Journal of Clinical Anesthesia (2017) 37, 7–13

Journal of Clinical Anesthesia

Original Contribution

Comparison of ropivacaine with and without fentanyl vs bupivacaine with fentanyl for postoperative epidural analgesia in bilateral total knee replacement surgery☆,☆☆

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Received 25 April 2016; revised 21 July 2016; accepted 9 August 2016

Keywords:
Total knee replacement;
Analgesia;
Postoperative;
Epidural;
Local anesthetics

Abstract

Study Objectives: Pain after total knee replacement (TKR) interferes with early rehabilitation. Although the use of epidural bupivacaine in post-TKR patients is associated with effective analgesia, the associated motor blockade effect delays functional recovery. We compared analgesic efficacy and side effects of postoperative patient-controlled epidural analgesia (PCEA) with plain ropivacaine 0.1% with/without fentanyl 2.5 μg/mL vs plain bupivacaine 0.0625% with fentanyl 2.5 μg/mL in patients undergoing bilateral TKR.

Design: Prospective, double-blind, randomized study.

Settings: Operation room, postoperative recovery room, and intensive joint replacement unit.

Patients: Ninety American Society of Anesthesiologists I to II post-TKR patients who were randomly allocated to receive postoperative PCEA with plain ropivacaine 0.1% (group 1), ropivacaine 0.1% with fentanyl 2.5 μg/mL (group 2), and plain bupivacaine 0.0625% with fentanyl 2.5 μg/mL (group 3).

Intervention: Postoperatively, the PCEA settings were standardized for a basal flow of 4 mL/h, demand dose of 6 mL, and lock-out interval of 20 minutes. "Rescue" analgesia included epidural boluses (6 mL) of respective study drug over and above PCEA administration.

Measurements: Postoperative pain profile, total PCEA drug used, heart rate, and noninvasive blood pressure, side effects, and patient satisfaction were recorded.

Main results: Demographic parameters, duration of surgery, and hemodynamic variables (heart rate and noninvasive blood pressure) were comparable for the 3 study groups. Pain scores and rescue drug requirements were greater in "ropivacaine-only" group. Motor blockade was greatest in "bupivacaine-fentanyl"

☆ Funding: Purely departmental/institutional.
☆☆ Conflict of interest: None declared.

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http://dx.doi.org/10.1016/j.jclinane.2016.08.020
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group. Postoperatively, despite the presence of minor side effects (nausea, itching) in the "ropivacaine-fentanyl" and bupivacaine-fentanyl groups, the patients belonging to these groups were more satisfied.
Conclusion: After bilateral TKR, ropivacaine-fentanyl combination administered through a PCEA system resulted in "superior" analgesic efficacy, that is, pain relief without motor blockade, than "ropivacaine alone" (lesser pain relief) and bupivacaine-fentanyl (pain relief but with attendant motor blockade). Overall, the addition of fentanyl to epidural local anesthetic returned favorable postoperative analgesia profile and patient satisfaction with minor incidence of opioid-related side effects.
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1. Introduction

Osteoarthritis or the "degenerative joint disease" is an abnormality involving degradation of large joints. Joint replacement surgery is indicated when pain due to osteoarthritis is persistent and is associated with debilitation and/or significant joint movement limitation.

Pain after total knee replacement (TKR) interferes with early rehabilitation. Unrelieved postarthroplasty pain may result in "clinical" (deep vein thrombosis, pulmonary embolism, coronary ischemia, myocardial infarction, pneumonia, poor wound healing, and insomnia) [1,2] and "psychological" changes that increase patient morbidity as well as the associated costs [1]. Negative clinical outcome resulting from ineffective post-TKR pain management and the add-on medical and economic implications (extended length of stay, re-admission, and patient dissatisfaction) worsen the problem [3]. Therefore, not only adequacy of post-TKR analgesia is vital to early postoperative mobilization and successful rehabilitation but also is a key to successful functional outcome [4].

Bupivacaine, the most widely used local anesthetic (LA) for epidural analgesia, is a chiral compound [5] and racemic mixture of S (−) and R (+) enantiomers. Typically, selective epidural administration of S-enantiomers, for example, ropivacaine, produces rarer motor blockade than racemic mixture of bupivacaine [6]. Although ropivacaine and bupivacaine are quite similar in structure, the former is relatively less toxic in terms of cardiovascular and central nervous systems effects [7]. There is evidence that suggests that epidural ropivacaine results in greater sensory blockade and motor block sparing and has lower cardiac toxicity [7] potential than bupivacaine [8].

Interestingly, Polley et al [9] who calculated the relative potencies of LA agents (bupivacaine and ropivacaine) by using an up-down sequential allocation study design reported ropivacaine to be significantly less potent than bupivacaine (potency ratio, 0.6) [9]. However, they contended that, for practical clinical situations, different LA solutions provide the same analgesic effectiveness.

Addition of fentanyl to epidural LA agent is not uncommon. There is evidence that epidurally administered LA when combined with opioids decreases LA requirements and potentiates pain relief [10]. However, addition of fentanyl to epidural LA adds to complications, such as nausea-vomiting, itching, sedation, and delayed respiratory depression [11].

With the contention that epidural ropivacaine, when administered alone, produces sensory blockade equivalent to racemic bupivacaine and because it has selective action on the pain transmitting Aδ and C fibers, it can decrease the need of adding fentanyl to epidural LA solution. We took plain ropivacaine as an isolated group to avoid the complication of opioids. Hence, our study compared the analgesic efficacy and side effects of equipotent ropivacaine (plain, 0.1%) with or without fentanyl (2.5 μg/mL) vs bupivacaine (plain, 0.0625%) with fentanyl (2.5 μg/mL) combination.

2. Materials and methods

After institutional ethics committee approval (EC/01/11/212 dated January 18, 2011) and written informed consent from the patient-participants, this prospective, randomized, and double-blind study was performed on 90 American Society of Anesthesiologists I to II adults (age range, 40-60 years; sex, male or female) who underwent bilateral TKR under combined spinal-epidural (CSE) anesthesia administered via a needle-through-needle technique. Exclusion criteria included patient refusal, revision TKR, patients with low body weight (<50 kg), anticipated technically difficult CSE application, history of LA allergy, substance abuse or dependence (narcotics and alcohol), local sepsis, and/or inability to use patient-controlled epidural analgesia (PCEA) device (psychiatric illness and uneducated).

A sample size of 22 participants per group was calculated based on a difference of "1" in visual analog scale (VAS) score among the 3 groups, a population variance of (1.0) 2, a 2-sided α of 0.05, and a power of 90%. We recruited 30 patients per group to cover for unanticipated losses.

The study participants were randomly allocated (sealed envelope technique) to receive postoperative analgesia as per 1 of the 3 PCEA plans given below:

- Group 1: Plain ropivacaine 0.1% (n = 30).
- Group 2: Plain ropivacaine 0.1% with fentanyl 2.5 μg/mL (n = 30).
- Group 3: Plain bupivacaine 0.0625% with fentanyl 2.5 μg/mL (n = 30).

Before the surgery, the participants underwent detailed preanesthetic assessment composing of presenting history, clinical examination, and relevant investigations. The preoperative

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