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ORIGINAL RESEARCH **REGIONAL ANESTHESIA**

A prospective randomized study to compare levobupivacaine and ropivacaine in ultrasound-guided supraclavicular brachial plexus block for forearm orthopedic surgery

Razi Shahid, Mukesh Kumar Prasad ✉, Md Alauddin Alam ✉, Payal Jain ✉, Macha Niranjan Reddy ✉, Gurdeep Singh Jheetay ✉

Author affiliation:

Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India.

Correspondence: Dr. Payal Jain; E-mail: payaljain27@yahoo.co.in; Phone: +91 8527182855

Abstract

Background: Brachial plexus block utilizing ultrasound imaging has now become either adjuvant to general anesthesia (GA) or as a mainstay anesthesia modality. There are fewer studies comparing the effects of ropivacaine and levobupivacaine for supraclavicular brachial plexus block. This prospective randomized study compared 0.5% Levobupivacaine and 0.5% Ropivacaine in patients undergoing forearm orthopedic surgeries under Ultrasound Guided Supraclavicular Brachial Plexus Block.

Methodology: A total of 56 patients were enrolled and randomized into two groups of 28 patient each. Group R was given 30ml of 0.5% Ropivacaine and Group L was given 30 ml of 0.5% Levobupivacaine in supraclavicular block under ultrasound guidance. Parameters assessed were onset and duration of sensory and motor block, duration of analgesia, and any adverse events. After administration of block, the block characteristics were assessed every 5 min till onset of complete blockade, then hourly till the effect of block. Data between the groups were analyzed using with SPSS 25.0 software.

Results: The study shows that there was statistically significant difference in onset of sensory and motor block between Levobupivacaine and Ropivacaine (7.54 min 2.10 vs 8.55 min 2.08) and (12.95 min 2.30 vs 14.07 min 2.22) respectively. The duration of analgesia was more in Levobupivacaine group (9.98 hours 4.88) as compared to Ropivacaine (8.03 hours 3.58).

Conclusion: The onset of action of sensory and motor was early with Levobupivacaine and can be a better choice when postoperative analgesia is prime concern. However, where faster recovery of motor function is required Ropivacaine is preferred choice.

Key words: Brachial plexus block, ropivacaine, levobupivacaine, supraclavicular brachial plexus block, ultrasound guidance

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1. Introduction

Peripheral nerve plexus blocks play an important role in modern anesthesia as they yield adequate working conditions for surgery without any significant adverse effects.[1] This technique is advantageous for upper limb elective orthopedic or reconstructive surgery, as well as in emergency surgeries. A big advantage of the nerve

blocks is a profound intraoperative analgesia, which extends into a reliable postoperative analgesia.[2]

The regional nerve blocks are cost-effective and are without the complications of general anesthesia. There has been a great evolution of the technique used for performing brachial plexus block (BPB), starting from landmark technique to peripheral nerve stimulator (PNS) guided to ultrasound-guided (USG) technique. Landmark technique and PNS guided are easy, with short learning curve, but not as precise as USG guided technique. With the advent of technology nerve localization is commonly done by using peripheral nerve stimulator or under ultrasound guidance or both.[3,4]

BPB is a technique from the 19th century, which has now become either adjuvant to general anesthesia (GA) or as a sole anesthesia modality. Almost complete block can be achieved especially mid arm to wrist, with possible sparing of intercostobrachial nerves. For emergency orthopedic surgeries BPB gives the best results for saving the limb of the patient. Peripheral nerve blocks can be used in patients with significant comorbidities without the added risks of GA.[5-7] With the advent of USG imaging, vital structures in the supraclavicular region can be easily identified in real-time along with optimum local anesthetic spread.[8]

Ropivacaine and levobupivacaine are propyl homologues of bupivacaine. They have low lipid solubility, short elimination half time, higher plasma clearance, less affinity to cardiac tissues than the parent drug bupivacaine. Levobupivacaine is also a safe and effective local anesthetic drug for spinal and epidural anesthesia.[9]

This prospective randomized study compared the difference between the sensory and motor block parameters with the use of levobupivacaine and ropivacaine in USG guided supraclavicular BPB in patients with fractures of forearm bones.

2. Methodology

After obtaining approval from Institutional Ethics Committee, this clinical study was carried out under CTRI registration No. CTRI/2019/04/018608, in our department of anesthesiology.

