ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 17, Issue 11, 2024

Online - 2455-3891
Print - 0974-2441

Research Article

A COMPARISON OF 0.5% BUPIVACAINE ALONE VERSUS 0.5% BUPIVACAINE WITH VERAPAMIL AS AN ADJUNCT IN ULTRASOUND-GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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Received: 02 September 2024, Revised and Accepted: 16 October 2024

ABSTRACT

Objective: Supraclavicular brachial plexus blocks are commonly performed for surgeries on the upper limb because they are highly effective for both anesthesia during the procedure and pain control afterward. This method targets the entire brachial plexus, making it a popular alternative to general anesthesia, as it minimizes associated risks while offering better pain relief after the surgery. Bupivacaine, a long-lasting local anesthetic, is often preferred for this block, though its pain-relieving effects eventually wear off. Owing to limitations regarding the duration of analgesia, many adjuncts have been tried since time immemorial to enhance the effectiveness of the blocking properties of these local anesthetics. Verapamil, a calcium channel blocker, has emerged as a promising adjunct that can potentially enhance and prolong the effects of Bupivacaine. This study aims to compare the efficacy of 0.5% Bupivacaine alone versus Bupivacaine combined with Verapamil in ultrasound-guided supraclavicular brachial plexus blocks.

Methods: A randomized clinical trial was conducted on patients undergoing elective upper limb surgeries under ultrasound-guided supraclavicular brachial plexus block. Group A received 30 mL of 0.5% Bupivacaine, whereas Group B received 30 mL of 0.5% Bupivacaine with 5 mg of Verapamil. Primary outcomes included the time of onset of sensory and motor blockade and the duration of analgesia for the same, whereas secondary outcomes included post-operative pain scores and hemodynamic stability.

Results: The addition of Verapamil to Bupivacaine significantly accelerated the onset of sensory and motor blockade in Group B compared to Group A. Group B also exhibited a significantly prolonged duration of both sensory and motor blockade and reduced post-operative analgesic requirements.

Conclusion: Verapamil helps boost the effectiveness of Bupivacaine in supraclavicular brachial plexus blocks, speeding up the onset of its actions and extending its pain-relieving effects. This makes it a useful addition to local anesthetics, making it a valuable adjunct in regional anesthesia.

Keywords: Bupivacaine, Supraclavicular block ultrasound-guided, Verapamil in regional anesthesia, Brachial plexus.

 DOI: http://dx.doi.org/10.22159/ajpcr.2024v17i11.52707. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

Regional anesthesia is increasingly favored in upper limb surgeries due to its ability to provide excellent surgical conditions with minimal systemic effects [1]. The supraclavicular brachial plexus block, performed at the level of the clavicle, provides anesthesia for surgeries involving the shoulder, arm, elbow, forearm, and hand [2]. This technique has several advantages over general anesthesia, including reduced post-operative nausea, vomiting, respiratory complications, and quicker recovery times. It also offers excellent post-operative pain control, which contributes to patient satisfaction and better outcomes.

Pain is a protective mechanism of the body, where the organism tries to overcome an unpleasant situation. The International Association for the Study of Pain defines "*pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage*" [3]. The conquest of pain has been a great human quest since time immemorial and people are trying to conquer pain with various pharmacological substances and physiological and psychological techniques.

"*William Stewart Halsted in 1885*," an American surgeon and pioneer in modern surgical techniques, performed the world's first brachial plexus block [4]. This groundbreaking procedure was a major step forward in the field of regional anesthesia, offering a new method for numbing the nerves responsible for sensation and movement in the upper extremities. Less than a year after "Koller" [5] demonstrated the anesthetic properties of cocaine. Halsted surgically exposed the nerve roots and, using a local anesthetic, injected small amounts of 0.1% cocaine directly into each one while watching the process closely. This allowed him to carefully administer the anesthetic with precision [6]. Halsted's innovation allowed surgeons to perform procedures on the arm and hand without the need for general anesthesia, which carried higher risks and complications at the time. His work laid the foundation for modern nerve block techniques, which have since become essential in pain management and surgical anesthesia.

The first percutaneous supraclavicular block was performed in 1911 by German surgeon "*Diedrich Kulenkampff* (*1880–1967*)," Kulenkampff subjected himself to the supraclavicular block in what is known as the Classical approach. Subsequently, studies showed a high incidence of pneumothorax (2–6%) with this approach, and so several modifications of supraclavicular techniques were made in an effort to decrease the incidence of the dreaded complications of pneumothorax [7].

