

THE STUDY OF EFFECTIVENESS OF ROPIVACAINE IN AXILLARY BRACHIAL PLEXUS BLOCK FOR FOREARM SURGERY

Acharya S,¹ Bajracharya GR,¹ Gauchan S,¹ Dhakal N²

¹Department of Anaesthesia, ²Department of Community Medicine, Nepal Medical College Teaching Hospital, Attarkhel, Gokarneshwor-8, Kathmandu, Nepal

ABSTRACT

Brachial plexus block is a suitable alternative to general anaesthesia for patient undergoing upper extremity surgery. Ropivacaine the S-enantiomer emerged as a possible replacement of Bupivacaine without undesirable toxic effects. Therefore this study was conducted to assess the block characteristics and side effects of 0.75% ropivacaine in axillary brachial plexus block for forearm surgeries. This interventional study was carried out in 30 patients of ASA physical status I or II, aged 18 to 60 yrs undergoing elective surgery under axillary brachial plexus block with 20 ml of 0.75 % Ropivacaine using ultrasound and nerve stimulator. The mean onset time of sensory block was 4.53 ± 1.18 minutes and duration of sensory block was 491.00 ± 57.45 minutes. The mean onset time of motor block was 9.17 ± 1.39 minutes and duration of motor block was 452.50 ± 52.34 minutes. The mean time for rescue analgesia or total analgesic effect was 569.47 ± 88.46 minutes. No patients developed any side effects. The result of this study concluded that Ropivacaine is a safe drug providing longer duration of sensory analgesic effect and early recovery of motor function with good operating conditions for forearm surgeries under brachial plexus block.

KEYWORDS

Ropivacaine, axillary brachial plexus block, forearm surgeries, Nepal

CORRESPONDING AUTHOR

Dr. Sulav Acharya,
Lecturer
Department of Anaesthesia,
Nepal Medical College Teaching Hospital,
Attarkhel, Gokarneshwor-8, Kathmandu, Nepal
Email: sulav37@hotmail.com
Orcid No: <https://orcid.org/0000-0002-8388-1450>
DOI: <https://www.doi.org/10.3126/nmcj.v22i4.34192>

INTRODUCTION

Peripheral nerve blocks have seen a big resurgence of interest in the past decade especially with the advent of ultrasound. Nerve blocks have evolved from being an art that only a few physicians can master to more objective and transferable skill largely due to the introduction of ultrasound guidance. Peripheral nerve blocks today are a major component of perioperative multimodal analgesia.^{1,2} In particular, for upper extremity surgeries, blocks of brachial plexus (interscalene, supraclavicular, infraclavicular and axillary approaches) have been consistently shown to be associated with time-efficient anaesthesia, faster recovery, fewer adverse events, better analgesia, and greater patient acceptance.³⁻⁵ The axillary brachial plexus block provides surgical anaesthesia at and below the elbow. The technique is relatively simple to perform because of superficial location and relatively lower risk of complications as compared to interscalene (e.g., phrenic nerve block, spinal cord or vertebral artery puncture) or supraclavicular (e.g. pneumothorax) approaches. Inadvertent intraneural and intravascular injections are the only significant risks. Various methods of axillary brachial plexus block have been described such as paraesthesia-seeking, nerve stimulating, perivascular, trans-arterial, and ultrasound-guided techniques. Bupivacaine is a well-established long-acting regional anaesthetic, which like all amide anaesthetics has been associated with cardiotoxicity when used in high concentration or when accidentally administered intravascularly. Ropivacaine is a long-acting regional anaesthetic that is structurally related to Bupivacaine. It is a pure S() enantiomer, unlike Bupivacaine, which is a racemate, developed for the purpose of reducing potential toxicity and improving relative sensory and motor block profiles.⁶ Ropivacaine is less lipophilic than bupivacaine and is less likely to penetrate large myelinated motor fibres, resulting in a relatively reduced motor blockade. Ropivacaine has a greater degree of motor sensory differentiation. It has selective action on the pain transmitting A δ and C nerves rather than A β fibres, which are involved in motor function. In the upper limb, surface ultrasound can clearly identify neural elements of the brachial plexus as well as surrounding structures.⁷⁻⁹ Ultrasound guided brachial plexus block gains the advantage of accurate nerve localization, real time visualization of brachial plexus, blood vessels, needle placement and local anaesthetic spread. It minimizes the number of needle attempts.

