Postoperative Pain Management

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Abstract

Although the long-term results following traditional total joint arthroplasty are excellent, postoperative pain management has been suboptimal. Undertreatment of pain is a focus of growing concern to the orthopedic community. Poorly controlled postoperative pain leads to undesirable outcomes, including immobility, stiffness, myocardial ischemia, atelectasis, pneumonia, deep venous thrombosis, anxiety, depression, and chronic pain. Over the past decade, the attempt to minimize postoperative complications, combined with the move toward minimally invasive surgery and early postoperative mobilization, has made pain management a critical aspect of joint replacement surgery. Effective protocols are currently available; all include a multimodal approach. Debate continues regarding the ideal approach; however, reliance on narcotic analgesia alone is suboptimal.

Traditionally, postoperative analgesia following total joint arthroplasty has focused on patient-controlled analgesia (PCA) or epidural analgesia and parenteral narcotics. These modalities frequently resulted in poorly controlled pain and reduced patient satisfaction.1,2 Poorly controlled pain results in medical complications and has detrimental psychological effects.3,4 In addition, the use of PCA with high doses of opioid results in sedation, constipation, confusion, urinary retention, nausea, vomiting, and pruritus. Although epidural infusions may provide superior analgesia, they are associated with hypotension, urinary retention, motor blockade that limits mobilization, and the potential for spinal hematoma secondary to anticoagulation.5

Multimodal analgesia focuses on improving postoperative pain management while minimizing side effects, most of which are opioid-related. By combining pharmacologic and nonpharmacologic modalities, multiple pain mechanisms can be addressed while reducing adverse effects through the use of lower doses of individual modalities. Multimodal therapy can shorten hospital stay, reduce opioid adverse effects, and improve patient outcomes.6,7

Nonopioid Medications in the Perioperative Period

Several medications are available to reduce perioperative narcotic analgesia. Nonsteroidal anti-inflammatory drugs (NSAIDs), including cyclo-oxygenase-2 (COX-2) inhibitors, are a component of most multimodal protocols.

Although theoretical concern regarding delayed or impaired bone osteointegration with the use of NSAIDs during uncemented total joint arthroplasty still remains for some surgeons, several studies have demonstrated that NSAIDs do not appear to affect ingrowth. In a randomized trial of 142 patients who underwent total hip arthroplasty (THA), Persson et al8 demonstrated no significant difference in aseptic loosening or overall rate of revision after 10 years of follow-up for patients who received ibuprofen for up to 14 days postoperatively compared to patients who did not receive ibuprofen.

Similar results have been observed with COX-2 inhibitors. Lionberger and Noble9 reported on a randomized, double-blind, controlled prospective trial of 49 patients who underwent THA. In this series, 6 weeks of postoperative celecoxib did not...
affect osteointegration or periprosthetic bone mineral density. In another study, Wurnig et al\(^4\) prospectively followed 162
patients after THA for a minimum of 6 years. In this series, the perioperative administration of indomethacin for hetero-
topic ossification prophylaxis did not influence osteointegration, the development of osteolysis, or prosthetic loosening.

At the same time, NSAIDs have proved effective in perioperative pain control. In a randomized, controlled trial of 70 patients
who underwent total knee arthroplasty (TKA),\(^11\) addition of a COX-2 inhibitor compared to placebo significantly reduced perioperative opioid requirements, median visual analog scale pain score (2.2 versus 3.5 on a visual analog scale), and postoperative vomiting (6% versus 26%), while improving patient satisfaction and knee range of motion at discharge (84° versus 73°). Similarly, a review of COX-
2 inhibitors versus placebo in 80 patients who underwent TKA found a significant reduction in visual analog scale pain score
(2.1 versus 3.4), a 40% reduction in opioid use, and improved range of motion (77.7° versus 64.3°).\(^12\)

Ketorolac is effective in relieving postoperative pain following orthopedic surgery and is used in many multimodal protocols. In a comparison of 4 doses of ketorolac to placebo in 59 patients undergoing TKA,\(^13\) ketorolac resulted in a 27% decrease in morphine consumption, without affecting overall blood loss or transfusion rate. However, a 6% increase in blood loss was seen on postoperative day 1, and the authors warned against the use of high doses (120 mg daily) concomitantly with routine anticoagulation.

