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Original Article

Anaesthesia Section

Ultrasound-guided Supraclavicular Brachial Plexus Block with Ropivacaine in Basilic Vein Transposition Surgery for Chronic Renal Failure Patients: An Interventional Study

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ABSTRACT

Introduction: Basilic Vein Transposition surgery (BVT) is preferred under ultrasound-guided supraclavicular brachial plexus block, which provides excellent and safe anaesthesia in Chronic Renal Failure (CRF) patients. Ropivacaine, with a shorter elimination half-life than bupivacaine and better pharmacokinetics, is a safer option as a local anaesthetic agent in CRF.

Aim: To assess the onset and duration of sensory and motor blockade with 20 mL of 0.5% ropivacaine in ultrasound-guided supraclavicular block and the need for additional local infiltration at the surgical site for BVT.

Materials and Methods: In present interventional study conducted in the Department of Anaesthesiology, Pramukhswami Medical College, Bhaikaka University, Karamsad, Anand, Gujarat, India, 25 American Society of Anaesthesiologists (ASA) III/IV CRF patients, aged 18-80 years, who underwent BVT surgery, were included from December 2021 to November 2022. A 20 mL dose of 0.5% ropivacaine was administered to these patients via ultrasound-guided supraclavicular block. The surgeon performed local infiltration with 10 mL of lignocaine at the T2 dermatomal area in all patients. Descriptive statistics were calculated for age, weight, ASA status, onset and duration of sensory and motor blockade, and the need for additional local infiltration.

Results: The mean age and mean weight of the patients were 52 years and 57.68 kg, respectively. Total 17 were male and eight were female, while 23 were ASA III and two were ASA IV. After administering the supraclavicular block, the mean onset of sensory and motor blockade was 9±2.3629 and 13.16±2.6721 minutes, respectively. The mean duration of sensory and motor blockade was 612.8±132.815 and 522.8±121.124 minutes, respectively. All patients required local site infiltration (10 mL of 1% lignocaine-Adrenaline) as the T2 dermatome is usually spared by the supraclavicular block. Three patients required additional local anaesthetic infiltration.

Conclusion: Minimising the concentration and volume of local anaesthetic drugs without compromising efficacy is challenging, particularly in BVT, where the incision is extensive and performed under supraclavicular BPB in high-risk CRF patients. The anaesthesia practice of using a low volume of 0.5% ropivacaine in BPB under ultrasound guidance, along with local anaesthetic infiltration with 1% lignocaine with adrenaline at the T2 dermatome, can serve this purpose without any complications.

Keywords: Anaesthesia, Dermatome, Interventional, Ultrasonography

INTRODUCTION

The recommended primary method of choice in patients undergoing haemodialysis is autologous radiocephalic or brachiocephalic fistula. However, for patients with failed radiocephalic or brachiocephalic fistula or those with smaller caliber superficial veins, vascular access becomes difficult. Therefore, BVT is a secondary option recommended in these patients [1]. BVT surgery can be performed using two methods: a) Conventional technique-which requires a long incision over the medial aspect of the arm to dissect the basilic vein upto the axillary vein, followed by cutting in the cubital fossa and transposing it into the subcutaneous tissue through multiple small incisions to perform the end-to-side basilic vein-brachial artery anastomosis; b) Modified technique- Basilic vein mobilisation of the basilic vein upto the axilla through dissection with small longitudinal incisions, ligation and division at the cubital fossa, and bringing it over the fascia through a newly created subcutaneous tunnel, followed by end-to-end anastomosis of the basilic vein with the brachial artery.

Regional anaesthesia produces sympathetic nerve block, resulting in an increase in intraoperative and postoperative venous diameter and vessel flow, thereby preventing thrombosis formation and fistula failure [2,3]. Thus, upper limb vascular surgery is preferably performed under regional anaesthesia, and especially peripheral nerve block, as it provides superior pain control in the postoperative period, better haemodynamic stability, increased vessel flow, avoids the risk of airway manipulation, and allows the patient to remain conscious. This can lead to faster discharge from the hospital when compared to general anaesthesia [3]. Under ultrasound guidance, peripheral block is a safe, highly effective, minimally invasive, and cost-effective method of anaesthesia for upper extremity vascular surgery. The ultrasound-guided technique provides the best quality of regional block, irrespective of the approach, most probably due to more accurate placement of the injection needle, more rapid onset, longer duration of the block, reduced vascular and neurological complications, and minimisation of the volume of local anaesthetic required.

