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Original Contribution

The effect of continuous interscalene brachial plexus block with 0.125% bupivacaine vs 0.2% ropivacaine on pain relief, diaphragmatic motility, and ventilatory function☆

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Abstract

Study objective: Outpatient continuous interscalene brachial plexus blocks containing bupivacaine or ropivacaine are commonly used to control pain after shoulder surgery. Interscalene blocks cause hemidiaphragmatic paresis. Because ropivacaine preferentially blocks sensory fibers, it may cause less blockade of the phrenic nerve. The purpose of this study was to evaluate the effects of 2 common continuous interscalene brachial plexus infusions: 0.125% bupivacaine vs 0.2% ropivacaine. The study hypothesis is that respiratory function will be less attenuated using ropivacaine than bupivacaine without affecting pain relief.

Design: Study design was a prospective randomized double-blind study, registered (NCT 02059070), with institutional review board approval and written informed consent.

Setting: The setting was the preoperative and postoperative area in an orthopedic teaching hospital.

Patients: Outpatients scheduled for shoulder arthroscopic surgery were included.

Interventions: All patients underwent baseline measurements and interscalene catheter placement, then randomized to receive pumps containing either 0.2% ropivacaine or 0.125% bupivacaine.

Measurements: Study measurements included preoperative and postoperative bedside spirometry and ultrasonographic evaluations of diaphragmatic excursion, postoperative pain scores, and postdischarge oral opioid (oxycodone) consumption.

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Main results: There were no statistically significant differences between bupivacaine vs ropivacaine in outcomes of forced expiratory volume at 1 second change (−22% ± 18.3% vs −29% ± 14.9%), diaphragmatic excursion (−81.4% ± 37.95% vs −75.5% ± 35.1%), VAS pain scores at rest (4.9 ± 2.9 vs 3.5 ± 2.8), or oral opioid consumption (33.7 ± 24.3 mg vs 35.1 ± 33.9 mg).
Conclusions: There was no difference in respiratory dysfunction or opioid requirements between interscalene continuous peripheral nerve blocks with 0.125% bupivacaine or 0.2% ropivacaine. Further study is required to identify anesthetic infusates that will control pain while decreasing the attenuation of pulmonary function.

1. Introduction

Shoulder surgery is associated with severe postoperative pain, and continuous interscalene brachial plexus blocks can control this pain. Compared to single-shot injections, continuous interscalene blocks can increase patient satisfaction [1,2] and decrease narcotic requirements, which then decreases postoperative nausea and vomiting [3], improves quality of sleep [2,3], and decreases length of stay [4].

The concept of continuous peripheral nerve blocks at home (CPNBH) with disposable pumps began in 1998 in Sweden [5]. The authors chose 0.125% bupivacaine for interscalene catheters. Two years later, as ropivacaine became more widely available, others chose to evaluate the safety and efficacy of 0.2% ropivacaine for continuous interscalene infusions [6]. To date, published reviews show that most studies use either of those formulations [7,8]; and although it is known that, for epidural labor analgesia [9], the ratio of ropivacaine to bupivacaine potency is 0.6, there have been no studies comparing the effects of these 2 drugs and concentrations in CPNBH, particularly on pain relief and on major adverse effects.

One of those major adverse effects is ipsilateral phrenic nerve paresis. This is because blockade of the brachial plexus at the interscalene groove with a single large-volume injection causes diaphragmatic hemiparesis in 100% of patients [10,11]. This incidence is decreased to 20% with a continuous infusion of a dilute solution [12], where 9% of patients have a subjective feeling of shortness of breath [13]. An ideal infusate in CPNBH would control postoperative pain and have minimal effects on the phrenic nerve.

Ropivacaine has been shown to have blockade properties that differ from bupivacaine; specifically, ropivacaine seems to preferentially block sensory nerve fibers, while weakly blocking motor fibers [14]. It is not known whether this translates into a more attenuated block of the phrenic nerve with ropivacaine. Therefore, the purpose of this study was to evaluate the effects of continuous interscalene peripheral nerve blocks with 0.125% bupivacaine vs 0.2% ropivacaine, comparing their effect on pain relief and respiratory function. The primary hypothesis is that respiratory function, defined by measurements derived from ultrasonographic evaluations of diaphragmatic excursion and bedside spirometry (forced expiratory volume at 1 second [FEV1], forced vital capacity [FVC], and peak expiratory flow [PEF]), will be less attenuated with ropivacaine than bupivacaine, without affecting pain relief.

2. Materials and methods

After institutional review board approval (Wayne State University, IRB# 050412M1F, approved 7/7/2012) and over a 10-week period, patients who were scheduled for moderately to severely painful unilateral shoulder surgery who agreed to continuous interscalene catheter placement were enrolled in the study and gave written consent. They had to agree to participate and understand the study protocol, be able to care for the catheter and pump, and agree to return to the hospital on the first postoperative day for further testing. Exclusion criteria included cardiopulmonary illness, sleep apnea, renal or hepatic insufficiency, anticoagulation, preexisting neurologic deficit, chronic opioid dependence, morbid obesity, diabetes, allergy to any of the study medications, and patients who lived too far from the facility so they could not be expected to return on the first postoperative day.

After obtaining written informed consent, all patients underwent baseline studies, which included ultrasonic evaluation of diaphragmatic excursion and bedside spirometry. All were placed in a 45° upright position on a hospital stretcher. Assessment of the range of motion of both hemidiaphragms was performed with a curvilinear low-frequency ultrasonographic probe (2.0-5.5 MHz, GE Logiq E; GE Healthcare, Little Chalfont, United Kingdom). Real-time B-mode and M-mode movements were measured. The probe was placed subcostally in the midaxillary line, angled 45° cephalad on both sides, using the liver on the right and the spleen on the left as acoustic windows [15]. If there was difficulty in obtaining a satisfactory image (frequently the case on the left side), the probe was moved laterally toward the anterior axillary line until the diaphragm was visualized. Range of motion of the diaphragm with normal respiration was assessed visually to exclude any preexisting diaphragmatic motion abnormalities, followed by sigh and sniff tests. During the "sniff test," movement of the diaphragm was evaluated from the resting expiratory position during quick inspirations of air taken through the nose. During the "sigh test," the range of diaphragmatic