The multimodal pain management approach in total knee arthroplasty

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Table 1: Summary of key randomized controlled trials on the multimodal approach to pain management

LIST OF ABBREVIATIONS
AUC Area Under Curve
DVT Deep Venous Thrombosis
h Hour
mg Milligrams
microg See mug
min Minutes
ml Milliliters
mug Microgram
n Number
P Probability
PCA Patient-controlled analgesia
PO Oral
ROM Range of Motion
SD Standard Deviation
TKA Total Knee Arthroplasty
TKR Total Knee Replacement
VAS Visual Analog Scale

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I Introduction

Total knee replacement (TKR) is a safe and cost-effective treatment for alleviating pain and restoring physical function in patients who do not respond to nonsurgical therapies. Postoperative pain is commonly reported following total knee arthroplasty. It is often acute and obvious in etiology and must be managed to the best ability of the treating surgeon. However, postoperative pain management is not always straightforward and can often be poorly managed. In addition, strategies to reduce postoperative nausea and vomiting are necessary to complement the pain management program. Consequences of uncontrolled pain following total knee arthroplasty include the inability to actively participate in therapy, a delayed recovery, poor or suboptimal surgical outcomes, prolonged hospitalization, and an increased use of health care resources. Pain management using a standardized preoperative, perioperative, and postoperative protocol enhances patients’ ability to undergo successful rehabilitation.

II Multimodal approach to pain management

The recent literature suggests that orthopedic surgeons must change the way they have traditionally thought about postoperative pain management following total knee arthroplasty. Orthopedic surgeons need to consider perioperative pain management as well as strategies to reduce postoperative nausea and vomiting to complement the pain management program. This effort involves more than just increasing the dose of pain medication [1].

Multimodal analgesia is a multidisciplinary approach to pain management with the goal of maximizing the analgesic effect and minimizing the side effects of the medications [2]. Preemptive analgesia is the foundation of the multimodal program because many of the negative effects of analgesic therapy are related to postoperatively administered parenteral opioids, limiting their use is a major principle of multimodal analgesia [1].

A multimodal approach may typically include administering preoperative antiinflammatories starting 48 hours in advance of surgery, an aggressive perioperative antiemetic program, blood loss management, regional nerve catheters for total knee replacement, scheduled narcotics with additional pain medications, and less-invasive surgical techniques [1]. The goal of the multimodal therapeutic approach is to preempt the pain signals, prevent postoperative nausea and vomiting, and attack these problems using different modalities [1].

The multimodal program is one that provides pain prevention at all three levels of pain control: the local wound receptors, the spinal cord, and the brain [2]. The multimodal approach targets different areas of the pain pathway. For example, celecoxib inhibits prostaglandin synthesis, primarily via the inhibition of cyclooxygenase-2 enzyme, reducing the inflammatory mediated pain signals [1]. The mechanism of hydrocodone or oxycodone is not precisely understood, but it is believed to work on opiate receptors in the central nervous system to inhibit pain [1]. Acetaminophen elevates the pain threshold, effectively improving analgesia [1]. Medications should also be prescribed to prevent postoperative nausea and vomiting, such as around-the-clock, scheduled, antiemetics [1].
III Purpose

The purpose of this review is to provide a summary of the high-quality literature on the multimodal approach to pain management in patients undergoing total knee arthroplasty or total hip arthroplasty.

IV Literature search

A systematic search of the Cochrane Library and PubMed was conducted to identify meta-analyses and randomized controlled trials on multimodal pain management. Keywords included multimodal approach, pain management, total joint replacement, total joint arthroplasty, total knee replacement, and total knee arthroplasty. Limits were set to English, randomized controlled trials, and meta-analyses.

V Results

The systematic search did not identify any relevant meta-analyses on the multimodal approach to pain management. Multiple searches of PubMed identified 27 key randomized controlled trials which are summarized in Table 1 [3–29]. The randomized controlled trials used various combinations of medications in their multimodal pathways, some of which improved patient outcomes, while others did not. Many of the trials were limited by small sample sizes, so it is difficult to make conclusive recommendations based upon their results.