Ropivacaine is a new long-acting amide, pure S-enantiomer local anaesthetic with a high pKa and relatively low lipid solubility. Ropivacaine is metabolised to 3-hydroxyropivacaine in the liver via cytochrome P450 1A2 and to 2,6 Pipercoloxylidide (PPX) by CYP3A4. Three-hydroxyropivacaine and PPX are excreted in the urine at 37% and 3%, respectively. 3-hydroxyropivacaine is non toxic, whereas unbound PPX can lead to Central Nervous System (CNS) toxicity. Only 1% of ropivacaine is excreted unchanged in the urine [4]. Thus, the pharmacokinetics of ropivacaine are not affected by renal failure [4]. Previous studies have been conducted where ropivacaine and other local anaesthetic agents were used in CRF patients undergoing Arteriovenous Fistula (AV fistula) surgery or other

non vascular surgeries [5-8]. Ropivacaine has also been studied for forearm surgeries, especially orthopedic surgeries, in patients with normal renal function [9-13]. BVT surgeries are invasive, involving an extended incision from the cubital fossa to the axilla, which includes the T2 dermatome. Some studies have shown the effectiveness of either intercostobrachial nerve block or pectoral nerve (PECS) II block with brachial plexus block to prevent the sparing effect of exclusive BPB at the T2 dermatome in BVT surgery [14,15]. Local anaesthetic infiltration with lignocaine can be an effective method to avoid sparing of the T2 dermatome. Thus, the present study was planned to evaluate anaesthesia practices that include low-volume ropivacaine in brachial plexus block, along with local anaesthetic infiltration at the T2 dermatome for such surgeries.

MATERIALS AND METHODS

An interventional study conducted in the Department of Anaesthesiology, Pramukhswami Medical College, Bhaikaka University and was planned in CRF patients posted for BVT surgeries under ultrasound-guided supraclavicular block at Shree Krishna Hospital, Karamsad, Anand, Gujarat, India, from December 2021 to November 2022. The study was approved by the Institutional Ethics Committee (IEC/BU/130/Faculty/6/218/2021) and registered with the Clinical Trials Registry India (CTRI/2021/12/038674). Written and informed consent was obtained from all participants who met the inclusion and exclusion criteria.

Sample size calculation: The sample size was calculated to be 27 patients in each group, with 80% power, 5% type I error, and considering a moderate effect size of 0.7 (Stata 14.2 statistical software).

Inclusion and Exclusion criteria: Patients between 18-80 years of age, with American Society of Anaesthesiologists (ASA) III/IV status, who were scheduled for BVT surgery under ultrasound-guided supraclavicular BPB, were included in the study. Patients with coagulopathy, skin infection near the block injection site, refusal to participate, or allergy to local anaesthetics were excluded from the study.

Study Procedure

The initial plan of the study was a randomised controlled trial, in which the study subjects were to be divided into two groups. One group would receive 20 mL of 0.5% ropivacaine in the ultrasound-guided supraclavicular block, and the other group would receive 30 mL of 0.5% ropivacaine. A pre-anaesthetic check-up was carried out in all patients, including a detailed history and general and systemic examination. All preoperative medications were administered as per the schedule. In the preoperative anaesthesia area, it was confirmed that patients had fasted for 6-8 hours overnight. An intravenous cannula was inserted, and baseline measurements of heart rate, blood pressure, oxygen saturation, and respiratory rate were recorded. The block was performed by anaesthesiologists who had expertise in performing ultrasound-guided supraclavicular block.

However, due to the Coronavirus Disease-2019 (COVID-19) pandemic, the number of BVT cases drastically reduced in present Institution. Therefore, the Institutional Ethics Committee was requested to allow an interventional study to be conducted in a single group with the available cases, as it was a novel project with positive implications for patient care. The IEC (IEC/BU/130/Faculty/6/62/2022) approved the modification to the study. During the study period, 25 participants were included in the study. Power calculation was not attempted because the aim of the study was changed to explore the sensory and motor blockade characteristics in a single group rather than comparing two groups.

Once inside the operating theatre, standard anaesthesia monitors were applied. All patients received premedication with intravenous midazolam at a dose of 0.02 mg/kg. Patients were positioned supine with their head turned 45 degrees away from the side to be blocked, and their arm adducted with the hand extended towards the ipsilateral knee. The block was performed under strict aseptic precautions using a 22-gauge stimuplex needle and an 8-12 MHz linear ultrasound probe. The transducer was positioned in the transverse plane just above the midpoint of the clavicle. After identifying the brachial plexus with ultrasound, the needle was inserted from a lateral to medial direction using an in-plane technique to reach the plexus. Once localised, 20 mL of 0.5% ropivacaine was administered. During the injection, negative aspiration was performed every 3 mL to prevent accidental intravascular injection. The time of drug administration was noted and patients were evaluated every five minutes after completion of the local anaesthetic injection until complete sensory and motor blockade was achieved. If, complete sensory and motor blockade was not achieved and the patient perceived pain, then it was considered a failed block. In such cases, a supplementary block was given, infiltration at the surgical site was performed, or general anaesthesia was administered.

