Postoperative Analgesia in TKA

Ropivacaine Continuous Intraarticular Infusion

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Published online: 5 January 2010
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Abstract

Background Postoperative pain control is a challenge in patients undergoing TKA due to side effects and technical limitations of current analgesic approaches. Local anesthetic infiltration through continuous infusion pumps has been shown to reduce postoperative pain in previous studies.

Questions/purposes We assessed the effectiveness of intraarticular ropivacaine infusions in reducing pain and postoperative opioid use after TKA and determined whether such infusions accelerate functional recovery of the patient and reduce length of hospital stay.

Methods In a randomized, prospective, double-blind study, two groups were assigned: Group A (n = 25) underwent continuous intraarticular infusion with 300 mL ropivacaine 0.2% at a speed of 5 mL/hour through an elastomeric infusion pump and Group B (n = 25) had an elastomeric pump insertion with 300 mL saline solution at an infusion speed of 5 mL/hour. All patients had the same prosthesis model implanted. Parameters analyzed over the first 3 days, at discharge, and 1 month later included

postoperative pain, joint function, opioid use, and length of hospital stay.

Results All patients in Group A showed a decrease in pain intensity measured by a visual analog scale and opioid use in the first 3 days. Mean length of hospital stay was also reduced in Group A (5.72 days) compared to Group B (7.32 days). There were no device-related complications.

Conclusions Use of an infusion pump is effective in treating pain after TKA, reducing postoperative pain and opioid use. It also improves immediate functionality and patient comfort, reducing the mean length of hospital stay, without increasing the risk of complications.

Level of Evidence Level I, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

TKA continues to be the most effective treatment for relieving pain and restoring joint function in patients with substantial joint impairment. Long-term results and reports are excellent. However, postoperative pain control after a TKA remains one of the greatest unmet challenges. It has a large impact upon patients and causes a state of discomfort that may directly influence their functional recovery. It can lead to high morbidity with repercussions affecting vital cardiorespiratory, cognitive, immune, digestive, and hemostatic functions. The pain involved has specific characteristics: a 55% to 60% incidence at rest and up to 70% upon mobilization; high or very high intensity; and pain peaking at 3 to 6 hours after surgery and continuing for the following 72 hours [2, 3, 6].

Currently, the primary goals of postoperative analgesia are to provide comfort to the patient with as few side

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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effects as possible, to facilitate the patient's early functional recovery, and to decrease length of hospital stay and convalescence. Multiple treatments and techniques have been designed in an attempt to achieve these goals. Recently, the most popular method has been the "preventive multimodal approach" to postoperative pain [13, 16, 20]. This strategy combines different techniques and medications to achieve maximum efficacy in pain control and reduce the side effects of each treatment. There are multiple analgesic modalities for controlling postoperative pain: intravenous opioids, patient-controlled analgesia, regional catheters, and adjuvant therapies (cryotherapy, minor analgesics, and NSAIDs). However, these analgesic approaches can have side effects and technical requirements that may limit their use.

Anesthetic techniques such as epidural analgesia or peripheral nerve blockade may reach effective analgesic levels that are higher than those for other techniques. However, they are not free of complications and limitations. They can be technically demanding and produce a motor blockade, making the initiation of rehabilitation more difficult [5].

As a result, other analgesic systems have been developed, such as intraarticular infiltration and wound infiltration with local anesthetics and analgesics, as well as local anesthetic infiltration through continuous infusion pumps. Recent studies of this technique have obtained promising results, showing a series of advantages for this technique compared with regional techniques or the use of intravenous opioids [4, 7, 14, 19, 22]. Local anesthetic use can produce analgesic effects through several mechanisms: afferent nociceptor blockade to prevent the transmission of painful nerve impulses, inhibition of inflammatory mediator release, and reduction of free radical and edema formation [11, 12].