The sample size was calculated by using formula [(Z×Z) α/2 (SD)×(SD) / E×E][10] which came about a total of 56 patients. A written informed consent was obtained from all patients. Patients were randomized into two groups of 28 patients each by sealed envelope technique. One group received 30 ml of 0.5% of levobupivacaine, while the other group received 30 ml of 0.5% of ropivacaine.

Inclusion criteria were elective patients of ASA grade I & II, aged 18–65 y, and with BMI 18.5–22.9 kg/m^2. Exclusion criteria [11] consisted of infection at the site of injection, any neuromuscular disorder, patients with pre-existing cardiovascular or cerebrovascular disease, severely altered mental status, patients with COPD, and the patients in whom conversion to general anesthesia was necessary intra-operatively.

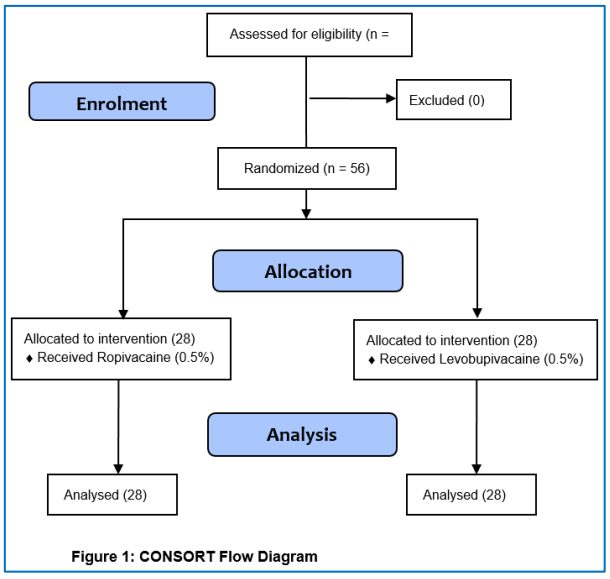

Figure 1: CONSORT Flow Diagram

Complete history and physical examination, including the neurological examination of the upper limb for any nerve damage was done during pre-anesthesia visit. The patients were kept nil orally for 6 h before the procedure. An intradermal sensitivity test of the study drugs was performed. Inj. ondansetron 4 mg I.V was given 30 min before operation. Intravenous ringer lactate fluid was started with 20 G cannula. In the operating room monitors were attached (non-Invasive blood pressure, ECG, SpO_2) and the patient was kept in supine position with the head turned opposite to the side to be operated. The arm was adducted. Ultrasound (M-Turbo, Sonosite, Inc., Bothwell, MO, USA) was used with high frequency linear probe (10-15 MHz) to locate subfascial cluster of supraclavicular brachial plexus.[7] Skin preparation was done using povidone-iodine solution on the ipsilateral supraclavicular area. The transducer was positioned just superior to the clavicle in its midpoint, with a slight caudal tilt to visualize the cross-sectional image of subclavian artery, the nerve bundles appeared as hypoechoic oval structure just superior and posterior to the subclavian artery. Inj. lignocaine 1.5 ml was injected just lateral to the linear probe to avoid pain during the needle insertion. Under direct visualization, the local anesthetic was given in small increments as per the groups allocated after adequate aspiration. The sensory and motor blocks were checked every 5 min till 30 min or until the onset of the block. Then the blocks were recorded every 60 min. Pinprick method using a 22G hypodermic needle was used to assess the sensory block.

All the dermatomes corresponding to the ulnar, radial, median and musculocutaneous nerves were assessed for

the sensory block. No sensation was labelled as complete sensory block.[8]

Sensory block was classified as; Grade 0 = sharp pain, Grade 1 = analgesia, dull sensation and Grade 2 = anesthesia, no sensation.

Assessment of motor function was done by modified Bromage Scale for the upper extremity.[9]

Grade 1 motor block was recorded as onset of motor blockade and Grade 3 block represented as achievement of peak motor block. Absence of sensory block till 30 min of administration of supraclavicular block was defined as block failure. Patients having failed block were given general anesthesia and excluded from the study. Hemodynamic parameters (heart rate, systolic, diastolic and mean blood pressures), respiratory rate and oxygen saturation were monitored during surgery. Visual analogue scale (VAS) was used to record duration of analgesia[11] by recording every 5 min for the first 30 min after administration of block followed by every hour till the score of 4 was achieved. Diclofenac sodium (75 mg) was ad ministered intramuscularly as rescue analgesia when VAS ≥ 4.