The onset of sensory block was defined as the time interval between complete administration of the drug and absence of sensation to pinprick. The duration of sensory block was defined as the time interval between the onset of complete sensory block and the return of normal sensation to pinprick. Sensory score was assessed using the needle prick method, with a score of 0 indicating normal sensation of pinprick, a score of 1 indicating a weaker sensation of pinprick (analgesia), and a score of 2 indicating no perception of pinprick (anaesthesia) [11].

The onset of motor block was defined as the time interval between complete administration of the drug and complete loss of muscle function. The duration of motor block was defined as the time interval between the onset of complete motor blockade and the recovery of normal muscle function.

The quality of motor blockade was assessed using a three-point scale based on wrist flexion and extension. A score of 0 indicated normal muscle function (no weakness), a score of 1 indicated paresis, and a score of 2 indicated absent movement (paralysis) [11].

All patients received 10 mL of 1% lignocaine with adrenaline in local infiltration at the T2 dermatomal area by the surgeon. The need for additional volume of local infiltration, if any, was assessed. Patients were also assessed for complications like difficulty in breathing, swelling/bruising at the block site, nausea, vomiting, hoarseness of voice, and neuropathy.

The primary objective of present study was to assess the onset and duration of sensory and motor blockade after ultrasound-guided supraclavicular block with 20 mL of 0.5% ropivacaine. The secondary objective was to evaluate the need for additional local anaesthetic infiltration at the surgical site, beyond the routine requirement at the T2 dermatome.

STATISTICAL ANALYSIS

The analysis was performed using descriptive statistics, including mean Standard Deviation (SD) and frequency (%), to portray the demographic, clinical, and biochemical characteristics of the study population. Age and weight were described using the mean, while sex and ASA status were described using frequency. The onset and duration of blockade were described using the mean and SD. The need for additional local infiltration was described using frequency.

RESULTS

The mean age of the patients enrolled in the study was 52 years, and the mean weight was 57.68 kg. Male patients accounted for 68% of the study population, while female patients accounted for 32%. In terms of ASA status distribution, 92% of the patients were classified as ASA III, while 8% were ASA IV [Table/Fig-1].

Parameters	Mean	Range
Age (years)	52.04	19-80
Weight (kg)	57.68	40-70
Gender	Male	Female
	17	8
ASA III/ASA IV	16/1	7/1

[Table/Fig-1]: Age, weight, gender and ASA distribution of subjects.

[Table/Fig-2] describes the data on the sensory and motor blockade of BPB, with the mean and SD provided in minutes. The mean onset of sensory and motor blockade was 9±2.3629 and 13.16±2.6721 minutes, respectively. The mean duration of sensory and motor blockade was 612.8±132.815 and 522.8±121.124 minutes, respectively, after administering the supraclavicular block.

Total	Minimum (minutes)	Maximum (minutes)	Mean±SD (minutes)
Onset of sensory blockade	5	15	9±2.3629
Onset of motor blockade	10	20	13.16±2.6721
Duration of sensory blockade	420	1020	612.8± 132.815
Duration of motor blockade	360	900	522.8 ±121.124

[Table/Fig-2]: Onset and duration of sensory and motor blockade.
Total patients observed=25; SD: Standard deviation

All patients required local site infiltration (10 mL of 1% lignocaine with adrenaline) as the T2 dermatome is typically not affected by the supraclavicular block. Upon assessing the need for additional local infiltration, three patients (12%) required more than 10 mL of additional local infiltration during surgery.

Vital signs were monitored throughout the study in all patients, and they remained within acceptable limits. No complications were observed in any of the patients.

DISCUSSION

Patients with Chronic Renal Failure (CRF) are at high-risk of perioperative morbidity due to the presence of risk factors such as hypertension, anaemia, coagulopathy, metabolic acidosis, and hyperkalemia. These risk factors are directly associated with uremia and other co-morbidities such as ischemic heart disease, diabetes mellitus, and chronic pulmonary disease [5]. In the case of a possible intravascular injection, the presence of acidosis and hyperkalemia in CRF patients may increase the cardiotoxicity associated with local anaesthetics [5].