Encouraged by the positive results of these studies, we undertook a study to analyze the possible benefits of continuous intraarticular infusion of ropivacaine in patients undergoing TKA. Our aims were (1) to analyze the efficacy of ropivacaine intraarticular infusion in decreasing the

patients' perception of pain and in reducing postoperative opioid use and (2) to determine whether ropivacaine intraarticular infusion accelerates the recovery of postoperative ROM. Our third research aim was to determine whether the ropivacaine infusion safely led to reduced length of hospital stay.

Patients and Methods

A prospective, randomized, double-blind study was conducted and included 50 patients (31 women, 19 men), with a mean age of 71.3 years (range, 55–84 years), undergoing TKA. Patients were informed about the study and gave their written consent to participate in the study.

Patients were recruited from our institution from October 2007 to February 2008. Inclusion criteria were met if patients had been diagnosed with primary knee arthrosis. Exclusion criteria were presence of a mental or neurologic illness that could interfere with the patient's postoperative assessment, diagnoses other than primary arthrosis, and allergy or any other contraindication to the use of local anesthetics.

All patients had undergone implantation with the cemented Nex-Gen[®] LPS with a patellar component (Zimmer, Inc, Warsaw, IN). The surgeries were performed by the two authors, and spinal anesthesia was used.

The patients were randomized immediately before the operation into two treatment groups (using sequentially numbered, opaque, sealed envelopes). Group A included 25 patients who underwent continuous intraarticular infusion with 300 mL ropivacaine 0.2% at a speed of 5 mL/hour through an elastomeric infusion pump, the OnQ Pain-Buster[®] (I-Flow Corp, Lake Forest, CA) (Fig. 1). Group B included 25 patients who had an elastomeric pump inserted filled with 300 mL saline solution at an infusion speed of 5 mL/hour.

Once the implant was in place, the ischemic tourniquet was removed with careful hemostasis. Subsequently, the

Fig. 1A–B Photographs show the continuous infusion system used in the study: (A) the intra-articular catheter and the trochar used in its insertion and (B) the elastomeric pump filled with ropivacaine.

Fig. 2A–B (A) Definitive placement of the intraarticular catheter in the upper knee area to facilitate the filling of the whole articular cavity is shown. (B) The ropivacaine infusion catheter with drain is shown.

intraarticular catheter of the infusion pump was inserted and a standard blood drainage device was put in place. Immediately after suturing the wound and applying the leg bandage, the drain suction was activated for 15 minutes then turned off allowing further passive blood drainage for 24 hours. The elastomeric continuous infusion pump was activated after the 15 minutes of active drainage at 5 mL/hour (Fig. 2). The drain was removed 24 hours after surgery. The infusion pump was removed when it was completely empty, 60 hours after being connected.

Patients remained in the recovery room during the first 24 hours and received analgesic treatment with oral paracetamol 1 g every 6 hours, intravenous ketorolac 10 mg every 8 hours, and rescue morphine intravenously or pethidine subcutaneously. Prophylactic antibiotic treatment with intravenous cefazolin 1 g every 8 hours until drain removal and thromboembolic prophylaxis with subcutaneous enoxaparin 40 mg for 4 weeks were given.

Four main end points were analyzed. (1) Postoperative pain was measured using a visual analog scale (VAS) the first 3 days, at discharge, and 1 month after surgery. Pain was considered controlled when VAS was less than 3, while 3 to 4 indicated mild pain, 4 to 7 moderate pain, and greater than 7 severe pain. The VAS reading was obtained by a member of the team (PGC) who was blinded to the contents of the elastomeric pump 6 hours after surgery and at 24, 48, and 72 hours postoperatively. (2) Opioid use was recorded as required frequency and doses given in mg/kg body weight morphine or pethidine use during the first 3 days. The presence of side effects (eg, nausea, vomiting, constipation) was also recorded. (3) Joint function was measured by the range of motion achieved during the first 3 days, at discharge, and 1 month post-op. (4) Mean length of hospital stay in each group was also recorded.