With the advent of ultrasound technology and nerve stimulator there is a marked improvement in the success rate, shorter onset time and reduction in the volume required for successful block. Paramount importance should be given to continuous visualisation of the needle advancement, tip position and spread of injectate in order to minimise intravascular and intraneural injection.

So this study was conducted to assess the block characteristics ie, the onset and duration of sensory and motor block, duration of analgesia and side effects of 0.75% ropivacaine in axillary brachial plexus block for forearm surgeries.

MATERIALS AND METHODS

This interventional study was carried out at Nepal Medical College Teaching Hospital from 1st of December 2019 to 30th of May 2020 after approval from institutional review committee. Written informed consent was taken from all patients who participated in the study. Thirty patients of ASA physical status I or II, aged 18 to 60 years, undergoing routine surgery under axillary brachial plexus block using 0.75% ropivacaine were included in the study. Patients with coagulopathy, history of brachial plexus injury, allergy to ropivacaine and presence of systemic infection or infection at site of injection were excluded from the study.

Pre anesthetic checkup was done. Anaesthetic procedure as well as 10cms visual analogue scale (VAS) (0-no pain and 10-worst pain imaginable) was explained to the patient. Informed written consent was obtained from all the patients who meet the inclusion criteria. The patient was shifted to the operating room. Standard monitors were connected. Base line heart rate (HR); noninvasive arterial systolic blood pressure (SBP) and diastolic blood pressure (DBP); and peripheral oxygen saturation (SpO₂) were recorded. An 18 gauge i.v cannula was inserted in non-operating hand and lactated Ringer's solution was started as standard protocol of our hospital. Axillary brachial plexus block was performed by using ultrasound (USG) Guided single-injection and nerve stimulator technique. All patients received 20 ml of 0.75% ropivacaine. Both sensory and motor blocks was assessed by the primary investigator.

Sensory block was assessed by a 3 – point scale¹⁰ by the pinprick method in the dermatomes corresponding to median, radial, ulnar and musculocutaneous nerve.

- » 0 – normal sensation
- » 1 – loss of sensation of pinprick (analgesia)/ dull sensation felt
- » 2 – loss of sensation of touch (anesthesia)

Onset time for sensory block was defined as the time interval between the end of ropivacaine administration and feeling of dull sensation along the distribution of any one nerves (score 1 for all nerves). Duration of sensory block was defined as the time between dull sensation felt to return to normal sensation. Motor blockade was assessed by modified Bromage scale¹¹ (MBS) for the upper limb;

- » 0-able to raise the extended arm to 90° for full two seconds.
- » 1-able to flex elbow and move the fingers but unable to raise the extended arm.
- » 2-unable to flex the elbow but able to move the fingers.
- » 3-unable to move the arm, elbow, fingers.

mg iv was given and time was noted. Patients were asked to note the subjective recovery of sensation and movements which was certified by principle investigator. The time between complete sensory block and first analgesic request was defined as duration of analgesia. Statistical Analysis was performed using SPSS 16 software.

RESULTS

Total 30 patients were recruited in this study. There was no block failure in any of these patients probably due to close deposition of drugs in the vicinity of nerve plexus using ultrasound and peripheral nerve stimulator.

The mean age of patients involved in the study was 34.63 ± 11.58 yrs. Out of 30 patients 22 were male and 8 were female with M: F ratio of

Table 1: Demographic Variables

S.No	characteristics	Mean	S.D	95% CI of Mean
1.	Age(years)	34.63	11.58	30.49 - 38.78
2.	M/F	22 /8 (73.33/26.67%)		
3.	ASA(I/II)	21/9 (70/30%)		

Motor block onset time was considered when there was grade 1 motor block (MBS score 1). Duration of motor block was determined by noting the time the patients first moved their fingers. Inadequate sensory and motor blockade beyond 30 min following the infiltration was considered as an unsuccessful block and was supplemented with general anesthesia. These cases were excluded from the study. Heart rate, SBP, DBP, Spo2 were recorded every 5 mins till completion of surgery. Hypotension (systolic blood pressure less than

73.33/26.67 % and 21 patients belonged to ASA I and 9 to ASA II (Table 1).