VI Conclusions

A multimodal pain management program should limit the use of parenteral narcotics and avoid the side effects of nausea and vomiting, which is one of the most important factors for in-hospital satisfaction [2]. A number of different multimodal approaches to pain management in patients undergoing total knee arthroplasty exist. Implementing a multimodal approach to pain management is something that all total joint surgeons, from high volume to occasional, can do to make a positive impact on patient care and hopefully improve patient outcomes. The optimal combination of medications to include in the multimodal approach remains unknown despite several randomized controlled trials evaluating different components. Future research is required to determine the optimal multimodal approach in managing pain following total knee arthroplasty.
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<tr>
<td>Kardashian et al, 2007 [3]</td>
<td>60 patients undergoing elective unilateral total knee arthroplasty under spinal anesthesia</td>
<td>In a randomized, double-blind manner patients received a femoral, obturator, or sham nerve block at the end of surgery. Blocks were performed using nerve stimulation and 20 ml bupivacaine 0.5% containing epinephrine 5 microg/ml. Patient-controlled IV analgesia with fentanyl, celecoxib 100 mg PO bid, and acetaminophen 650 mg PO every 6 h were started on arrival in the recovery room.</td>
<td>There were no significant differences in the obturator block group and the control group in any outcome variable. With baseline pain scores subtracted, femoral nerve block resulted in less pain at rest compared with control and less pain with movement at recovery room discharge. Neither block had a significant effect on opioid use, functional outcome, or side effects.</td>
<td>Femoral nerve blocks rarely block the obturator nerve. Single-injection femoral nerve block improved multimodal analgesia after spinal anesthesia for total knee arthroplasty, but this effect did not persist beyond the day of surgery.</td>
<td>★★★★☆</td>
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<td>Andersen et al, 2007 [4]</td>
<td>40 patients undergoing total hip replacement</td>
<td>Patients received wound infiltration at the end of surgery and through an intraarticular catheter 24 h postoperatively. One group received solutions of ropivacaine, ketorolac, and adrenaline. Patients in the control group were injected with saline instead.</td>
<td>The patients who received the analgesic solution had less pain up to 2 weeks postoperatively. They reached an earlier and lower pain minimum during the first days postoperatively, had lower use of analgesia up to day 4 postoperatively, and were more satisfied. Use of analgesic solution resulted in less postincisional pain and better function 1 week postoperatively.</td>
<td>Operative and postoperative wound infiltration with multimodal drugs reduces pain and the requirement for analgesics after hip replacement, leading to faster postoperative mobilization.</td>
<td>★★★★★</td>
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<td>Busch et al, 2006 [5]</td>
<td>64 patients undergoing total knee arthroplasty</td>
<td>Patients were randomized either to receive a periarticular intraoperative injection containing ropivacaine, ketorolac, and epinephrine or to receive no injection. The perioperative analgesic regimen was standardized. All patients in both groups received patient-controlled analgesia for 24 hours after the surgery, and this was followed by standard analgesia.</td>
<td>Patients who had received the injection used significantly less patient-controlled analgesia at 6 hours, 12 hours, and over the first 24 hours after the surgery. They had higher visual analog scores for patient satisfaction and lower visual analog scores for pain during activity in the post-anesthetic-care unit and 4 hours after the operation.</td>
<td>Intraoperative periarticular injection with multimodal drugs can significantly reduce the requirements for patient-controlled analgesia and improve patient satisfaction, with no apparent risks, following total knee arthroplasty.</td>
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<td>Vendittioli et al, 2006 [6]</td>
<td>42 patients undergoing unilateral total knee arthroplasty</td>
<td>Patients were randomized to receive either a perioperative infiltration mixture, consisting principally of local anesthetic and self-administered morphine, or self-administered morphine only.</td>