Statistical analysis was performed using the Mann-Whitney U test and Fisher's exact test. SPSS® Version 9 software (SPSS Inc, Chicago, IL) was used for statistical analysis.

Results

For the end point of postoperative pain, all patients with the ropivacaine pump showed lower VAS scores ($p < 0.001$) during the first 3 days (Fig. 3). Values leveled out at discharge and 1 month after surgery and showed no differences. In the ropivacaine group, there was a reduction ($p < 0.004$) in the number of patients who required opioids for pain control during the first 3 days (Fig. 4). On Day 1, 38% of patients in Group B required supplementary analgesia with opioids compared with 14% in Group A. On Day 2, in Group B, 22% continued needing rescue analgesia with opioids compared with 4% in Group A. On Day 3, 3% in Group B still required opioids versus none in Group A. In the patients who required opioids to control pain, there was a high percentage of adverse effects (eg, nausea, vomiting, dizziness). A total of 61% of patients suffered from dizziness, 55% nausea, 41% vomiting, and 10% other (constipation, disorientation) (Fig. 5).

There was no difference ($p < 0.104$) in ROM in flexion and extension throughout the study period when Groups A

Fig. 3 A graph shows mean VAS scores for each group in the preoperative period (PRE), on Postoperative Days 1, 2, and 3, at discharge (DISCH), and at 1 month after surgery. The baseline situation was similar between groups, yet during the first 3 postoperative days, pain reduction occurred, which leveled out at discharge and at 1 month.

Fig. 4 A graph shows the percentage of patients requiring opioid use as supplementary analgesia to control pain during the first 3 postoperative days in Groups A and B. There was a reduction ($p < 0.004$) in the number of patients who required opioids for pain control during the first 3 days.

Fig. 5 In both groups, the patients requiring opioid treatment showed a high percentage of side effects.

Fig. 6 A graph shows ROM in Groups A and B on Postoperative Days 1, 2, and 3, at discharge (DISCH), and at 1 month. In the postoperative period, the two groups were similar. Improvements in ROM leveled out 1 month after surgery for both groups.

and B were compared (Fig. 6). Improvements in ROM leveled out 1 month after surgery for both groups.

The mean length of hospital stay was shorter ($p < 0.001$) in patients with the ropivacaine pump (5.72 days) than in the saline solution group (7.32 days). No wound complications or infections associated with the use of the intraarticular device or ropivacaine-related adverse effects were found.

Discussion

Poor control of postoperative pain after TKA may cause a series of adverse events that could negatively influence functional recovery and the final results and reports on the procedure [18]. An option that has gained popularity is local infiltration with local anesthetics through the placement of an intraarticular catheter that allows for continuous local anesthetic infusion within the joint [4, 7, 14, 17, 19, 22]. Recent studies have examined continuous intraarticular infusion of local anesthetic in orthopaedic surgery, concluding postoperative pain, the need for opioids as rescue medication, and mean length of hospital stay are reduced [4, 8, 10, 14, 19, 21]. We undertook this study to analyze the possible benefits of continuous intraarticular infusion of ropivacaine in patients undergoing TKA. Our aims were (1) to analyze the efficacy of ropivacaine intraarticular infusion in decreasing the patients' perception of pain and in reducing postoperative opioid use and (2) to determine whether ropivacaine intraarticular infusion accelerates the functional recovery of the patient and reduces length of hospital stay.

This study has some limitations. Firstly, the sample size may be too small for analyzing certain variables such as infection or recovery of ROM. Secondly, pain at rest and on movement were not analyzed separately. Lastly, the amount of ropivacaine that may have been lost in drainage was not analyzed.

We found the patients with the ropivacaine pump had lower VAS scores during the first 3 days and had a reduction in the number of patients who required opioids for pain control during the first 3 days. In the patients who required opioids to control pain, there was a high percentage of adverse effects (eg, nausea, vomiting, dizziness). The mean length of hospital stay was shorter in patients with the ropivacaine.