Onset of sensory block till return of dull sensation to pinprick was defined as duration of sensory block and onset of motor block till appearance of first movement fingers was taken as duration of motor blockade.[12] Any episode of hypotension, bradycardia, respiratory distress and pruritus during administration of block or surgery were recorded and treated as appropriate.

Statistical analysis: The data of 56 patients were taken and two groups consisted of at least 28 patients with an α error = 0.05, power = 80%. The student's t-test was used for comparing the mean values of the continuous variables between the two groups. The chi-square test was applied for comparing the categorical variables, such as gender, adverse events between the two groups. SPSS software version 25.0 (SPSS Inc, Chicago, IL, USA) was used to perform all statistical analysis. A $p < 0.05$ was

Table 1: Distribution of study population according to age, sex, ASA grade in both the groups

Parameters	Levobupivacaine Group	Ropivacaine Group	p-value
Sex (Male/ Female)	22/6	19/9	0.37#
Age (years) (Mean ± SD)	30.93 ± 11.04	31.14 ± 11.76	0.944#
ASA Status (ASA 1/ ASA 2)	18/10	17/11	0.77#

 # Non-significant

Table 2: Onset of sensory and motor block and mean duration of analgesia in both groups

Variable	Levobupivacaine Group	Ropivacaine Group	p-value
Onset of sensory Block (min)	7.54 ± 2.10	8.55 ± 2.08	0.045*
Onset of motor Block (min)	12.95 ± 2.30	14.07 ± 2.22	0.048*
Mean Duration of Analgesia	9.98 ± 4.88	8.03 ± 3.58	0.001*

** Significant; Data given as Mean ± SD*

Table 3: Comparative distribution of study population according to duration of sensory block

Time	Levobupivacaine Group			Ropivacaine Group			p-value
	Zero	1	2	Zero	1	2	
5 min	28	0	0	28	0	0	1.000
10 min	23	5	0	25	3	0	1.000
15 min	0	23	5	0	24	4	0.716
20 min	0	2	26	0	1	27	0.553
25 min	0	0	28	0	0	28	1.000
30 min	0	0	28	0	0	28	1.000
35 min	0	0	28	0	0	28	1.000
40 min	0	0	28	0	0	28	1.000
45 min	0	0	28	0	0	28	1.000
50 min	0	0	28	0	0	28	1.000
55 min	0	0	28	0	0	28	1.000
60 min	0	0	28	0	0	28	1.000
90 min	0	0	28	0	0	28	1.000
2 h	0	0	28	0	0	28	1.000
3 h	0	0	28	0	0	28	1.000
4 h	0	3	25	0	6	22	1.000
5 h	3	5	20	2	9	17	0.452
6 h	4	10	14	8	10	10	0.368
7 h	6	15	7	16	10	2	0.016*
8 h	13	15	0	17	11	0	0.284

** Significant*

Table 4: Comparative distribution of study population according to duration of motor block

Time	Levobupivacaine Group				Ropivacaine Group				p-value
	Zero	1	2	3	Zero	1	2	3	
5 min	28	0	0	0	28	0	0	0	1.000
10 min	25	3	0	0	12	6	8	2	0.001*
15 min	5	18	5	0	2	10	6	10	0.003*
20 min	0	7	15	6	0	2	7	19	0.002*
25 min	0	0	0	28	0	0	0	28	1.000
30 min	0	0	0	28	0	0	0	28	1.000
35 min	0	0	0	28	0	0	0	28	1.000
40 min	0	0	0	28	0	0	0	28	1.000
45 min	0	0	0	28	0	0	0	28	1.000
50 min	0	0	0	28	0	0	0	28	1.000
55 min	0	0	0	28	0	0	0	28	1.000
60 min	0	0	0	28	0	0	0	28	1.000
90 min	0	0	0	28	0	0	0	28	1.000
2 h	0	0	0	28	0	0	0	28	1.000
3 h	0	0	0	28	0	1	3	24	1.000
4 h	0	8	10	10	0	15	8	5	0.134
5 h	14	8	6	0	20	4	4	0	0.248
6 h	19	2	7	0	23	2	3	0	0.371
7 h	25	3	0	0	28	0	0	0	0.075
8 h	28	0	0	0	28	0	0	0	1.000

** Significant*

considered as significant. The study was conducted based on the null hypothesis that there was no significant difference between the two drugs used on the basis of sensory and motor block parameters.