<td>Although there was high satisfaction and good pain control in both groups, morphine consumption was significantly lower in the local analgesia group than it was in the control group. Over the 5-day period after the procedure, the patients in the local analgesia group reported a total of 2.6 +/- 3.9 hours of nausea compared with 71 +/- 12.2 hours in the control group.</td>
<td>This multimodal perioperative analgesia protocol that included infiltration of a local anesthetic offered improved pain control and minimal side effects to patients undergoing total knee arthroplasty.</td>
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<td>Barrington et al, 2005 [7]</td>
<td>108 patients undergoing total knee arthroplasty</td>
<td>Patients undergoing total knee replacement under spinal anesthesia were randomized to receive either a femoral infusion of bupivacaine 0.2% (median infusion rate 9.3 ml/h) or an epidural infusion of ropivacaine 0.2% with fentanyl 4 microg/ml (median infusion rate 7.6 ml/h). Adjuvant analgesics were oral rofecoxib and oxycodone and IV morphine.</td>
<td>There were equivalent pain scores, range of movement, and rehabilitation in both groups. There was significantly less nausea and vomiting in the continuous femoral nerve blockade group. The continuous femoral nerve blockade group received more rofecoxib and oxycodone than the continuous epidural analgesia group.</td>
<td>Continuous femoral nerve blockade is an effective regional component of a multimodal analgesic strategy after total knee replacement.</td>
<td>★★★★★</td>
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</table>
| REFERENCE | SAMPLE | TREATMENT GROUPS AND PAIN MANAGEMENT DETAILS | KEY RESULTS | AUTHORS’ CONCLUSIONS | EFFECTIVENESS OF TREATMENT?
|-----------|--------|---------------------------------------------|-------------|------------------------|-------------------|
| Buvanendran et al, 2003 [8] | 70 patients undergoing total knee arthroplasty | Patients were randomly assigned to receive 50 mg of oral rofecoxib at 24 hours and at 1 to 2 hours before TKA, 50 mg daily for 5 days postoperatively, and 25 mg daily for another 8 days, or matching placebo at the same times. | Total epidural analgesic consumption and in-hospital opioid consumption were less in the group receiving rofecoxib compared with the group receiving placebo. Median pain score achieved for the knee was lower in the rofecoxib group compared with the placebo group during hospital stay and 1 week after discharge. There was less postoperative vomiting in the rofecoxib group (6%) compared with the placebo group (26%). Knee flexion was increased in the rofecoxib group compared with the placebo group at discharge and at 1 month postoperatively, with shorter time in physical therapy to achieve effective joint range of motion. | Perioperative use of an inhibitor of cyclooxygenase 2 is an effective component of multimodal analgesia that reduces opioid consumption, pain, vomiting, and sleep disturbance, with improved knee range of motion after total knee arthroplasty. | 5
| Camu et al, 2002 [9] | 195 patients undergoing total hip replacement | This study compared the opioid-sparing effects, analgesic efficacy, and safety of 20- and 40-mg doses of valdecoxib twice daily with placebo in patients receiving morphine by patient-controlled analgesia after hip arthroplasty. Study medication was first administered 1 to 3 hours preoperatively. | Patients receiving 20 or 40 mg valdecoxib twice daily required on average 40% less morphine than those receiving placebo after hip arthroplasty. Pain intensity levels and patient satisfaction were significantly improved in both valdecoxib groups compared with placebo. Valdecoxib and placebo were equally well tolerated. | Pre- and postoperative administration of valdecoxib reduces the amount of morphine required for postoperative pain relief and provides greater analgesic efficacy compared with morphine alone. | 5
| Adam et al, 2005 [10] | 40 patients undergoing total knee arthroplasty | Patients were randomly assigned to receive an initial bolus of 0.5 mg/kg ketamine followed by a continuous infusion of 3 mg/h (kg-1 · h-1) during surgery and 1.5 mg/h (kg-1 · h-1) for 48 h (ketamine group) or an equal volume of saline (control group). Additional postoperative analgesia was provided by patient-controlled IV morphine. | The ketamine group required significantly less morphine than the control group. Patients in the ketamine group reached 90° of active knee flexion more rapidly than those in the control. Outcomes at 6 weeks and 3 months were similar in each group. | These results confirm that ketamine is a useful analgesic adjuvant in perioperative multimodal analgesia with a positive impact on early knee mobilization. | 5