Opioid side effects, which are mainly nausea and vomiting, occur at an incidence of 30% to 80% and negatively influence patient satisfaction and well-being. They are sometimes reported to be one of the main negative factors, even more so than pain [5]. In our study, the use of rescue medication was reduced and therefore opioid-related side effects were also decreased.

Reduction of length of hospital stay is another of the noteworthy findings. The use of ropivacaine administered by a continuous infusion pump resulted in a mean reduction of length of stay of 1.5 days compared to the control group. This reduction in length of stay is similar to other reports which employ continuous infusion of anesthetics [7, 22, 23]. In a randomized study comparing continuous ropivacaine infusion with intravenous morphine and ketorolac infusion in 37 patients, Bianconi et al. [4] concluded the group receiving ropivacaine infiltration showed less postoperative pain at rest and on movement, less need for rescue medication, and shortened mean length of hospital stay. In another study, Vendittoli et al. [23] concluded patients undergoing ropivacaine infusions needed lower amounts of opioids to control pain and their side effects. Busch et al. [7] performed a randomized study of 64 patients undergoing TKA to compare ropivacaine, morphine, ketorolac, and epinephrine infiltration versus the standard analgesic treatment, concluding such infiltration improved patient satisfaction, pain control, and use of rescue medication. In another study of 154 patients who underwent TKA, Rasmussen et al. [19] concluded continuous intraarticular infusion of ropivacaine and morphine reduced postoperative pain and promoted early onset of functional recovery. Length of stay reductions of this magnitude have the potential to meaningfully improve hospital throughput with cost savings.

In contrast, other reports in the literature do not show improved results in patients in whom this technique was used. DeWeese et al. [9] found, with continuous intraarticular infusion of bupivacaine, patients needed more rescue analgesia compared with others who received epidural analgesia. In a randomized study, Alford and Fadale [1] examined the effectiveness of intralesional infusion of local anesthetics after ACL reconstruction. Patients were divided into three groups: those without catheter, those with constant infusion of saline solution, and those with continuous local anesthetic infusion. Differences favoring local anesthetic infusion were only found at peak pain levels, and they concluded the catheter had a placebo effect [1]. Nechleba et al. [17] studied the effectiveness of continuous bupivacaine infusion to control pain after TKA and found differences in pain reduction on Day 2 but not during the rest of the treatment. They suggested continuous infusion of local anesthetics does not provide improvements in pain reduction and in the use of medication. We believe that these less favorable results may have resulted from the simultaneous use of wound drainage during the treatment period. These results may be influenced by loss of local anesthetic volume through drainage, which may reach up to 27% [17].

There were no complications associated with the use of the device; no infection, changes in wound healing, or

increase in wound drainage were seen. One of the concerns with using this system could be increased risk of infection. It is possible, with pain control, there is an inhibition of inflammatory mediators, less edema, and, therefore, better tissue oxygenation. In addition, it is known that local anesthetics have a bactericidal and/or bacteriostatic effect, as well as a fungistatic effect [15]. Therefore, it seems local anesthetic infusion could reduce the risk of infection [23].

The local anesthetic used in most studies is ropivacaine due to its pharmacologic properties. It shows less cardiotoxicity and neurotoxicity than bupivacaine, thus enabling patients to tolerate higher doses [9]. In our study, ropivacaine 300 mg was used at a concentration of 0.2% and at an infusion speed of 5 mL/hour. Although plasma ropivacaine levels were not analyzed, no patients developed itching, perioral inflammation, tinnitus, or other symptoms of toxicity to local anesthetics.

Based on our results, we conclude the use of the continuous infusion pump is effective in the treatment of postoperative pain after TKA, reducing the degree of postoperative pain and the use of opioids during the peak pain period, while also reducing mean length of hospital stay. It is a simple and effective technique that could become part of the current treatment armamentarium in the multimodal approach to postoperative pain control in TKA.

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