3. Results

We compared efficacy of ropivacaine and levobupivacaine in 56 patients who underwent upper limb orthopedic surgeries under USG guided supraclavicular BPB. CONSORT diagram of the study is shown in Figure 1.

The demographic profile of the patient's age, sex, ASA grade were comparable in both groups (Table 1). The onset of mean sensory and motor blockade was significantly rapid in group levobupivacaine compared to ropivacaine group (Table 2). Distribution of both mean sensory and motor blockage with respect to time was analyzed. (Table 3 and 4). Duration of pain free analgesic time was higher more among levobupivacaine against ropivacaine (Table 2).

Hemodynamic variables were comparable in both of the groups. Comparative readings of systolic blood pressure are shown in Figure 2, comparative mean blood pressure in Figure 3, comparative diastolic blood pressure in Figure 4 and comparative heart rates are shown in Figure 5.

The mean VAS scores at different time intervals are depicted in Figure 6.

There was no significant difference in mean respiratory rate and mean oxygen saturation in both of the groups.

No complications were reported in the groups. All blocks were performed successfully.

4. Discussion

Regional nerve and nerve plexus blocks, performed with the ultrasound technology, either alone or combined with other anesthesia techniques, are the standard for the regional surgeries.[13] BPBs can be ad ministered via three approaches; interscalene groove, supraclavicular, infraclavicular and axillary. [14] Progress in ultrasound machines have led the perioperative physicians to use supraclavicular approach more often due to the ability to visualize the pleura in real-time.[15] The brachial plexus

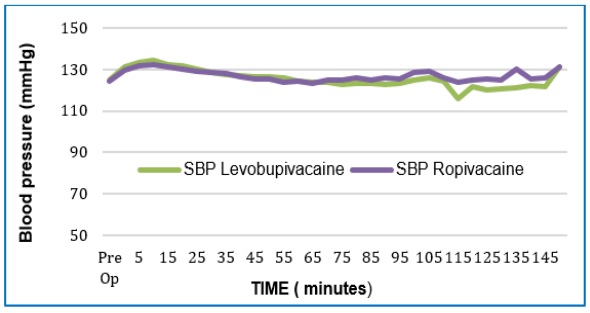

Figure 2: Comparative systolic blood pressures in both groups

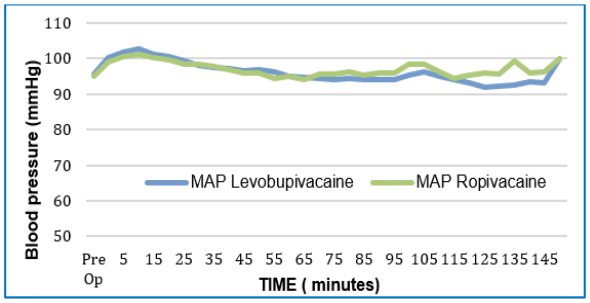

Figure 3: Comparative mean blood pressures in both groups

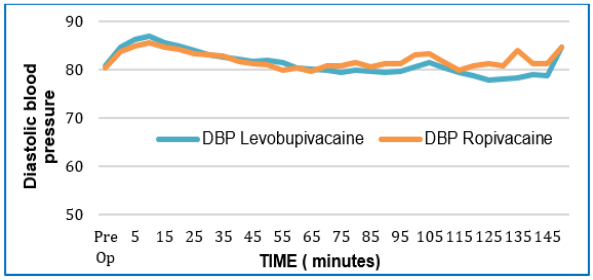

Figure 4: Comparative diastolic blood pressures in both groups

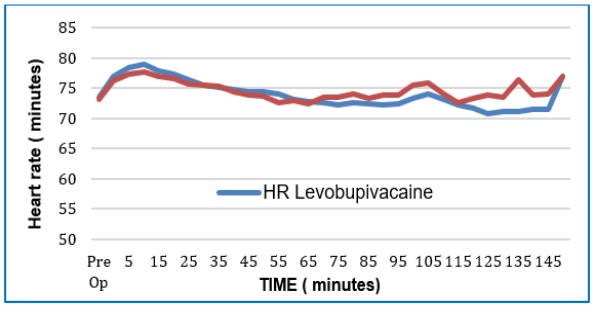

Figure 5: Comparative heart rates in both groups

surrounds posterior and superficial to the subclavian artery. The utilization of ultrasound for regional anesthetic technique gives a visual arrangement of tissues such as lung surface and arteries with directly depicting the local spread of the local anesthetic.[16]

