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RESEARCH ARTICLE

Determining the Minimum Effective Volume of Local Anesthetics for Ultrasound-Guided Supraclavicular Brachial Plexus Block

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ABSTRACT

This study aims to identify the minimum effective volume of local anesthetics required for an ultrasound-guided supraclavicular brachial plexus block (BPB). Proper identification of this volume could enhance pain management while minimizing potential complications associated with higher volumes.

A total of 60 patients undergoing upper limb surgery were enrolled in this randomized, double-blind study. Participants were divided into three groups receiving varying volumes of local anesthetic: 15 mL, 20 mL, and 25 mL of a 0.25% bupivacaine solution. The onset time, quality of anesthesia, and duration of sensory and motor block were evaluated. Pain scores were assessed using a visual analog scale (VAS) postoperatively at 1, 6, and 12 hours.

Results indicated that the 20 mL volume provided adequate anesthesia with a faster onset and longer duration compared to the 15 mL group, while the 25 mL group did not show significant benefits. These findings suggest that 20 mL may be the optimal volume for effective analgesia in ultrasound-guided supraclavicular BPB, offering a balance between efficacy and safety.

Keywords: supraclavicular brachial plexus block, local anesthetics, ultrasound-guided, minimum effective volume, bupivacaine.

INTRODUCTION:

Ultrasound-guided supraclavicular brachial plexus block (BPB) has gained popularity as a technique for providing regional anesthesia for upper limb surgeries due to its high success rates and reduced complication risks compared to traditional methods (1, 2). Effective anesthesia relies heavily on the accurate administration of local anesthetics, with the volume used being a critical factor influencing both the efficacy and safety of the procedure (3).

The brachial plexus is a complex network of nerves originating from the cervical spinal roots C5 to T1. Properly blocking this plexus requires a sufficient volume of local anesthetic to diffuse through the surrounding tissue and reach the target nerves (4). However, the relationship between the volume of local anesthetic and the resultant block efficacy is not linear; increasing the volume can lead to higher risks of complications, including vascular puncture, hematoma formation, and neurological injury (5, 6).

Research has indicated that lower volumes of local anesthetics may still achieve effective blocks without the associated risks of higher volumes (7, 8). However, the minimum effective volume has yet to be standardized in clinical practice. Various studies have shown conflicting results regarding the optimal volume, with recommendations ranging from 15 mL to 30 mL (9, 10). Therefore, establishing a consensus on the minimum effective volume of local anesthetics for ultrasound-guided supraclavicular BPB is essential to enhance patient outcomes.

This study aims to investigate the minimum effective volume of local anesthetics required for ultrasound-guided supraclavicular BPB, focusing on the volume's impact on the onset time, quality of anesthesia, and duration of sensory and motor block. By identifying the most effective volume, we aim to optimize anesthesia protocols and improve patient safety.

Aim and Objectives

Aim: To determine the minimum effective volume of local anesthetics for ultrasound-guided supraclavicular brachial plexus block.

Objectives:

1. To compare the onset time and quality of anesthesia among different volumes of local anesthetics.
2. To evaluate the duration of sensory and motor block for each volume group.

Materials and Methods

This randomized, double-blind study included 60 adult patients scheduled for elective upper limb surgery requiring regional anesthesia. Inclusion criteria included patients aged 18-65 years, ASA physical

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status I-II, and those providing informed consent. Exclusion criteria comprised contraindications to regional anesthesia, infection at the injection site, and previous history of neurological disorders.

Patients were randomly assigned to one of three groups: Group A (15 mL), Group B (20 mL), and Group C (25 mL) of 0.25% bupivacaine. An ultrasound-guided approach was utilized for the BPB, ensuring accurate placement of the local anesthetic adjacent to the brachial plexus. Onset time for sensory and motor blocks was assessed using pinprick and modified Bromage scale assessments, respectively. Pain scores were recorded using a visual analog scale (VAS) at 1, 6, and 12 hours postoperatively.

Results

Table 1: Onset Times and Quality of Anesthesia

Group	Onset Time (min)	Sensory Block Quality (1-5)	Motor Block Quality (1-5)
15 mL	15.5 ± 2.1	3.2 ± 0.8	3.0 ± 0.7
20 mL	10.2 ± 1.5	4.1 ± 0.6	3.8 ± 0.6
25 mL	10.0 ± 1.8	4.0 ± 0.7	4.0 ± 0.5

Table 2: Duration of Sensory and Motor Block

Group	Duration of Sensory Block (hours)	Duration of Motor Block (hours)
15 mL	4.5 ± 1.0	3.5 ± 0.8
20 mL	6.0 ± 1.2	5.5 ± 1.0
25 mL	6.5 ± 1.1	5.7 ± 0.9

The results indicate that the 20 mL group exhibited the fastest onset time and superior quality of anesthesia compared to the 15 mL group. The duration of sensory and motor blocks was longer in the 25 mL group, but the differences were not statistically significant when compared to the 20 mL group.

Discussion

The findings of this study highlight the importance of identifying an optimal volume of local anesthetic for ultrasound-guided supraclavicular BPB. The results demonstrate that a volume of 20 mL provides a significant advantage in terms of onset time and quality of anesthesia compared to the lower 15 mL volume, while not significantly outperforming the 25 mL volume in terms of block duration.

The faster onset and better quality of anesthesia in the 20 mL group can be attributed to more effective distribution of the local anesthetic around the brachial plexus. This supports previous research suggesting that a sufficient volume of anesthetic facilitates better nerve blockade and improved patient comfort during and after the procedure (11, 12). Conversely, the lack of significant improvement in efficacy with the 25 mL volume suggests that exceeding the minimum effective volume may not confer additional benefits and could potentially increase the risk of complications, such as vascular puncture or prolonged motor block (13, 14).

Additionally, the use of ultrasound guidance has been shown to enhance the precision of needle placement and minimize complications associated with nerve blocks (15). This study reinforces the efficacy of ultrasound-guided techniques in optimizing local anesthetic administration, particularly in the context of BPB.

In conclusion, the study suggests that 20 mL of 0.25% bupivacaine is the minimum effective volume for achieving optimal anesthesia in ultrasound-guided supraclavicular BPB. This volume balances effective pain management with safety, potentially informing clinical practices in regional anesthesia.

Conclusion

Identifying the minimum effective volume of local anesthetics for ultrasound-guided supraclavicular brachial plexus block is crucial for optimizing patient outcomes. This study concludes that 20 mL of 0.25% bupivacaine provides adequate anesthesia with a favorable balance of onset time, quality, and duration of the block. These findings can enhance anesthetic protocols, contributing to improved patient safety and satisfaction in upper limb surgeries.

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