Pain Management After Total Knee Arthroplasty Using a Multimodal Approach

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abstract

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Improvements in pain management techniques over the past decade have had a significant impact on the outcomes of total knee arthroplasty. Of these techniques, multimodal approaches have shown potential. The purpose of this study was to compare the results of periarticular injection (PAI) to a combination of patient-controlled epidural analgesia and femoral nerve block (PCEA/FNB). Ninety patients undergoing primary unilateral total knee arthroplasty between June 2010 and March 2011 were randomized into 2 groups. The first group received the PCEA/FNB protocol, whereas the second group received the PAI. Mean patient age was 66.1 ± 8.7 years. All patients were operated on using a similar standard medial parapatellar approach, and all received preemptive analgesia and postoperative pain protocols. All patients were interviewed twice daily for the first 3 days postoperatively, once on day 7, and once in month 6. The 2 groups had similar readiness for discharge (PCEA/FNB group, 3.3 ± 1.2 days; PAI group, 3.2 ± 1.9 days). The results indicated no statistical difference between the 2 groups in 3 of 4 categories (rest in the morning, rest in the evening, and ambulation in the morning). Pain on ambulation was the only category that was statistically lower in the PCEA/FNB group than in the PAI group.

Although the study demonstrates similar results between the 2 groups, PAI can play a major role in postoperative pain control in institutions that may not have appropriately trained individuals, equipment, and resources for PCEA/FNB. It also reduces many of the side effects and complications associated with regional anesthesia.

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The Bone and Joint Decade (2001-2010) has been characterized by innovations in total knee arthroplasty (TKA), including minimally invasive techniques, computer-assisted procedures, advanced rehabilitation protocols, and improved perioperative pain management. However, more than half of all patients undergoing surgical procedures worldwide may receive suboptimal pain control and experience severe pain in the early postoperative period. The International Association for the Study of Pain (IASP) defines pain as “an unpleasant sensory or emotional experience associated with actual or potential tissue damage, or described in terms of such damage.” The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has made adequate pain management a priority and has deemed monitoring pain as the “fifth vital sign.” Severe postoperative pain may lead to prolonged hospital stays, increased hospital readmissions, increased use of opioids, and overall lower patient satisfaction.

Multimodal pain management is defined as the use of multiple agents that act at different sites on the pain pathway. Over the past 10 years, our multimodal pain management protocol after TKA has undergone several changes using various agents to reduce postoperative pain, including the adoption of preemptive analgesia, the use of local periarticular injections, and the introduction of a comprehensive postoperative pain protocol.

The purpose of this study was to compare the results of periarticular injection (PAI) to a combination of patient-controlled epidural analgesia and femoral nerve block (PCEA/FNB) in a prospective, randomized control trial.

**Materials and Methods**

After receiving Institutional Review Board approval, 90 patients (90 knees) undergoing primary unilateral TKA between June 2010 and March 2011 were included in the study. The study group comprised 32 men and 58 women with a mean age of 66.1±8.7 years (range, 18-85 years). Patients were randomized into 1 of 2 groups: the first group received the PCEA/FNB protocol that did not include PAI, and the second group received the PAI only. All patients were interviewed twice daily for the first 3 days postoperatively, once on day 7, and once in month 6. Readiness for discharge criteria including adequate pain control without significant side effects, stable vital signs, tolerable solid diet, ability to urinate, and achievement of physical therapy criteria were recorded. A validated postoperative visual analog pain scale was used to assess the level of pain.

The 2 groups were demographically similar for sex, age, body mass index, and race (Table 1). Patients with bilateral TKAs, previous revisions, or deformities >15° of varus, valgus, or flexion contracture were excluded. Surgical technique included a standard medial parapatellar approach. All patients received similar preemptive analgesia and postoperative pain protocols. All descriptive statistics (mean, SD, and mean standard error) and calculations were performed with SPSS version 16.0 software (SPSS, Inc, Chicago, Illinois). Two-tailed P values <.05 were considered statistically significant.

A preemptive analgesic regimen of oxycodone, celecoxib, gabapentin, tramadol, and clonidine was administered to each patient within 1 hour postoperatively (Table 2). The next step in the current protocol involved 2 intraoperative injections. The first injection (deep injection) was administered prior to cementation. The cocktail included a combination of marcaine, morphine sulphate, adrenaline, antibiotic, corticosteroids (in selected patients), and normal saline (Table 3). Modifications could be made to adjust for various allergies and comorbidities. Corticosteroids are potent, local anti-inflammatory agents that reduce the local stress responses to surgical trauma and can be omitted for patients in whom their use is controversial or contraindicated (eg, patients with diabetes mellitus, immu-
nocompromised patients, or patients older than 80 years). This cocktail was injected in 3 areas: the posterior capsule, posteromedial structures, and the periarticular synovium (Figure 1).

The second injection (superficial injection) was then administered after cementation and prior to closure. This cocktail included marcaine, epinephrine, and normal saline (Table 4). The superficial injection was administered in the following areas: the extensor mechanism, pes anserinus, anteromedial capsule, periosteum, iliotibial band, and subcutaneous plane (Figure 2). The posterolateral corner was not injected to prevent inadvertent blockade of the peroneal nerve.