Benefits for regional anesthesia include excellent perioperative analgesia, avoidance of opioid-related side effects, decreased recovery time and short hospital stay. The choice of local anesthetic agent, dose, volume, concentration and the use of adjuncts, govern the onset, extent, quality and duration of anesthesia. Ropivacaine and levobupivacaine being less lipophilic generally block only the small A-delta and C conduction fibers responsible for sensory block and large myelinated A-α fibers are usually spared, thus reporting lesser motor block than bupivacaine. Thfis property of these enantiomers makes them less efficacious in joining the cardiac sodium channels thus rendering them less cardiotoxic too. [16- 18]

Contrary to our findings, Garg et al.[16] reported comparable results between the two groups. The statistically significant difference in onset of the blockade in sensory and motor was observed being faster in levobupivacaine group. Similar results were observed by Kulkarni et al.[1] and Mageswaran and Choy.[19] Similarly in a study Deshpande et al. found that the onset of sensory and motor block was statistically significantly earlier with levobupivacaine 0.5%.[20] The duration of sensory, motor block and postoperative analgesia was prolonged with 0.5% levobupivacaine as compare to the analgesic effect of 0.5% ropivacaine.[21] Garg et al.[16] recorded a comparable onset time for sensory as well as motor blockade in both groups; which was supported by the findings of Casati et al. and Liisanantti et al.[22, 23]

These findings are coincidental with our study with levobupivacaine and ropivacaine ($p = 0.045$ and $p = 0.048$ respectively). The onset time was quicker in the current study compared to other studies because the drugs were deposited precisely near the target nerves under ultrasound guidance. An opposite trend in the studies of Mankad et al. and Gonzalez et al. was seen as they found a faster onset of sensory and motor blockade for ropivacaine than levobupivacaine which was statistically significant, because most anesthetic agents block C fibers at the same rate but A fiber blockade depends on the chemical properties of the drug and also the difference in the anatomical location of the blocks and the technique used.[14, 24] Some researcher found that ropivacaine produced rapid sensory block than levobupivacaine ($p < 0.05$), and a rapid motor.[14, 15]

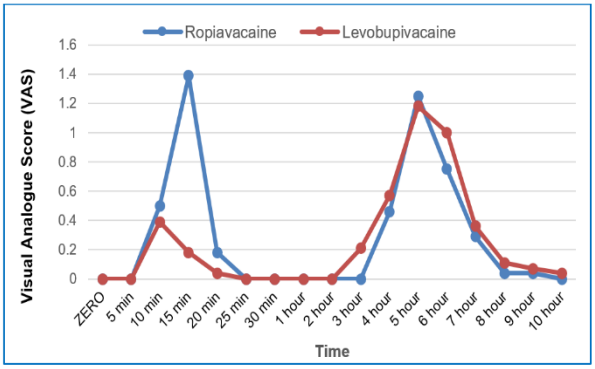

Figure 6: Visual analogue scale (VAS) in both groups at different times

In our study, the mean VAS score at 15 min was significantly higher in levobupivacaine compared to ropivacaine (p = 0.001). Kulkarni et al. however, stated that the VAS was less with levobupivacaine which was found to be statistically significant especially from 8th h onwards. Various researchers have reported variable results about VAS score by both drugs. [13, 16, 24]

In one study, the duration of analgesia was noted to be more in levobupivacaine compared to ropivacaine, but another study found no significant difference in post-operative pain scores when ropivacaine and levobupivacaine. [22, 23, 25] In contrast to these a study conducted by Gonzalez-Suarez et al. noted that the duration of analgesia was prolonged with ropivacaine) than with levobupivacaine, which was contrary to the result of our study. [24]

Hemodynamically there were no significant observations in the study. All the parameters were found to be statistically equivalent. Similar findings were found in studies performed by Kulkarni et al. during postoperative period. Deshpande et al. and found comparable parameters in both groups throughout the surgery.[20] Similar findings were observed by Fusun et al. in their study. [26]

In our study, there was no unsuccessful block. No complications were reported. Other researchers also reported no significant incidence of complications in either group.[14, 25]

5. Limitations

USG has a learning curve and the plasma concentrations of the drugs could not be measured.

