Journal of Clinical Anesthesia (2014) **26**, 222–226

ELSEVIER

Journal of Clinical Anesthesia

Original Contribution

Effective low dosage of mepivacaine in ultrasound-guided axillary nerve block: a double-blinded, randomized clinical trial of efficacy in patients undergoing distal upper extremity surgery☆

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Received 19 December 2012; revised 31 October 2013; accepted 5 November 2013

Keywords:
Axillary plexus block;
Ultrasound-guided;
Functional block;
Mepivacaine;
Regional anesthesia;
Surgical block

Abstract

Study Objective: To evaluate two low-dose volumes (20 mL or 30 mL) of 1.5% mepivacaine solution used for ultrasound-guided axillary blockade for outpatients undergoing distal upper limb surgery.

Design: Prospective, double-blinded randomized study.

Setting: Outpatient surgical setting of a university-affiliated hospital.

Patients: 64 adult, ASA physical status 1, 2, and 3 patients, aged 28-46 years, scheduled for upper limb surgery.

Interventions: Patients were randomized to two groups to receive either 20 mL of 1.5% mepivacaine solution (n=31) or 30 mL of 1.5% mepivacaine solution (n=33) for ultrasound-guided axillary plexus blockade.

Measurements: Block duration, proportion of surgical and functional successful blocks, onset of sensory and motor blockade measured from 0 to 30 minutes following final needle extraction, total amount of preoperative sedative (midazolam), and intraoperative propofol administered were recorded.

Main Results: Following axillary plexus blockade, neither patient group showed any statistically significant difference in the percentage of functionally successful blockade (30 mL, 100%: 20 mL, 97%; $P = 0.48$), surgically successful blockade (30 mL, 100%; 20 mL, 94%; $P = 0.23$), cumulative sensory or motor blockade surgical time, block performance time, preoperative midazolam use, or intraoperative propofol use.

Conclusion: Low volumes (30 mL or 20 mL) of 1.5% mepivacaine provides satisfactory anesthesia for ambulatory distal upper limb surgery with no significant difference in clinical outcomes.

☆ This study was performed at the Detroit Medical Center, Detroit, Michigan, USA.

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http://dx.doi.org/10.1016/j.jclinane.2013.11.016
0952-8180/

1. Introduction

The use of ultrasonography as an adjunct to regional anesthesia has increased significantly [1]. Brachial plexus blockade by an axillary approach is amenable to the use of ultrasound guidance. Real-time sonography of nerve structures ensures an optimal distribution of the block solution. When compared with other methods of nerve localization, sonography decreases failure rate [2,3], procedure time [4,5], and the onset time for blockade [6,7]. Furthermore, the use of ultrasound for peripheral nerve blockade demonstrates decreased procedure-related complications such as nerve injury and unintentional vascular puncture [8,9].

Traditional axillary nerve block techniques relying on surface anatomical landmarks require large volumes of local anesthetic, generally 40 mL and greater [10,11]. Local anesthetic concentration and volume significantly affect nerve block effects [12,13]. A local anesthetic shows large variations in analgesic effect depending on the infusion rate and bolus amount [14]. Using the increased accuracy offered by ultrasound, some studies have shown that lower volumes of local anesthetic can yield successful axillary plexus blockade [1,15–17] and interscalene brachial plexus block [18]. With smaller volumes of local anesthetic observed to be clinically effective, the tradition of using large volumes of local anesthetic for axillary blocks, even without ultrasound, may be unwarranted.

Institutionally, 30 mL of a 1.5% solution of mepivacaine for axillary plexus blockade is clinically the most common volume we use. Therefore, in this study we used a 30 mL volume as the standard treatment to compare with 20 mL of a 1.5% solution of mepivacaine.

Although recent investigations support using a low volume of local anesthetic for brachial plexus blockade [18], there is a lack of outcome data from blinded randomized trials. The primary objective of this study was to evaluate two different volumes of local anesthetic for axillary blockade: 1) 30 mL or 2) 20 mL. A 1.5% solution of mepivacaine was used due to its widespread clinical use in axillary blocks, which is secondary to rapid onset of action, intermediate duration of effect, and relative low cost. The primary outcome was block success rate for outpatients undergoing distal upper limb surgery. Secondary objectives included comparing the two volumes with respect to time required to perform the block and onset of sensory and motor blockade.

2. Methods and materials

The current study had institutional review board approval and was registered at ClinicalTrials.gov NCT01485653. This study was a prospective, double-blinded, randomized trial of 64 patients recruited from the Detroit Receiving Hospital, Detroit, MI. All participating patients underwent upper limb surgery in an outpatient setting. After giving their written, informed consent, patients were randomly assigned using a computerized number generator to receive either 20 mL (n=31) or 30 mL (n=33) of a 1.5% mepivacaine solution for axillary plexus blockade. All block placements used standard medical protocol. Nerve localization was performed using a GE LOGIQe ultrasound machine (GE Medical Systems, Milwaukee, WI, USA), with a 12L-RS transducer (42 mm x 7 mm footprint, 5-13 MHz). On identification of the axillary neurovascular bundle, a 22-gauge x 50 mm poly medic UPC electric stimulation needle was inserted and advanced along the longitudinal axis of the ultrasound transducer to visualize the entire shaft and tip. A peri-arterial injection of 1.5% mepivacaine near all the individual nerve sheaths was performed after negative aspiration, with the endpoint being the circumferential "donut sign" spread around the artery. Then the musculocutaneous nerve was identified and 1.5% mepivacaine injected around the nerve. Depending on the patient group allocation, there was infiltration of either 20 mL or 30 mL of 1.5% mepivacaine. For the group receiving 20 mL, 15 of the total 20 mL was spread around the axillary artery and 5 mL spread around the musculocutaneous nerve. For the group receiving 30 mL, 20 of the total 30 mL was spread around the axillary artery with 10 mL spread around the musculocutaneous nerve. By instituting this injection technique, there is extrapolation to non-ultrasound-guided axillary blocks. For preblock sedation all subjects were administered < 0.8 mg/kg of midazolam with no administration of preoperative opioids. All block procedure times were less than 10 minutes in duration. All subjects consented to light intraoperative sedation.

2.1. Inclusion criteria

All subjects recruited into the study were patients undergoing forearm, wrist, or hand surgery in an outpatient setting. Other attributes were ASA physical status 1, 2, or 3; body mass index < 35 kg/m^2, and age between 18 and 89 years. All subjects had no history of stroke, diabetes, anxiety disorder, obstructive sleep apnea, previous surgery or scarring in the axillary to elbow area, neurological impairment of either upper extremity, allergies to local anesthesia, coagulopathy, infection at site of block, chronic opioid therapy for chronic pain, or casts or dressing on the limb that would impair assessment of blocks.

2.2. Data collection

Preoperative variables, including demographics, ASA physical status, height, weight, surgical procedure, location of procedure (hand, wrist, forearm), sedation used in the preoperative holding area, amount of sedation used, block start and end time (duration of time taken between needle insertion and extraction), onset of sensory blockade, and onset of motor blockade were all recorded.