Brachial plexus anatomy

The brachial plexus is a group of nerves that starts in the neck and stretches down into the shoulder, arm, and hand. These nerves control movement and feeling in the upper limb, making them essential for tasks involving the arm and hand. It originates from the cervical and thoracic spinal roots (C5-T1) and innervates the upper extremity [8]. The supraclavicular approach to blocking the brachial plexus is particularly advantageous because the plexus is most compact at this location, allowing for dense and reliable blockade. The close proximity of the nerve structures in the supraclavicular area

allows the local anesthetic to effectively anesthetize the entire upper extremity below the shoulder [9].

Local anesthetics such as Bupivacaine are commonly used in these blocks due to their long duration of action and ability to provide profound sensory and motor blockade [10]. Even with long-lasting anesthetics such as Bupivacaine, the pain relief after surgery sometimes does not last long enough, especially for procedures that take several hours or for patients who need extended pain control. To address this, researchers have been looking into different additives that can extend the effects of these anesthetics without causing more side effects. This has ideated the exploration of various chemical additives that can increase the effects of local anesthetics without increasing the undesirable effects [11].

Verapamil as an adjuvant

Verapamil, a calcium channel blocker, was initially developed for cardiovascular applications, particularly in managing hypertension, angina, and arrhythmias. The main mechanism is that it works by the inhibition of calcium ions influx into cells, leading to relaxation of smooth muscle and decreased cardiac contractility. Recent research indicates that Verapamil might have its own anesthetic qualities. Since calcium ions are essential for nerve signaling and pain transmission, Verapamil's ability to block calcium from entering cells could boost the effects of Bupivacaine. This means it could lead to longer-lasting numbness and weakness, as well as extended pain relief after surgery [12-14].

Given the potential benefits of Verapamil as an adjuvant, this study aims to compare the effectiveness of 0.5% Bupivacaine alone versus 0.5% Bupivacaine combined with Verapamil in ultrasound-guided supraclavicular brachial plexus block. The primary outcomes measured include the onset time of sensory and motor blockade, the duration of analgesia, and post-operative pain scores.

METHODS

Study design

This study was designed as a randomized, double-blinded clinical trial to ensure unbiased results. This trial was performed at a tertiary health-care institution, and approval was obtained from the institutional ethics committee. All participants were extensively detailed about the procedure properly and then written informed consent was obtained from them before including them in the study.

Participants

A total of 120 patients, aged between 21 and 65 years, who were scheduled for elective upper limb surgeries, were recruited for the study. Patients classified as American Society of Anesthesiologists (ASA) physical status I or II were eligible to participate. The criteria for exclusion included a history of allergy to local anesthetics or Verapamil, patients on calcium channel blockers for hypertension and other cardiovascular pathology, coagulopathy, peripheral neuropathy, or any significant cardiovascular or respiratory disease that might contraindicate the use of regional anesthesia.

Group allocation and randomization

Patients were randomly allocated to one of two groups using a computer-generated randomization sequence:

Group A (control group, n=60): Received 30 mL of 0.5% Bupivacaine alone for the supraclavicular brachial plexus block.

Group B (intervention group, n=60): Received 30 mL of 0.5% Bupivacaine combined with 5 mg of Verapamil for the block.

Both the patients and the investigators responsible for analyzing the outcomes were exempted from the group allocation process to eliminate biasing.

Block procedure

All patients were positioned in a semi-supine position with their heads turned away from the side to be blocked. The skin over the supraclavicular fossa was sterilized, and a high-frequency (8–18 MHz) linear ultrasound transducer was placed over the fossa to visualize the brachial plexus and surrounding structures [15,16]. The plexus appeared as a cluster of hypoechoic round structures lateral and superficial to the subclavian artery.

After identifying the plexus and subclavian artery, (brachial plexus appears as honeycombing with pulsatile subclavian artery laterally and hyperechoic first rib downward) [17,18] a 22-gauge insulated block needle was inserted in-plane under continuous ultrasound guidance. The needle was advanced until its tip was visualized adjacent to the brachial plexus. After confirming the correct position of the block needle, the local anesthetic solution was injected incrementally, with intermittent aspiration checking the blood return, to avoid intravascular injection [19]. In Group B, Verapamil was admixed with Bupivacaine before administration.

Outcomes measured

Primary and secondary outcomes were measured to assess the efficacy of the block and the safety of the adjuvant.

