspartate. (©Pacira Pharmaceuticals, Inc. All Rights Reserved. Used Under License.)

PREEMPTIVE ANALGESIA

Preemptive analgesia is one of the hallmarks of multimodal pain management. By addressing pain before making the incision, the process of sensitization and production of inflammatory chemicals is prevented. With the absence of nerve fiber sensitization, the patient's pain threshold is effectively increased resulting in a decreased risk of chronic neuropathic pain and improved pain management.[1]

Treating pain before surgery allows the patient to stay ahead of the pain, which ultimately improves the efficacy of the other modes of treatment. Throughout the postoperative and rehabilitation phases, taking pain medication prophylactically keeps pain to a minimum and avoids peaks of discomfort that may interfere with recovery (Fig. 2).

MEDICATIONS

Preemptive analgesic medications are typically administered in the preoperative holding area 1 to 2 hours before the procedure but may also be initiated days before surgery. These medications typically include nonsteroidal anti-inflammatory medications (NSAIDs), cyclooxygenase (COX)-2 inhibitors, gabapentinoids, and acetaminophen (Table 1).

COX-2 inhibitors are particularly attractive for total joint replacement patients because of their reduced risk of gastric and platelet effects compared with other traditional NSAIDs. These medications have been shown to improve pain scores in total knee arthroplasty (TKA) patients with less opioid consumption and improved range of motion when analyzed in multiple randomized control trials.[2] However, in doses greater than 400 mg daily, COX-2 inhibitors increase the risk of cardiac events and should be used cautiously in patients with active cardiac disease.[3]

Glucocorticoids, specifically dexamethasone and methylprednisolone, are beneficial in the role of preemptive analgesia by decreasing the postoperative inflammatory response. These medications are often given at the time of surgery by the anesthesiologist and work together as an adjuvant treatment to prolong analgesia while reducing nausea and vomiting. Furthermore, they have been used safely without increasing wound complications with short-term use.[4]

One of the effects of preemptive analgesia is reducing narcotic consumption in the perioperative period. Although opioids still play a central

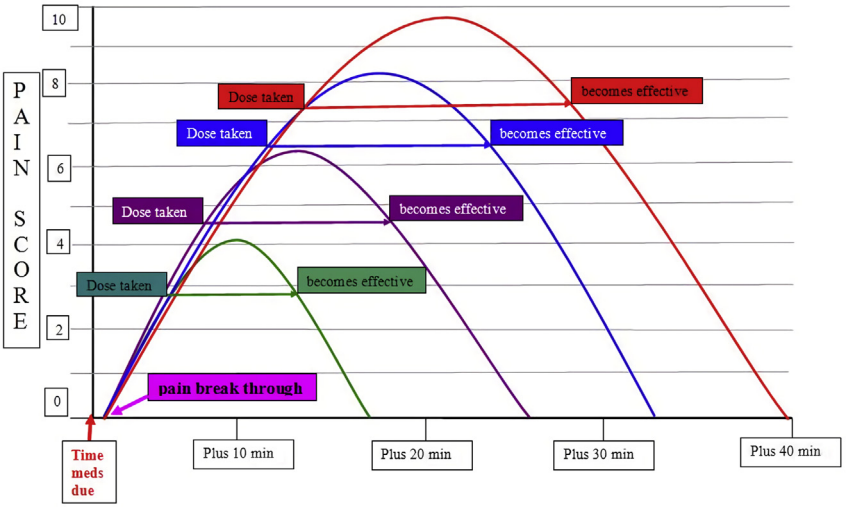

Fig. 2. To stay ahead of the pain curve, medication is best administered before high pain levels build up. (*Courtesy of* www.BoneSmart.org.)