In another study comparing ketorolac versus placebo in 174 patients who underwent total joint arthroplasty,\(^14\) ketorolac patients reported better analgesia, less sedation, required less antiemetic medication, and received less morphine (35% for hips and 44% for knees). Blood loss was similar with ketorolac and placebo. Finally, a meta-
analysis of randomized controlled trials comparing ketorolac to placebo\(^15\) found ketorolac reduced morphine consumption by 36%.

Concerns remain regarding the use of ketorolac concomitantly with low-molecular-weight heparins for deep venous thrombosis prophylaxis. However, in a study of 60 patients who underwent THA, there was no difference in blood loss, wound drainage, transfusion, or ecchymosis with the use of enoxaparin and ketorolac versus enoxaparin and opioid analgesia.\(^16\) Confirmation of these results is necessary; thus, lower doses of ketoro-
lac over a short duration remain advisable due to risk of bleeding, hypertension, and renal insufficiency. Additional concern
should exist for high-risk patients, including elderly patients.

Gabapentin is a nonopioid medication being examined in multimodal pain protocols. A small series that compared perioperative gabapentin versus placebo in 36 TKA patients\(^17\) found patients who received gabapentin required significantly less PCA morphine, had better active-assisted knee flexion, and reported less pruritus compared with patients who received placebo. However, gabapentin was ineffective when added to a multimodal pain regimen for THA.\(^18\) In this double-blind, randomized, controlled study of 126 THA patients, a single dose of gabapentin did not reduce morphine consumption, pain scores, or chronic pain.\(^18\) More research on gabapentin dosing and efficacy is neces-
sary before it can be recommended routinely.

**Newer Opioid Medications for Perioperative Pain Control**

Although some recent protocols avoid opioid medications, most surgeons continue to use opioids with the emphasis on minimizing side effects. Sustained-release formulations have demonstrated benefit when used as preemptive anesthesia and have been shown to reduce postoperative pain. A review of the use of oxycodone in 59 patients after TKA\(^19\) found oxycodone increased overall opioid consumption but resulted in significantly less pain, improved range of motion and quadriceps strength, and substantially earlier discharge.

Newer formulations of oral opioids are available that may reduce side effects while offering similar efficacy. Tapentadol is a novel, centrally acting analgesic with 2 mechanisms of action: mu-opioid receptor agonism and norepinephrine reuptake inhibition.\(^20\) A study that compared tapentadol with oxycodone in 901 bunionectomy patients\(^21\) found tapentadol (50 mg) demonstrated similar ef-
cacy to oxycodone (10 mg), while significantly reducing the incidence of nausea and vomiting from 59% to 35% (Figure).

Another phase III trial compared tapentadol with oxycodone in 666 patients with end-stage osteoarthritis of the hip or knee.\(^22\) Tapentadol immediate release (50 and 75 mg) provided efficacy comparable to oxycodone immediate-release (10 mg). The odds ratios for nausea and vomiting for tapentadol compared with oxycodone were 0.21 and 0.32, respectively, and the odds ratios for constipation were 0.13 and 0.20, respectively. Although additional studies are needed, tapentadol may be an alternative to oxycodone, providing similar efficacy with reduced side effects.

Oral extended release oxymorphone is another alternative opioid now available. Extended release oxymorphone has been studied for use in both opioid-experienced and opioid-naive patients with chronic low back pain.\(^23,24\) In both of these series, extended release oxymorphone proved efficacious and was generally well tolerated. The most common adverse events included constipation (6%), nausea (3%), and somnolence (3%). More studies are need regarding the use of extended release oxymorphone for perioperative pain control.

**Improving Pain Control With Peripheral Anesthesia**

Regional anesthesia in orthopedic surgery is well established. The combi-
nation of peripheral nerve blockade and multimodal pain protocols is effective in reducing postoperative pain, expediting recovery, and improving early functional rehabilitation.