The protocol for FNB included a bolus of 30 cc of bupivacaine 0.375% with epinephrine 1:200,000. The PCEA consisted of bupivacaine 0.1% with fentanyl 2 µg/mL. The postoperative protocol included celecoxib, tramadol, oxycodone, oxycodone controlled release, acetaminophen, intravenous ketorolac, and dexamethasone. Dilaudid could be added for breakthrough pain (Table 5). Patients received 1000 IU of low-molecular-weight heparin for deep vein thrombosis prophylaxis during femoral preparation. Those considered at risk for thromboembolic complications, such as severely obese or less mobile patients, were administered warfarin (with a target international normalized ratio of 1.5-2). Otherwise, aspirin was used for routine deep vein thrombosis prophylaxis. All patients also received bilateral pneumatic compression devices in the immediate postoperative period.

RESULTS
At 6-month follow-up, no infections, fractures, or reoperations occurred. No statistical difference (P>.05) existed for readiness for discharge between the 2 groups (PCEA/FNB group, 3.3±1.2 days; PAI group, 3.2±1.9 days). Pain numeric rating scales were statistically lower in the PCEA/FNB group on postoperative day 1 for pain with ambulation in the evening (P<.05).

However, for every other category (rest in the morning, rest in the evening, and ambulation in the morning) on postoperative day 1, and every category on postoperative days 2 and 3, both groups were statistically similar (P>.05) (Table 6).

DISCUSSION
The concept of preemptive analgesia has been studied extensively in the past decade. It is defined as an analgesic intervention administered prior to the onset of noxious stimuli. Preemptive analgesia is intended to limit sensitization of the nervous system with the goal of reducing subsequent pain. The magnitude and time for these types of interventions are critical because they must produce a dense blockade to prevent transmission of noxious signals to the spinal cord and brain.12

A common option for perioperative pain control is regional anesthesia (ie, epidural catheters). The authors’ initial experience with 24-hour epidural catheter infusions was negatively influenced by several patients who experienced rebound pain after catheter removal. As a result, the duration of the epidural catheter infusions was extended to 48 hours. Later, a combination of epidural infusion and FNB with or without intravenous PCEA was used. However, these techniques led to several side effects,

Table 4
Dosages for Superficial Intraoperative Injection

<table>
<thead>
<tr>
<th>Agent</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marcaine 0.5%</td>
<td>200-400 mg</td>
</tr>
<tr>
<td>(5 mg/cc)</td>
<td></td>
</tr>
<tr>
<td>Normal saline</td>
<td>22 cc</td>
</tr>
</tbody>
</table>

Table 5
Dosages for Postoperative Pain Control Protocol

<table>
<thead>
<tr>
<th>Agent</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celecoxib</td>
<td>200 mg/d</td>
</tr>
<tr>
<td>Tramadol</td>
<td>50 mg every 6 h</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>5 mg every 6 h as needed</td>
</tr>
<tr>
<td>Oxycodone CR</td>
<td>10 mg/d</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>650 mg every 6 h</td>
</tr>
<tr>
<td>Ketorolac IV</td>
<td>15° or 30° mg every 6 h</td>
</tr>
<tr>
<td>Dexamethasone</td>
<td>10 mg (post-anesthesia care unit and postoperative day 1)</td>
</tr>
<tr>
<td>Dilaudid</td>
<td>As needed for breakthrough pain</td>
</tr>
</tbody>
</table>

Abbreviations: CR, controlled release; IV, intravenous.
*For mild pain and patients older than 65 years.
*For moderate pain and patients younger than 65 years.
including respiratory depression, nausea, vomiting, ileus, urinary retention, pruritus, hypotension, bradycardia, cognitive changes, and quadriceps weakness. As a result, a perioperative multimodal approach was designed to limit narcotic usage.

Periarticular drug injections have shown promise. In a randomized clinical trial, Busch et al. demonstrated that a periarticular intraoperative injection containing ropivacaine, ketorolac, epinephrine, and epinephrine decreased visual analog scores for pain and increased scores for patient satisfaction after TKA. Furthermore, their technique reduced the use of PCEA postoperatively. Our practice has evolved into using a multimodal protocol that uses preemptive analgesia, local periarticular injections, and a postoperative pain protocol to minimize the use of parenteral narcotics.

The results of the current study indicate that a role may exist for local PAI in the management of postoperative pain after TKA. These results are significant for institutions that may not have appropriately trained individuals who can administer a catheter for PCEA and/or FNB, or those without the appropriate equipment and resources. In addition, the use of PAI avoids many of the complications associated with epidural analgesia and FNB. The risk of peripheral neuropathy after FNB has been estimated to be approximately 3 in 10,000. Furthermore, the number of postoperative falls leading to reoperations is greater in patients who had FNB as opposed to those who did not. Epidural analgesia has been associated with side effects, such as spinal headache, neurogenic bladder, hypotension, respiratory depression, pulmonary hypertension, cardiac decompensation, and a risk of spinal infection. When epidural analgesia is used in combination with anticoagulation, epidural or subarachnoid bleeding can become a major issue. More importantly, in cases where bleeding occurs, symptoms can be masked by the anesthesia, leading to clinical reports, such as vague back pain, that can easily be overlooked.

**Conclusion**

Although more research is warranted, the results of this study show that local PAI can play a major role in the management of postoperative pain after TKA.

**REFERENCES**

11. Ranawat AS, Ranawat CS. Pain management and accelerated rehabilitation for total hip...