6. Conclusion

The onset of sensory and motor block with an equivalent dose of ropivacaine and levobupivacaine are equivalent, however, ropivacaine offers an advantage where early recovery of motor function is desired in the postoperative period. Levobupivacaine can be a better choice when postoperative analgesia is the prime concern as compared to early return of motor activity as duration of analgesia is significantly prolonged postoperatively.

7. Conflict of interest

None declared by the authors

8. Authors' contribution

RS: Concepts, Design, Literature search, Statistical analysis, Manuscript preparation

MKP: Concepts, Design, Statistical analysis, Manuscript preparation

AA, MNR: Literature search, Data acquisition, Manuscript preparation

PJ: Concepts, Design, Literature search, Manuscript preparation

GSJ: Design, Manuscript preparation

9. References

1. Kulkarni SB, Pimpare M, Balasaheb T, Govardhane. Comparison of levobupivacaine with Ropivacaine for supraclavicular brachial plexus block. Int J Res Med Sci. 2016;4:3789-96. DOI: 10.18203/2320-6012.ijrms20162878
2. Murphy DB, McCartney CJ, Chan VW. Novel analgesic adjuncts for brachial plexus block: a systematic review. Anesth Analg. 2000 May;90(5):1122-8. [PubMed] DOI: 10.1097/00000539-200005000-00023
3. Abrahams MS, Aziz MF, Fu RF, Horn JL. Ultrasound guidance compared with electrical neurostimulation for peripheral nerve block: A systematic review and meta-analysis of randomized controlled trials. Br J Anaesth. 2009;102:408-17. [PubMed] DOI: 10.1093/bja/aen384
4. Williams SR, Chouinard P, Arcand G, Harris P, Ruel M, Boudreault D, et al. Ultrasound guidance speeds execution and improves the quality of supraclavicular block. Anesth Analg. 2003;97:1518-23. [PubMed] DOI: 10.1213/01.ANE.0000086730.09173.CA
5. Kumar S, Palaria U, Sinha AK, Punera DC, Pandey V. Comparative evaluation of ropivacaine and ropivacaine with dexamethasone in supraclavicular brachial plexus block for postoperative analgesia. Anesth Essays Res. 2014;8(2):202–08. [PubMed] DOI: 10.4103/0259-1162.134506
6. Kunitaro W, Joho T, Alan KL, Kumi M, Hideaki S, Tetsuo I, et al. Postoperative analgesia comparing levobupivacaine and ropivacaine for brachial plexus block:A randomized prospective trial. Medicine (Baltimore). 2017;96(12):e6457. [PubMed] DOI: 10.1097/MD.0000000000006457
7. Macfarlane A, Perlas A, Chan V, Brull R. Eight ball, corner pocket ultra-sound-guided supraclavicular block: avoiding a scratch. Reg Anesth Pain Med. 2008;33:502-3. [PubMed] DOI: 10.1016/j.rapm.2008.02.001
8. Dilip K, Supraclavicular brachial plexus block: A new approach. Indian J Anaesth. 2003;47:287-88. [Free Full Text]
9. Brull R, Wijayatilake DS, Perlas A, Chan VW, Abbas S, Liguori GA, et al. Practice patterns related to block selection, nerve localization and risk disclosure: a survey of the American Society of regional Anesthesia and Pain Medicine. Reg Anesth Pain Med. 2008;33:395-403. [PubMed] DOI: 10.1016/j.rapm.2008.02.007
10. Kaur A, Singh RB, Tripathi RK, Choubey S. Comparision between bupivacaine and ropivacaine in patients undergoing forearm surgeries under axillary brachial plexus block: a prospective randomized study. JCDR. 2015;9:UC01-6. [PubMed] DOI: 10.7860/JCDR/2015/10556.5446