| Stiller et al, 2007 [11] | 63 patients undergoing total knee arthroplasty | Patients were randomized to receive saline or tramadol 100 mg/ml intravenously every 6 h during the first postoperative day (total, 400 mg/24 h). All patients had access to morphine via a patient-controlled analgesia pump. | There was no difference within the first postoperative day with regard to pain intensity, sedation and nausea between patients treated with tramadol and the placebo group. The withdrawal rate caused by insufficient pain relief was greater in the tramadol group (7/31) than in the saline group (2/32). In the group of patients who remained in the study for 24 hours, those randomized to receive tramadol had significantly lower morphine consumption than the placebo group. | This study does not support the combination of tramadol and morphine via patient-controlled analgesia for postoperative pain relief after primary total knee arthroplasty. | 4
| Parvataneni et al, 2007 [12] | 131 patients undergoing total hip or knee arthroplasty | Patients were randomized to either a study group receiving periarticular injections or a control group receiving patient-controlled analgesia with or without femoral nerve block (total knee patients). All patients received a comprehensive multimodal perioperative protocol. | The total hip arthroplasty study group demonstrated significantly lower average pain scores and higher overall satisfaction than the control group. There was no significant difference in pain scores between the study and control groups in the total knee cohort. Both study groups demonstrated lower narcotic usage and side effects as well as improved early functional recovery. | Periarticular injection with a multimodal protocol was shown to safely provide excellent pain control and functional recovery and can be substituted for conventional pain control modalities. | 4
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<td>Long et al, 2006</td>
<td>70 patients undergoing total knee arthroplasty</td>
<td>Patients received the same postoperative pain management plan, with the exception of random assignment to either continuous epidural catheter or continuous femoral nerve catheter infusion for 36 hours post-operatively.</td>
<td>The femoral catheter group had less pain on day 0 and day 1 compared to the epidural group. The femoral catheter group consumed less morphine on day 1 compared to the epidural group.</td>
<td>The continuous femoral catheter provided superior pain relief compared to the continuous epidural catheter.</td>
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<td>Kim et al, 2007</td>
<td>50 patients undergoing unilateral total knee replacement</td>
<td>Patients were randomly assigned to receive either sufentanil in ropivacaine alone (group C) or the same solution with naloxone (group N) for their postoperative epidural analgesia.</td>
<td>The nausea score in group N was significantly lower than that in group C. The VAS pain score at rest and on movement were significantly lower in group N than in group C at 24 h. Other opioid-induced side-effects were not significantly different.</td>
<td>Epidural naloxone was effective in reducing postoperative nausea and vomiting induced by epidural sufentanil and additionally enhanced the analgesic effect. Therefore, concomitant infusion of a small dose of epidural naloxone should be considered to reduce postoperative nausea and vomiting, especially in patients at greater risk for postoperative nausea and vomiting.</td>
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<td>Han et al, 2007</td>
<td>90 patients undergoing total knee arthroplasty</td>
<td>Patients were randomly divided into three equal groups. Before wound closure, patients were given intrasynovial injections of the following solutions: patients in group I received 40 ml of 300 mg ropivacaine with 1,200,000 epinephrine and 5 mg morphine; patients in group II received 40 ml of 300 mg ropivacaine with epinephrine; and patients in group III received 50 ml normal saline as a control. All patients received an epidural patient-controlled analgesia (PCA) for 24 postoperative hours.</td>