Primary outcomes

1. Onset time of sensory blockade: This is defined as the time taken from the end of the injection to when the patient no longer feels a pinprick sensation in the areas served by the median, radial, ulnar, and musculocutaneous nerves
2. Onset time of motor blockade: Defined as the time from the completion of the injection to the loss of movement in the same nerve distribution
3. Duration of analgesia: Measured from the time of injection to the first request for rescue analgesia postoperatively.

Secondary outcomes

1. Post-operative pain scores: Assessed using a Visual Analog Scale (VAS) at 6, 12, and 24 h postoperatively
2. Hemodynamic stability: Blood pressure, heart rate, and oxygen saturation were continuously monitored throughout the procedure and for the first 24 h postoperatively to assess any undesirable effects of Verapamil.

Statistical analysis

Data were analyzed using IBM Statistical Packages for the Social Sciences software (version 29). Continuous variables were reported as mean±standard deviation, whereas categorical variables were shown as percentages. The Student's t-test was employed to compare continuous variables between the two groups, and the Chi-square test was used for categorical variables. A $p<0.05$ was deemed statistically significant.

RESULTS

Demographic and clinical characteristics

The baseline demographic and clinical characteristics of the patients in both groups were comparable. There were no statistically significant differences between Group A and Group B in terms of age, gender distribution, ASA status, or mean duration of surgery (Table 1). This ensured that the outcomes observed were not influenced by any confounding factors related to the patient population.

Onset of sensory and motor blockade

Adding Verapamil noticeably sped up the onset time for both sensory and motor blockade. In Group B, the average time for sensory blockade to start was 9.93 min, which was significantly shorter than the 12.48 min recorded in Group A ($p<0.05$). Similarly, the onset of motor blockade was faster in Group B, occurring at a mean time of 12.33 min compared to 15.95 min in Group A ($p<0.05$) (Table 2).

Table 1: Demographic characteristics of patients

Characteristics	Group A		Group B		p-value
Age (years)	<30 years	>30 years	<30 years	>30 years	
	32	28	28	32	0.64
Gender (M/F)	M	F	M	F	Non-significant
	15	45	17	43	
ASAI/II	ASA-I	ASA-II	ASA-I	ASA-II	
	26	34	40	20	

ASA: American Society of Anesthesiologists

This acceleration in the onset of the blockade in Group B can be attributed to Verapamil's ability to enhance the local anesthetic effect of Bupivacaine by inhibiting calcium influx through voltage-gated calcium channels. Calcium ions are crucial for the transmission of nerve impulses [20,21], and their inhibition by Verapamil may potentiate the action of Bupivacaine, leading to a quicker onset of anesthesia.

Duration of sensory and motor blockade

Group B demonstrated a significantly prolonged duration of both sensory and motor blockade compared to Group A. The mean duration of sensory blockade in Group B was 399.25 min, which was significantly longer than the 307.23 min observed in Group A ($p<0.05$). Similarly, the motor blockade lasted for 327.83 min in Group B compared to 295 min in Group A ($p<0.05$)(Table 3).

This prolongation of sensory and motor blockade can be explained by the pharmacological properties of Verapamil, which blocks calcium channels and thus prolongs the depolarization and repolarization phases of nerve transmission. A longer blockade is helpful in clinical practice because it means patients need fewer repeated doses of pain relievers after postoperatively. This not only enhances patient comfort but also helps lower health-care costs.

Duration of analgesia

The duration of post-operative analgesia was significantly longer in Group B. Patients in Group B did not require rescue analgesia for 60 min postoperatively, whereas patients in Group A required their first dose of rescue analgesia after 90 min ($p<0.05$). This finding is particularly important as prolonged analgesia can enhance patient recovery and reduce post-operative pain-related complications.

Post-operative pain scores

Post-operative pain was measured using the VAS at several intervals (6, 12, and 24 h after surgery). Group B consistently reported lower pain levels than Group A at every time point. At 6 h post-surgery, the average VAS score for Group B was between 2 and 3, whereas Group A's scores ranged from 4 to 6 ($p<0.05$). This pattern continued at 12 and 24 h, with Group B experiencing significantly less pain than Group A. The lower pain scores in Group B are likely due to the longer-lasting pain relief provided by Verapamil.

Hemodynamic stability

Both groups maintained stable hemodynamic parameters throughout the procedure and during the post-operative period. There were no significant differences in systolic blood pressure, diastolic blood pressure, or heart rate between the two groups at any time point ($p>0.05$). No adverse cardiovascular events, such as bradycardia or hypotension, were observed in either group.