11. Maga JM, Cooper L, Gebhard RE. Outpatient regional anesthesia for upper extremity surgery update (2005 to present) distal to shoulder. Int Anesthesiol Clin. 2012;50:47-55. [PubMed] DOI: 10.1097/AIA.0b013e31821a00a8
12. Tran DQ, Munoz L, Russo G, Finlayson R. A trick shot to the corner pocket. Reg Anesth Pain Med. 2008;33:503-4. [PubMed] DOI: 10.1016/j.rapm.2008.02.002
13. Cline E, Franz D, Polley RD, Maye J, Burkard J, Pellegrini J. Analgesia and effectiveness of levobupivacaine compared with ropivacaine in patients undergoing an axillary brachial plexus block. AANA J. 2004;72:339-46. [PubMed]
14. Mankad PP, Makwana JC, Shah BJ. A comparative study of 0.5% ropivacaine and 0.5% levobupivacaine in supraclavicular brachial plexus block. Int J Med Sci Public Health. 2016;5:74-9. DOI: 10.5455/ijmsph.2016.1306201528
15. Rathore A, Bhosale JP. A comparative double blinded study of levobupivacaine and ropivacaine in USG guided supraclavicular brachial plexus block. Int J Med. 2017;4(3):320-4. [Free Full Text]
16. Garg A, Rawat HS, Sharma P, Kashalkar S, Aggarwal M. Comparison between 0.5% levobupivacaine and 0.5% ropivacaine for ultrasound guided supraclavicular brachial plexus block in patients undergoing upper limb orthopedic surgeries. Sch J App Med Sci. 2019;7:212-6. [Free Full Text]
17. Halaszynski TM. Ultrasound brachial plexus anesthesia and analgesia for upper extremity surgery: essentials of our current understanding, 2011. Curr Opin Anaesthesiol. 2011;24:581–591. [PubMed] DOI: 10.1097/ACO.0b013e32834aca03
18. Mirza F, Brown AR. Ultrasound-guided regional anesthesia for procedures of the upper extremity. Anesthesiol Res Pract. 2011;2011:579824. [PubMed] DOI: 10.1155/2011/579824
19. Mageswaran R, Choy YC. Comparison of 0.5% ropivacaine and 0.5% Levobupivacaine for infraclavicular brachial plexus block. Med J Malaysia. 2010;65:300–3. [PubMed]
20. Deshpande JP, Ghodaki PS, Sardesai S. Comparative clinical study between racemic bupivacaine and levobupivacaine in supraclavicular brachial plexus block. Indian J Applied Res. 2014;4:451-4. [Free Full Text]
21. Gamo K, Kuriyama K, Higuchi H, Uesugi A, Nakase T, Hamada M, et al. Ultrasound-guided supraclavicular brachial plexus block in upper limb surgery: outcomes and patient satisfaction. Bone Joint J. 2014;96-B:795-9. [PubMed] DOI: 10.1302/0301-620X.96B6.31893
22. Casati A, Borghi B, Fanelli G, Montone N, Rotini R, Fraschini G, et al. Interscalene brachial plexus anesthesia and analgesia for open shoulder surgery: a randomized, double-blinded comparison between levobupivacaine and ropivacaine. Anesth Analg. 2003;96:253-9. [PubMed] DOI: 10.1097/00000539-200301000-00051
23. Liisanantti O, Luukkonen J, Rosenberg PH. High-dose bupivacaine, levobupivacaine and ropivacaine in axillary brachial plexus block. Acta Anaesthesiol Scand. 2004;48:601–6. [PubMed] DOI: 10.1111/j.0001-5172.2004.00393.x
24. González-Suárez S, Pacheco M, Roigé J, Puig MM. Comparative study of ropivacaine 0.5% and levobupivacaine 0.33% in axillary brachial plexus block. Reg Anesth Pain Med. 2009;34:414-9. [PubMed] DOI: 10.1097/AAP.0b013e3181ae729b
25. Chauhan AP, Pandya J, Jain A. Comparison of block characteristics and postoperative analgesia of 0.5% Levobupivacaine with 0.5% Ropivacaine in ultrasound guided supraclavicular block for orthopedic forearm surgery - a prospective, comparative, randomized, clinical study. Indian J Clin Anaesth. 2020;7:399-404. DOI: 10.18231/j.ijca.2020.073
26. Fusun E, Berit GC, Sinem SAK, Mehmet T, Tolga A, Lutfi Y. Comparative study of two agents in axillary brachial plexus block: Bupivacaine Vs Levobupivacaine. Smyrna Tip Dergisi. 2011:27-34. [Free Full Text]