A comprehensive approach that emphasizes peripheral nerve blockade has been developed by the Mayo Clinic. Hebl et al\(^{23}\) compared 40 total joint arthroplasty patients treated with their total joint regional anesthesia clinical pathway to historical controls. The pathway included preemptive anesthesia with oxycodone and a COX-2 inhibitor, followed by peripheral nerve blockade (lumbar plexus continuous nerve catheter and a single shot sciatic nerve block), and a multimodal postoperative regimen including ketorolac, oxycodone, and acetaminophen.

Compared with historical controls, patients demonstrated a significant reduction in pain scores, opioid requirement, and length of stay, despite earlier mobilization. In the control group, only 3% of patients were able to sit in a chair on the night of surgery compared to 83% of patients in the study group. Earlier mobilization and improved pain control allowed 88% of patients in the study group to be discharged on postoperative day 2 compared to 18% of the controls. Average length of stay was reduced from 5 days in the control group to 2.8 days in the study group. In addition, the mean maximum pain scores were reduced substantially on the first 3 postoperative days.

**INTRAOPERATIVE PERIARTICULAR INJECTION**

Some centers focus on peripheral nerve blockade; others focus their multimodal pathway around periarticular injection. One recent protocol focuses on multimodal pain management, patient education, and periarticular injection.\(^{26}\) Preemptive analgesia includes a COX-2 inhibitor, acetaminophen, tramadol, and oxycodone. Intraoperative periarticular injection includes bupivacaine, morphine, epinephrine, cefuroxime, and methylprednisolone. Postoperative pain is managed with ketorolac, a COX-2 inhibitor, oxycodone, and acetaminophen.

This protocol has been successful in reducing pain, narcotic requirements, and side effects, while improving functional recovery.\(^{27}\) In a randomized, prospective trial in 131 patients, THA patients demonstrated significant reduction in pain, while both TKA and THA patients reported better satisfaction with pain control, reduced time to straight leg raise, and reduced length of stay (3.2 versus 4.2 days for THA patients) compared with control patients.

Some surgeons remain concerned regarding the use of periarticular injections. The most controversial agent remains the addition of a steroid because of the concern for an increased risk of infection. A recent study attempted to address this issue. Christensen et al\(^{28}\) performed a double-blind, randomized trial of 76 patients undergoing TKA. Thirty-seven patients received a periarticular injection without steroid and 39 patients received a periarticular injection with steroid. No significant difference with regard to pain, motion, or function was seen between the groups. However, in the steroid group, 3 complications occurred. Two patients required manipulation under anesthesia for stiffness, and 1 patient developed perioperative infection, which led to numerous complications and ultimately death. Although more studies concerning the perioperative use of steroid are needed, the theoretical risks currently outweigh the perceived benefit.

**COMBINING MODALITIES TO MAXIMIZE PAIN CONTROL**

The approach at the author’s institution has been to implement a multimodal pain protocol including both peripheral nerve blockade and periarticular injection. Following TKA, continuous femoral nerve blockade is supplemented with intraoperative periarticular injection. The intraoperative injection focuses on the posterior capsule and posterior knee pain, which is not covered by the femoral nerve blockade. Narcotic requirements are minimized with preemptive analgesia and postoperative COX-2 inhibitors, ketorolac, and acetaminophen. In their study of 70 TKA patients, Dorr et al\(^{29}\) combined peripheral nerve blockade or epidural infusion with periarticular injection and were able to avoid parenteral narcotics in 96% of patients; on a scale of 0 to 10, the average daily pain score was <4. Nausea
was reported in 21% of patients, but emesis occurred in only 1 patient (1.4%).

CONCLUSION
The focus on performing less invasive surgery, recovering early function, and improving postoperative pain has led to an eruption of pain protocols in the recent literature. Debate remains on the best approach to pain management; however, traditional pain management, which relies on high-dose parenteral narcotics, results in poorly controlled pain and a high rate of side effects. Many modalities, including nonnarcotic analgesics, improved narcotics, peripheral nerve blockade, and periarticular injections, are currently available. Although available resources and supporting departments may limit the use of peripheral blocks, all institutions can incorporate a multimodal pain protocol to reduce narcotic requirements, improve pain control, and minimize side effects.

REFERENCES