Table 1
Nonopioid medications administered for preemptive analgesia

Medication	Dose, mg	Route	Preoperative, h	Postoperative
Ketorolac	15–30	Oral/intravenous	1–2	15–30 mg every 6 h
Celecoxib	400	Oral	1–2	200 mg daily
Gabapentin	300	Oral	1–2	300 mg × 1 after 24 h
Pregabalin	75	Oral	1–2	75 mg × 1 after 12 h
Acetaminophen	1000	Oral/intravenous	0–2	650 mg every 6 h

role in controlling postoperative pain, reducing them improves patient satisfaction and curtails complications related to nausea, vomiting, ileus, respiratory depression, and cognitive dysfunction, especially in the elderly patient.[5]

NEURAXIAL ANESTHESIA

One of the most important advances in rapid recovery protocol for joint replacement patients is the use of short-acting spinal/epidural anesthesia. In a study evaluating general versus neuraxial anesthesia in more than 500,000 patients undergoing TKA, general anesthesia patients had higher rates of pulmonary complications, pneumonia, infections, acute renal failure, 30-day mortality, and prolonged hospital length of stay.[6,7]

Using primarily anesthetic agents, such as lidocaine or bupivacaine, and limiting narcotic use in the spinal anesthesia has a dual benefit. It reduces opioid-related side effects, and a short-acting anesthetic allows the patient to participate in physical therapy shortly after their procedure. Lidocaine is ideal in the neuraxial anesthesia because of its much shorter duration than bupivacaine. Lidocaine typically works fast, with a short initial onset, and only lasts for 1 to 2 hours, whereas bupivacaine typically lasts 4 to 8 hours, depending on the dose. Concern about transient radiculitis, a rare side effect of lidocaine, has caused some anesthesiologists to eschew lidocaine in favor of bupivacaine.

REGIONAL ANESTHESIA

Regional nerve blocks are another component to a successful multimodal program (Table 2).[8] The two most common regional blocks used in TKA are the femoral nerve block and the more distal adductor canal block. The femoral nerve block can result in quadriceps weakness causing falls and prolonged time to ambulation because of its mixed motor and sensory involvement.[9] The adductor canal block primarily targets sensory nerve fibers. The adductor canal block results in a sensory blockade of the anteromedial knee from the superior patella to the medial leg with minimal decrease in quadriceps strength.[10]

LOCAL INFILTRATION ANALGESIA

Although regional nerve blocks are effective for decreasing pain following TKA, they do not address many of the pain generators within the joint itself. The introduction of an anesthetic "cocktail" injection has improved pain management following total joint surgery by infusing a combination of medications directly into the soft tissues surrounding the joint space, including the posterior capsule, synovium, and periosteum. Our injection technique begins

Table 2
Anesthetic medications used for regional nerve blocks

Regional Nerve Block Medication	Lidocaine	Mepivacaine	Bupivacaine	Ropivacaine
Maximum dose, mg/kg	4.5	4.5	3	3
Dose with epinephrine, mg/kg	7	7.5	3	3
Strength, %	1–2	1.5–2	0.125–0.75	0.25–0.75
Volume, mL	10–30	10–40	10–40	15–30
Anesthesia duration, h	2–5	2–5	5–15	4–10
Duration of analgesic effect	Up to 8 h	Up to 8 h	Up to 30 h	Up to 24 h

posterior to the joint and proceeds anterior. Starting with the posterior capsule, we infuse 10 mL being careful to aspirate before injecting to ensure no vascular structure is injected. Next, 20 mL is injected into the periosteum of the femur and tibia, followed by 20 mL into the anterior femoral fat pad/synovium and extensor mechanism. The final 10 mL is infused in the subcutaneous tissues.

The role of local infiltration analgesia has continued to evolve since 2006 when the first randomized controlled trial was performed demonstrating its effectiveness.[11] Since that time, multiple studies have confirmed the efficacy of injecting a combination of a long-acting anesthetic, NSAID, steroid, and epinephrine into the soft tissues surrounding the hip or knee. Recently, multiple randomized controlled trials have been performed demonstrating similar pain scores but improved quad strength with local infiltration analgesia compared with femoral nerve block in TKA patients.[12,13] There are a wide variety of ingredients and concentrations used, with the key ingredient of an NSAID, such as ketorolac, in the injection.[14] There is not sufficient evidence in the literature to endorse liposomal bupivacaine in the setting of total hip and knee replacement as superior to its cheaper alternatives when multimodal analgesia is performed.[15] We have found no difference in our patient population and do not currently use it at our institution. The author's preferred mixture includes