<td>There were no significant differences among the three groups with regards to the VAS and the required dose of rescue analgesia. None of the groups demonstrated significant differences in the range of knee flexion and the incidence of postoperative nausea and emesis.</td>
<td>The authors found that ropivacaine, alone or with morphine, injected into the synovial tissue, along with an epidural PCA has no additional benefits in pain control after a total knee arthroplasty.</td>
<td>★★★★</td>
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<td>Toftdahl et al, 2007</td>
<td>80 patients undergoing total knee arthroplasty</td>
<td>Patients who received spinal anesthesia were randomized to receive continuous femoral nerve block (group F) or peri- and intraarticular infiltration and injection (group I). Group I received a solution of 300 mg ropivacaine, 30 mg ketorolac, and 0.5 mg epinephrine by infiltration of the knee at the end of surgery, and 2 postoperative injections of these substances through an intrarticular catheter.</td>
<td>More patients in group I than in group F could walk &lt;3 m on the first postoperative day (29/39 vs 7/37, p &lt;0.001). Group I also had significantly lower pain scores during activity and lower consumption of opioids on the first postoperative day. No differences between groups were seen regarding side effects or length of stay.</td>
<td>Peri- and intraarticular application of analgesics by infiltration and bolus injections can improve early analgesia and mobilization for patients undergoing total knee arthroplasty. Further studies of optimal drugs, dosage, and duration of this treatment are warranted.</td>
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<td>Inan et al, 2007 [17]</td>
<td>46 patients undergoing total knee arthroplasty</td>
<td>In this double-blind, randomized, placebo controlled study, the effect of lornoxicam administration (32 mg/48 hour) on morphine consumption and drug-related side effects were investigated in elderly patients undergoing total knee replacement. Group M and group L received morphine with patient controlled analgesia (PCA) device postoperatively. Additionally group L received lornoxicam 16 mg intravenously 15 minutes before surgery and 8 mg at postoperative 12th and 24th hours.</td>
<td>At the end of 48th hour, mean total morphine consumptions (mean +/- SD) for group M and group L were 63.70 +/- 15.70 mg and 34.60 +/- 16.32 mg, respectively. AUC (area under the curve) morphine 0-48h in group M was 59 +/- 13 and in group L it was 30+/-13 (P &lt;0.001). Incidence of side effects in group M were 60% and 25% in group L (P &lt;0.05). In group M, 8 patients (40%) experienced nausea and 3 (15%) patients experienced itching where as in group L, 3 patients (15%) experienced nausea, 1 patient (5%) itching, 1 patient (5%) dry mouth.</td>
<td>Lornoxicam administration in total knee replacement is associated with decreased morphine consumption for postoperative analgesia and fewer side effects.</td>
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<td>Chu et al, 2006 [18]</td>
<td>60 patients undergoing total knee arthroplasty</td>
<td>Patients were randomized to either general anesthesia followed by postoperative intravenous patient-controlled analgesia with morphine, or combined spinal-epidural anesthesia followed by postoperative epidural infusion of bupivacaine 0.1% with fentanyl 2 microg/ml.</td>
<td>Postoperative median pain scores were consistently lower at 1 (P &lt;0.0001), 6 (P = 0.08), 12 (P = 0.003), 24 (P = 0.14), and 48 hours (P = 0.007) in those patients given regional anaesthesia. Although there was a trend towards fewer complications in the latter group, there were no statistically significant differences between the two groups with respect to the incidence of postoperative blood loss, hemodynamic instability, pruritus, nausea, vomiting, urinary retention, or other surgical/medical complications. Postoperatively, patients given regional anesthesia also resumed meals earlier (P &lt;0.0001), and showed a trend towards earlier ambulation and hospital discharge.</td>
<td>Patients undergoing total knee arthroplasty with regional anesthesia/ regionally delivered analgesia enjoyed better postoperative pain relief and resumed meals earlier than those receiving general anesthesia/ intravenous patient-controlled analgesia.</td>
<td>★★★★☆</td>
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<td>Zaric et al, 2006 [19]</td>