The mean onset time of sensory block with 0.75% Ropivacaine was 4.53 ± 1.18 minutes and duration of sensory block was 491.00 ± 57.45 minutes (Table 2).

The mean onset time of motor block with 0.75% Ropivacaine was 9.17 ± 1.39 minutes and duration of motor block was 452.50 ± 52.34 minutes (Table 3).

Table 2: Mean Time for Onset and Duration of Sensory Blockade

S.No	Variables	Mean	SD	95% CI of Mean
1.	Onset Time (minute)	4.53	1.18	4.11 – 4.95
2.	Duration of block (minute)	491.00	57.45	470.44 – 511.56

20% from baseline value), bradycardia (heart rate <50/min), and other complications such as nausea and vomiting, headache and signs and symptoms of local anaesthetics systemic toxicity was looked for and managed, if any. In the post-operative ward pain was assessed with VAS 0-10.¹² If VAS >4, inj. tramadol 50

The mean time for rescue analgesia or total analgesic effect of 0.75% Ropivacaine was 569.47 ± 88.46 minutes (Table 4).

In this study drug induced side effects were not seen in any patients.

Table 3: Mean Time for onset and duration of Motor blockade

S.No	Variables	Mean	SD	95% CI of Mean
1.	Onset Time (minute)	9.17	1.39	8.67 – 9.66
2.	Duration of block (minute)	452.50	52.34	433.77 – 471.28

Table 4: Mean Time for Rescue Analgesia

S.No	Variable	Mean	SD	95% CI of Mean
1.	Analgesic Effect (minute)	569.47	88.46	537.81 – 601.12

DISCUSSION

Sessler *et al* demonstrated that regional anaesthesia to upper extremity is a suitable alternative to general anaesthesia and confers significant benefit to patient improving safety.^{13,14} It minimises the stress response, and avoids opioid-related complications. Among various approaches to neural block of the upper extremity, axillary block is a common regional anaesthetic technique for forearm and hand surgery. It is performed in a variety of orthopedic and soft tissue surgical procedures of the upper extremity.¹⁵

Bupivacaine has been the most widely used long-acting local anaesthetic agent. However, it is associated with various CNS and cardiac side effects and unintended intravascular injection of bupivacaine lead to cardiac arrest, prolonged resuscitation and a disproportionately high number of deaths.^{16,17} In search of better alternative, ropivacaine has been proposed as a promising drug with fewer cardiovascular and central nervous system toxic effects compared with bupivacaine.¹⁸ Ropivacaine is less lipophilic than bupivacaine and is less likely to penetrate large myelinated motor fibres, resulting in a relatively reduced motor blockade. Numerous comparative studies between ropivacaine and bupivacaine suggested that ropivacaine produces less cardiac as well as central nervous system toxic effects, less motor block and a similar duration of action of sensory analgesia as bupivacaine.^{19,20} Hence in this study we have used ropivacaine in search for more safe and effective drug for brachial plexus block.

In our study, it was found that mean time for onset of sensory block was 4.53 ± 1.18 minutes and for motor block was 9.17 ± 1.39 minutes, which shows early onset of sensory effect than the motor. Mean time for duration of sensory block was 491 ± 57.45 minutes and for motor block was 452.50 ± 52.34 minutes which shows longer duration of sensory effect than motor. The duration of analgesia or analgesic

effect lasted for 569.47 ± 88.46 minutes and no adverse effects related to drugs were seen. similar findings were reported in studies done by Kaur *et al*²¹ using 30 ml of 0.5 % Ropivacaine in axillary block.

In study done by Tripathi *et al*²² onset of sensory block was 4.22 ± 1.52 minutes and motor was 8.92 ± 2.92 minutes. Duration of sensory block was 9.72 ± 2.73 hours and motor was 8.53 ± 1.02 hours without any side effects. Thus 0.75 % of ropivacaine provided early onset and long duration of sensory block than motor without any side effects similar to our study. Study of Klein *et al*²³ also reveal similar findings where a mean onset time for sensory blockade less than 6 minute and motor blockade between 7 to 9 minute was observed with 30 ml of 0.75 % of Ropivacaine in inter scalene brachial plexus block which is comparable to our study. Study of Modak *et al*²⁴ had similar onset and duration of sensory and motor block without any side effects as ours using 30 ml of 0.5 % ropivacaine but the duration of analgesia was longer.