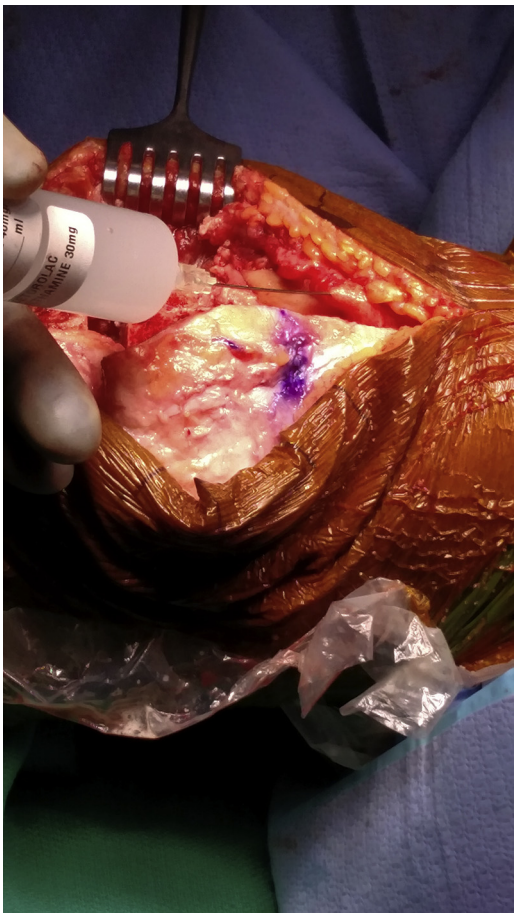

Fig. 3. Local infiltration analgesia in a total knee patient infuses a combination of medications directly into the soft tissues surrounding the joint space. Local infiltration analgesia injection of the vastus medialis oblique muscle. Just below that the synovial sleeve and femur periosteum have been injected.

Box 1
Timeline of standard multimodal pain management

1. Preoperative medications
   - Tylenol, 1 g
   - Oxycontin, 10 mg
   - Celebrex, 400 mg
   - Lyrica, 75 mg
   - Scopolamine patch
2. Anesthesia: single-shot spinal
   - 2% Lidocaine, 75 mg
   - Sufentanil, 7 μg
3. Intraoperative anesthesia
   - Propofol sedation
   - Zofran, 4 mg
   - Dexamethasone, 4 mg
4. TKA regional block
   - Adductor canal block: 0.5% ropivacaine, 25 mL
5. Local infiltration analgesia (60-mL syringe mixed with normal saline)
   - 0.5% ropivacaine, 30 mL
   - Morphine, 10 mg
   - Ketorolac, 30 mg
   - Depomedrol, 40 mg
   - Epinephrine, 0.5 mg
6. Postoperative medication
   - Ketorolac, 30 mg once
   - [a]Tylenol, 650 mg q 4
   - Ultram, 50 mg q 6
   - Norco, 5/325 q 4 PRN
   - Celebrex, 200 mg

[a] No more than 3 g of acetaminophen in 24 hours.

0.5% ropivacaine, 30 mL; morphine, 10 mg; ketorolac, 30 mg; depomedrol, 40 mg; and epinephrine, 0.5 mg mixed in a 60-mL syringe with normal saline (Fig. 3).

Box 1 shows a standard protocol for a patient younger than 65 years old with no allergies, in overall good health, and with no comorbidities or renal disease.

SUMMARY

Adherence to a multimodal pain management protocol minimizes the undesired effects of opioid medications and allows for rapid recovery following joint replacement. Inadequate pain control following total joint replacement has the potential to create complications, readmissions, and unnecessary procedures with costly diagnostic tests and imaging.[16] A patient who is in significant pain is less likely to be satisfied with decreased mobilization and higher risk for venous thromboembolism and pulmonary complications.

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