<td>60 patients undergoing total knee arthroplasty</td>
<td>Patients were prospectively randomized to receive either epidural infusion or combined continuous femoral and sciatic nerve blocks. Ropivacaine 2 mg/ml plus sufentanil 1 mug/ml was given either epidurally or through the femoral nerve catheter, and ropivacaine 0.5 mg/ml was given through the sciatic nerve catheter using elastomeric infusers (delivering 5 ml/h for 55 h).</td>
<td>One or more side effects were present in 87% of patients in the epidural group whereas only 35% of patients in the femoral and sciatic block groups were affected on the first postoperative day (P = 0.0002). Motor blockade was more intense in the operated limb on the day of surgery and the first postoperative day in the peripheral nerve block group (P = 0.001), whereas the nonoperated limb was more blocked in the epidural group on the day of surgery (P = 0.0003).</td>
<td>The results demonstrate a reduced incidence of side effects in the femoral/sciatic nerve block group than in the epidural group on the first postoperative day.</td>
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<td>Seet et al., 2006 [20]</td>
<td>60 patients undergoing total knee arthroplasty</td>
<td>Patients undergoing elective unilateral total knee arthroplasty under subarachnoid block were randomized into three groups. Postoperative analgesia was provided with a continuous 3-in-1 femoral nerve catheter with 0.15% ropivacaine in group A, a continuous 3-in-1 femoral nerve catheter with 0.2% ropivacaine in group B, or patient controlled intravenous morphine in group C (control group). Groups A and B received patient controlled intravenous morphine pumps for rescue analgesia.</td>
<td>There was no statistical difference in pain score between the groups. Total morphine use was highest in group C (P &lt; 0.05). No appreciable difference could be found with somatosensory blockade, morphine usage and satisfaction scores when comparing groups A and B. Femoral catheter dislodgement rate was 7.9%. There was no statistical difference between the groups when comparing the day of first ambulation and the time to discharge from the hospital. Satisfaction scores were higher in group A (P = 0.028) and group B (P = 0.002) compared to group C.</td>
<td>The authors concluded that a continuous 3-in-1 femoral nerve block with ropivacaine 0.15% or 0.2% for elective unilateral total knee arthroplasty has an opioid-sparing effect.</td>
<td>★★★☆☆</td>
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<td>Casey et al., 2006 [21]</td>
<td>40 patients undergoing total knee arthroplasty</td>
<td>Patients were randomized to receive capsules containing either nimodpine 30 mg or placebo in a double-blind study design. All patients received 3 capsules (nimodpine 90 mg or placebo 1–2 h before induction of anaesthesia followed by oral nimodpine 30 mg or placebo 6 hourly for 48 hours postoperatively. Spinal anaesthesia was induced with hyperbaric bupivacaine 0.5% (2.4) 3.0 ml, and fluids and ephedrine were given at the discretion of the anesthesiologist. Morphine patient-controlled analgesia (PCA, bolus 1 mg, lockout 5 min) was given for postoperative analgesia.</td>
<td>Morphine consumption was significantly larger in nimodpine patients at 12 h (39 +/- 18 versus 29 +/- 15, P = 0.04), 24 h (62 +/- 23 versus 45 +/- 24, P = 0.02), and 48 h (88 +/- 34 versus 61 +/- 27, P = 0.01). There were no significant differences in pain scores at rest or moving, or in time to first use of morphine analgesia.</td>
<td>This study has demonstrated increased morphine consumption after 12 h in postoperative patients receiving nimodpine, suggesting that, in patients undergoing knee replacement surgery, it has no adjunctive analgesic effect and may actually inhibit the analgesic effect of morphine.</td>
<td>★★★☆☆</td>
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<td>Axelsson et al., 2005 [22]</td>
<td>45 patients undergoing total knee arthroplasty</td>
<td>Postoperative pain relief with a combination of epidural ropivacaine (group L: 10 mg h⁻¹, group H: 16 mg h⁻¹) and morphine (0.16 mg h⁻¹) was evaluated in 30 patients. A placebo group (group PL) of 15 patients having PCA morphine served as the control.</td>