Considering all the advantages of ultrasound, especially in high-risk CRF patients, ultrasound-guided supraclavicular Brachial Plexus Block (BPB) was preferred using 20 mL of 0.5% ropivacaine in patients undergoing BVT surgery. A study by Wong MH et al., concluded that the minimum effective volume of 0.5% ropivacaine for ultrasound-guided costoclavicular BPB was 20.9 mL with a 95% confidence interval in patients undergoing forearm or hand surgery [6]. The results of present study were comparable to the current study, which used the same volume of 20 mL of 0.5% ropivacaine.

In the current study, the mean onset of sensory blockade was 9±2.3629 minutes, and the mean onset of motor blockade was 13.16±2.6721 minutes. In comparison, Tawfic TA and Agameya HM and Altintas F et al., reported delayed onset times of sensory blockade (14.01 minutes and 13.8±8.3 minutes, respectively) and motor blockade (17.9 minutes and 19.2±7.1 minutes, respectively) [7,8]. This difference in onset times may be attributed to the use of Peripheral Nerve Stimulator (PNS) guided blocks and lower concentrations of ropivacaine (0.25% and 0.33%) in those studies.

In the present study, a volume of 20 mL of ropivacaine was required to achieve effective anaesthesia and analgesia. In contrast, Kaur A et al., required a larger volume (30 mL) to achieve the same effect. This discrepancy may be due to the lower volume of local anaesthetic required with the ultrasound-guided technique [9].

The mean duration of sensory blockade in the current study was 612.8±132.815 minutes, while the mean duration of motor blockade was 522.8±121.124 minutes. Tawfic TA et al., found similar results but with a higher volume of 30 mL [7]. This suggests that PNS-guided blocks require a higher volume to produce the same anaesthetic and analgesic effect compared to ultrasound-guided blocks.

In the studies by Altintas F et al., and Kaur A et al., the duration of sensory and motor blockade was shorter (590±140 minutes and 421.2±38.33 minutes for sensory blockade, 450±70 minutes and 365.6±34.29 minutes for motor blockade, respectively) [8,9]. This difference may be attributed to the lower concentration (0.33%) of ropivacaine and the use of landmark-guided blocks in those studies. In contrast to the current study, Chadha M et al., found prolonged analgesia with a higher volume (35 mL) of ropivacaine [10].

The BVT surgery involves an incision extending upto the axilla. A supraclavicular block anesthetizes the dermatomes of C7 to T1, leaving the medial side of the upper arm spared, which is supplied by the intercostobrachial nerve (T2 dermatome). Therefore, in present study, all patients undergoing BVT surgery with ultrasound-guided supraclavicular BPB required local anaesthetic infiltration at the T2 dermatome. Similar results were found in a study by Mathew D and Wong MH where they observed that patients remained pain-free during surgery without the need for supplemental local anaesthetic after performing an ultrasound-guided intercostobrachial nerve block and axillary BPB in patients undergoing transposed brachial basilic arteriovenous fistula surgery for vascular access [14].

Beh ZY et al., used a pectoral nerve (PECS) II block in addition to BPB to avoid sparing the T2 dermatome. They administered an additional volume of 0.25% ropivacaine for the PECS II block in their case series [15].

In the present study, to cover the T2 dermatome, every patient required local site infiltration by the surgeon before making the incision in the T2 dermatomal area. The surgeon used 10 mL of 1% lignocaine adrenaline for this purpose. Patients did not report any pain with this infiltration. However, in three patients, the surgeon needed to use more than 10 mL of local infiltration volume.

The use of ultrasound can help reduce the risk of complications such as pneumothorax and accidental intravascular injection. Ultrasound provides better visualisation of the needle tip, drug delivery, and visualisation of the pleura and 1st rib. In the present study, no complications were observed in any patient, and vital signs remained within acceptable limits throughout the procedure.

In contrast, Tawfic TA and Agameya HM observed complications such as respiratory distress and Horner's syndrome in the bupivacaine group [7], and Hickey R et al., reported complications such as Horner's syndrome, particularly with bupivacaine, and the need for additional supplements in the block due to failure [11].

Limitation(s)

The present was a single-arm interventional study with a limited number of patients enrolled due to the COVID-19 pandemic. In the future, studies comparing different volumes of ropivacaine or comparing ropivacaine with other local anaesthetic agents can be conducted.

CONCLUSION(S)

In surgeries like BVT, where the incision is extensive and performed under supraclavicular BPB in high-risk CRF patients, it is preferred to use lower concentrations and volumes of local anaesthetic drugs. This approach helps ensure effective anaesthesia while maintaining safety. In this study, a low volume of 0.5% ropivacaine (20 mL) was used for the BPB under ultrasound guidance. Additionally, local anaesthetic infiltration with 1% lignocaine with adrenaline at the T2

dermatome was performed. This combination allowed for effective anaesthesia without compromising safety.

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