It is reported by various investigators that the total volume and concentration of local anesthetic used are crucial factors for the speed with which the neural blockade begins.^{25 - 28} In our study, even though small volume of drug was used, higher concentration of ropivacaine used in addition to close deposition of drug in the vicinity of nerve plexus using nerve locator and ultrasound may be the major factors in increasing the rate of satisfactory block. In many studies, maximum dose of ropivacaine up to 5mg/kg was reported to be safe without any toxic effect.^{23,29,30} However Casati *et al*³¹ reported that ropivacaine was suitable and safe local anesthetic for brachial plexus block at a dose of 2.5-2.6 mg/kg without any adverse effects and we have also used similar dose in our study. Based on this study we can conclude that 0.75 % ropivacaine has effective anaesthetic and safety profile in axillary brachial plexus block with excellent post-operative analgesia.

REFERENCES

- Gritsenko K, Khelemsky Y, Kaye AD, Vadivelu N, Urman RD. Multimodal therapy in perioperative analgesia. *Best Pract Res Clin Anaesthesiol* 2014; 28: 59-79.
- Liu SS, Strodbeck WM, Richman JM, Wu CL. A comparison of regional versus general anesthesia for ambulatory anesthesia: a meta-analysis of randomized controlled trials. *Anesth Analg* 2005; 101: 1634-42.
- Hadzic A, Arliss J, Kerimoglu B, et al. A comparison of infraclavicular nerve block versus general anesthesia for hand and wrist day-case surgeries. *Anesthesiology* 2004; 101: 127-32.
- Lehmann LJ, Loosen G, Weiss C, Schmittner MD. Interscalene plexus block versus general anaesthesia for shoulder surgery: a randomized controlled study. *Eur J Orthop Surg Traumatol* 2014; 14833.
- O'Donnell BD, Ryan H, O'Sullivan O, Iohom G. Ultrasound-guided axillary brachial plexus block with 20 milliliters local anesthetic mixture versus general anesthesia for upper limb trauma surgery: an observer-blinded, prospective, randomized, controlled trial. *Anesth Analg* 2009; 109: 279-83.
- Hansen TG. Ropivacaine: A pharmacological review. *Expert Rev Neurother* 2004; 4: 781-91.
- Sheppard DG, Iyer RB, Fenstermacher MJ. Brachial plexus: demonstration at US. *Radiology* 1998; 208: 402-6.
- Yang WT, Chui PT, Metreweli C. Anatomy of the normal brachial plexus revealed by sonography and the role of sonographic guidance in anesthesia of the brachial plexus. *Am J Roentgenol* 1998; 171: 1631-36.
- Ootaki C, Hayashi H, Amano M. Ultrasound-guided infraclavicular brachial plexus block: an alternative technique to anatomical landmark-guided approaches. *Reg Anesth Pain Med* 2000; 25: 600-4.
- Swami SS, Keniya VM, Ladi SD, Rao R. Comparison of dexmedetomidine and clonidine as an adjuvant to local anaesthesia in supraclavicular brachial plexus block. A randomised double-blind prospective study. *Indian J Anaesth* 2012; 56: 243-49.
- Cline E, Franz D, Polley RD, Maye J, Burard J, Pellegrini J. Analgesia and effectiveness of Levobupivacaine compared with Ropivacaine in patients undergoing an axillary brachial plexus block. *American Assocn Nurse Anaesth J* 2004; 72: 339-44.
- Junca A, Marret E, Goursot G, Mazoit X, Bonnet F. A comparison of ropivacaine and Bupivacaine for cervical plexus block. *Anesth Analg* 2001; 92: 720-24.
- Sessler DI, Rubinstein EH, Moayeri A. Physiological responses to mild perianesthetic hypothermia in humans. *Anesthesiology* 1991; 75: 594-610.