<td>VAS scores at rest were significantly lower in groups L and H compared to group PL. On movement, group H had lower VAS scores than group PL during 3–27 h (P &lt; 0.05) and group L during 4–9 h (P &lt; 0.05), while group L had a lower VAS than group PL during 9–18 h (P &lt; 0.05). Morphine consumption after 48 h was greater in group PL (64.6 +/- 36.3 mg) vs. group L (23.3 +/- 33.9 mg) (P &lt; 0.001) and group H (4.3 +/- 9.6 mg) (P &lt; 0.0001). Motor block was seen in group H in 20% and 14% of patients at 24 h and 48 h, respectively, but time to mobilization was similar between the groups. Pruritus was more common in the ropivacaine groups (P &lt; 0.05).</td>
<td>Lumbar epidural analgesia using a combination of ropivacaine (16 mg h⁻¹) and morphine (0.16 mg h⁻¹) provides superior analgesia compared to the PCA technique or ropivacaine (10 mg h⁻¹) and morphine (0.16 mg h⁻¹).</td>
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<td>YaDeau et al, 2005 [23]</td>
<td>80 patients undergoing total knee arthroplasty</td>
<td>Forty-one patients received a single-injection femoral nerve block with 0.375% bupivacaine and 5 microg/mL epinephrine; 39 patients served as controls. All patients received combined spinal-epidural anesthesia and patient-controlled epidural analgesia with 0.06% bupivacaine and 10 microg/mL hydromorphone. Average duration of epidural analgesia was 2 days.</td>
<td>Median visual analog scale scores with physical therapy were significantly lower for 2 days among patients who received a femoral nerve block versus controls: 3 versus 4 (day 1), 2.5 versus 4 (day 2); P &lt;0.05. Median VAS pain scores at rest were 0 in both groups on days 1 and 2. Flexion range of motion was improved on postoperative day 2 (70° versus 63°; P &lt;0.05).</td>
<td>The authors conclude that the addition of femoral nerve blockade to epidural analgesia significantly improved analgesia for the first 2 days after total knee arthroplasty.</td>
<td>★★★★★</td>
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<td>Nechleba et al, 2005 [24]</td>
<td>30 patients undergoing total knee arthroplasty</td>
<td>Patients randomly received either 0.25% bupivacaine or normal saline by local infusion pump. Standard wound drainage also was implemented.</td>
<td>Mean preoperative visual analog scores were similar between the saline and bupivacaine groups (6.5 +/- 1.4 and 6.1 +/- 2.0, respectively; P = .535). By the end of the second postoperative day, scores decreased to 3.4 +/- 3.2 for the saline group and 2.5 +/- 1.6 for the bupivacaine group. Mean narcotic demand and usage were 87 +/- 114.1 requests with usage of 11.8 +/- 12.3 mg for the saline group and 96 +/- 104.8 requests with usage of 7.5 +/- 3.8 mg for the bupivacaine group (P = .505).</td>
<td>These findings suggest continuous local analgesic infusion after total knee arthroplasty does not offer significant improvements in either pain relief or medication use.</td>
<td>★★★★★</td>
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<td>Farag et al, 2005 [25]</td>
<td>38 patients undergoing total knee arthroplasty</td>
<td>One group received spinal anesthesia with 0.5% bupivacaine and analgesia with intravenous patient-controlled analgesia morphine, demand mode only. The other group was given epidural anesthesia with 1.0% ropivacaine with 1:200,000 epinephrine and analgesia with 0.2% ropivacaine at 8 ml/h, maintained for 7 days. Both groups had compression stocking for deep venous thrombosis (DVT) prophylaxis, urinary catheter for the first 24 hours, and duplex scanning at days 3 and 10.</td>
<td>There was no difference in demographics between groups. The pain scores at rest and with ROM were significantly less in the epidural group. ROM was better in the epidural group compared with the spinal group after day 1. No DVT was detected on day 3 or 10 in either group. No patient in either group required reinsertion of bladder catheter for urinary retention.</td>
<td>By using epidural analgesia in the first 7 days postoperatively, we achieved improved early rehabilitation due to excellent pain relief effect and an antithrombotic effect with an efficacy comparable to low molecular-weight heparin.</td>
<td>★★★★★</td>
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<td>Pham Dang et al, 2005 [26]</td>
<td>28 patients undergoing total knee arthroplasty</td>
<td>Patients were allocated randomly to receive a continuous femoral nerve block or continuous blocks of both the femoral and sciatic nerves. Stimulating catheters were used in all cases. A loading dose of 15 ml ropivacaine 0.75% was injected into each catheter, followed by administration of ropivacaine 0.2% (2–5 ml/h infusion via the femoral catheter; bolus 10 ml repeated every 12 hours in the sciatic catheter).</td>