The hemodynamic stability observed in both groups suggests that the addition of Verapamil, at the dose used in this study, does not significantly affect cardiovascular function. This finding aligns with previous studies that have reported minimal hemodynamic disturbances with the use of Verapamil in regional anesthesia.

DISCUSSION

The results of this study show that Verapamil is a safe and effective addition for extending the effects of Bupivacaine in ultrasound-guided supraclavicular brachial plexus blocks. By adding Verapamil, the onset time for both sensory and motor blockade was significantly reduced, indicating that it speeds up the action of Bupivacaine. This aligns with earlier research suggesting that calcium channel blockers such as Verapamil can enhance local anesthetics by blocking calcium entry and prolonging nerve blockade.

Table 2: Time of onset of sensory and motor block

Outcome	Group A	Group B	p-value
Onset time of sensory block (minutes)	12.48±1.42	9.93±1.40	<0.05
Onset time of motor block (minutes)	15.95±1.47	12.33±0.84	

Table 3: Duration of sensory and motor block

Outcome	Group A	Group B	p-value
Duration of sensory block (minutes)	307.23±23.06	399.25±25.16	<0.05
Duration of motor block (minutes)	295	327.83±23.04	

In terms of duration, Group B experienced significantly longer sensory and motor blockades compared to Group A. This is an important finding for clinical practice because longer-lasting anesthesia means patients need fewer additional doses of pain relief after surgery. This can improve comfort, reduce opioid use, and minimize the risks linked to systemic analgesics. Verapamil likely contributes to this extended duration by blocking calcium channels and preventing nerve depolarization.

Patients in Group B also enjoyed significantly longer post-operative pain relief, lasting several hours more than those in Group A. This extended relief is particularly beneficial for surgical procedures that require ongoing pain management. The lower pain scores in Group B at 6-, 12-, and 24-h post-surgery further emphasize the effectiveness of Verapamil in enhancing pain relief.

Maintaining hemodynamic stability is crucial in regional anesthesia, especially when using adjuvants that may impact the body systemically. Throughout the procedure and recovery period, both groups showed stable hemodynamic parameters, suggesting that a dose of 5 mg of Verapamil does not negatively affect cardiovascular function. This finding supports previous studies that have confirmed the safety of Verapamil as an adjunct in regional anesthesia.

Comparison with previous studies

Several studies have explored the use of Verapamil as an adjunct in regional anesthesia, yielding mixed results. For instance, Lalla *et al*. found that Verapamil extended sensory blockade when combined with Bupivacaine but did not have a significant effect on motor blockade duration. However, this study demonstrated that Verapamil significantly prolonged both sensory and motor blockade. This difference could be attributed to variations in drug dosage, concentration, or the use of

ultrasound guidance, which allows for more accurate placement of the anesthetic agent [22].

Mosaffa *et al*. reported that Verapamil reduced the onset time of anesthesia, motor blockade, and total anesthesia duration, but there was no statistically significant difference between the 2.5 mg and 5 mg doses ($p>0.05$). In addition, patients who received Verapamil did not experience more than a 20% change in blood pressure or heart rate from baseline.

Reuben and Kreitzer found that calcium channel blockers enhance the pain-relieving effects of both local anesthetics and opioids. They observed these effects when administering morphine, Verapamil, or a combination of the two along with lidocaine into the brachial plexus sheath in 75 patients undergoing upper limb orthopedic surgery [23].

Other studies have also reported minimal changes in hemodynamic parameters with the use of Verapamil in regional anesthesia, aligning with the findings of this study. The stable hemodynamic readings in both groups indicate that Verapamil can be safely used in clinical practice without increasing the risk of cardiovascular complications.

CONCLUSION

The findings of this study indicate that adding Verapamil to 0.5% Bupivacaine in ultrasound-guided supraclavicular brachial plexus blocks significantly improves both the onset and duration of sensory and motor blockade. Verapamil also extends post-operative pain relief, decreasing the need for additional pain medication and enhancing patient comfort after surgery. Importantly, using Verapamil does not affect hemodynamic stability, making it a safe and effective adjunct for regional anesthesia.

Thus, Verapamil is a valuable tool for anesthesiologists looking to boost the effectiveness of peripheral nerve blocks in upper limb surgeries. Future research should investigate various doses of Verapamil and other calcium channel blockers in regional anesthesia to maximize their benefits while ensuring patient safety. In addition, long-term follow-up studies are necessary to evaluate the safety of Verapamil in larger groups of patients and to explore any potential neurotoxic effects that may arise from high doses or extended use.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

CONFLICT OF INTEREST

There is no conflict of interest.

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