- Sessler DI. Perioperative hypothermia. *New Eng J Med* 1997; 336: 1730-77.
- Crews JC, Weller RS, Moss J, James RL. Levobupivacaine for Axillary Brachial Plexus Block: A Pharmacokinetic and Clinical Comparison in Patients with Normal Renal Function or Renal Disease. *Anesth Analg* 2002; 95: 219-23.
- Mazoit JX, Boico O, Samii K. Myocardial uptake of bupivacaine: II. Pharmacokinetics and pharmacodynamics of bupivacaine enantiomers in the isolated perfused rabbit heart. *Anaesth Analg* 1993; 77: 477-82.
- Mazoit JX, Decaux A, Bouaziz H, Edouard A. Comparative ventricular electrophysiologic effect of racemic bupivacaine, levobupivacaine, and ropivacaine on the isolated rabbit heart. *Anesthesiology* 2000; 93: 784-92.
- Scott DB, Lee A, Fagan D, Bowler GMR, Bloomfield P, Lundh R. Acute toxicity of ropivacaine compared with that of bupivacaine. *Anaesth Analg* 1989; 69: 563-69.
- Mc Glade DP, Kalpokas MV, Mooney PH, Chamley D, Mark AH. A comparison of 0.5% Ropivacaine and 0.5% Bupivacaine for axillary brachial plexus anaesthesia. *Anaesth Intensive Care* 1998; 26: 515-20.
- Thornton KL, Sacks MD, Hall R, Bingham R. Comparison of 0.2% Ropivacaine and 0.25% Bupivacaine for axillary brachial plexus blocks in paediatric hand surgery. *Paediatr Anaesth* 2003; 13: 409-12.
- Kaur A, Singh RB, Tripathi RK, Choubey S. Comparison Between Bupivacaine and Ropivacaine in Patients Undergoing Forearm Surgeries Under Axillary Brachial Plexus Block: A Prospective Randomized Study. *J Clin Diagn Res* 2015; 9: 1-6.
- Tripathi D, Shah K, Shah C, Shah S, Das E. Supraclavicular Brachial Plexus Block for Upper Limb Orthopedic Surgery: A Randomized, Double Blinded Comparison Between Ropivacaine and Bupivacaine. *Int'l J Anaesth* 2012; 30.
- Klein SM, Greengrass RA, Steele SM. A comparison of 0.5% bupivacaine, 0.5% ropivacaine and 0.75% ropivacaine for interscalene brachial plexus block. *Anaesth Analg* 1998; 87:1316-19.
- Modak S, Basantwani S. Comparative study of 0.5% ropivacaine and 0.5% bupivacaine for brachial plexus block by supraclavicular approach for upper limb surgeries. *Int'l J Basic Clin Pharmacol* 2016; 5: 1205-09.
- Vester-Anderson T, Christiansen C, Sorensen M, Eriksen C. Perivascular axillary Blockade following 40 ml of 1% mepivacaine with adrenaline. *Acta Anaesthesiol Scand* 1982; 26: 519-23.
- Vester-Anderson T, Husum B, Lindeburg T, Borrits L, Gothgen I. Perivascular axillary block IV: Blockade following 40, 50 or 60 ml of mepivacaine 1% with adrenaline. *Acta Anaesthesiol Scand* 1984; 28: 99-105.

27. Denson D, Mazoit JX. Physiology, pharmacology, and toxicity of local anesthetic: adult and pediatric considerations. *Clinical Practice of Regional Anesthesia*. New York: Churchill Livingstone, 1991; 73-105.
28. Scott DB, McClure JH, Giasi RM, Seo J, Covino BG. Effects of concentration of local anaesthetic drugs in extradural block. *Br J Anaesth* 1980; 52: 1033-7.
29. Hickey R, Candido KD, Ramamurthy S. Brachial plexus block with new local anaesthetic 0.5% ropivacaine. *Can J Anaesth* 1990; 37: 732-8.
30. Vainionpaa VA, Haavisto ET, Huha TM. A clinical and pharmacokinetic comparison of ropivacaine and bupivacaine in axillary plexus block. *Anaesth Analg* 1995; 81: 534-8.
31. Casati A, Fanelli G, Aldegheri G, Barti M. Interscalene brachial plexus anesthesia with 0.5%, 0.75%, 1% ropivacaine: double blind comparison with 2% mepivacaine. *Br J Anaesthesia* 1999; 83: 872-5.