<td>The VAS scores at rest were significantly higher when there was only continuous femoral nerve block than when there was both continuous femoral and sciatic nerve blocks. This difference progressively decreased and disappeared at 36 hours after surgery. The combined femoral and sciatic blocks decreased the morphine consumption by 8% and significantly decreased the occurrence of postoperative nausea and vomiting.</td>
<td>During the 36 hours immediately after total knee replacement, the combination of continuous femoral and sciatic nerve blocks improves analgesia while decreasing morphine consumption and postoperative nausea and vomiting.</td>
<td>★★★★☆</td>
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<td>REFERENCE</td>
<td>SAMPLE</td>
<td>TREATMENT GROUPS AND PAIN MANAGEMENT DETAILS</td>
<td>KEY RESULTS</td>
<td>AUTHORS’ CONCLUSIONS</td>
<td>EFFECTIVENESS OF TREATMENT?*</td>
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<td>Forster et al,</td>
<td>72 patients undergoing total knee arthroplasty</td>
<td>After the operation, patients received an epidural infusion consisting of ropivacaine 2 mg ml⁻¹ and fentanyl 5 microg ml⁻¹ either without (group RF, n = 33) or with clonidine 2 microg ml⁻¹ (group RFC, n = 36). The infusion rate was adjusted within the range 3–7 ml h⁻¹.</td>
<td>Average rate of infusion was slightly smaller in Group RFC than in Group RF (mean [sd] 4.7 [0.72] vs 5.2 [0.8] ml h⁻¹, P = 0.004). Compared with the RF group, patients in the RFC group required significantly less rescue pain medication, that is i.m. oxycodone (median [25th, 75th percentile] 0 [0, 7] vs 7 [0, 12] mg, P = 0.027). Arterial pressure and heart rate were slightly lower in group RFC throughout the study period (mean difference between the groups 5 mm Hg [P &lt;0.002] and 3 min⁻¹ [P = 0.12], respectively). The groups did not differ statistically with respect to nausea, motor block, and sedation.</td>
<td>The small amount of clonidine added to the low-dose ropivacaine-fentanyl mixture reduced the need for opioid rescue pain medication after total knee arthroplasty. Clonidine slightly decreased arterial pressure and heart rate without jeopardizing hemodynamics. Otherwise, the side effect profiles were comparable in both groups.</td>
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<td>2005 [27]</td>
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<td>Davies et al,</td>
<td>60 patients undergoing total knee arthroplasty</td>
<td>Patients were prospectively randomized to receive either a lumbar epidural infusion or combined single-shot femoral (3-in-1) and sciatic blocks (combined blocks). All patients received standard general anesthesia.</td>
<td>In both groups, pain on movement was well controlled at discharge from recovery and 6 h postoperatively but increased at 24 and 48 h. VAS pain scores with the combined blocks were significantly lower at 24 h (P = 0.004). Total morphine usage was low in both groups: median epidural group 17 mg (IQR 11–23) versus combined blocks 13 mg (IQR 8–27). Patient satisfaction was high in both groups with median.</td>
<td>Combined femoral (3-in-1) and sciatic blocks offer a practical alternative to epidural analgesia for unilateral knee replacements.</td>
<td>★★★★☆</td>
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<td>2004 [28]</td>
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<td>Brown et al,</td>
<td>60 patients undergoing total knee arthroplasty</td>
<td>Patients were randomized to receive bupivacaine 20 ml 0.5% (100 mg) or 20 ml normal saline injected into the joint space after capsule closure.</td>
<td>The bupivacaine group had lower pain scores and reduced narcotics during the 24-hour period, with a 2.3-minute shorter time to discharge from the post anesthesia care unit than the placebo group (P = 0.02).</td>
<td>Although a bupivacaine bolus injected at capsule closure results in decreased pain levels and narcotic consumption, it is not statistically significantly better than placebo.</td>
<td>★★★★☆</td>
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<td>2004 [29]</td>
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* Scale of 1 to 5, where 5 represents treatments that appear to be very effective based on the results reported, and 1 represents treatments that do not appear to be effective based on the results reported. This rating does not take into consideration the methodological rigor of each study.