International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Comparison of the Supraclavicular, Infraclavicular, and Axillary Approaches for Ultrasound Guided Brachial Plexus Block for Surgical Anaesthesia

Dr. Vaibhav Singh[1], Dr. Neelam Singh[2], Dr. Sakshat[3], Dr. L. S. Mishra [4]

[1]Associate Professor, Department of Anaesthesiology and Critical Care, Moti Lal Nehru Medical College, Prayagraj.

[2]Professor and Head, Department of Anaesthesiology and Critical Care, Moti Lal Nehru Medical College, Prayagraj.

[3]Junior Resident, Department of Anaesthesiology and Critical Care, Moti Lal Nehru Medical College, Prayagraj.

[4]Professor, Department of Anaesthesiology and Critical Care, Moti Lal Nehru Medical College, Prayagraj.

Abstract: ***Introduction**: Brachial plexus blocks (BPB) have become integral in managing perioperative pain for upper limb surgeries, providing benefits such as reduced opioid use, enhanced postoperative pain control, and fewer side effects compared to general anaesthesia. With the advent of ultrasound (US) technology, BPB has gained precision, improved block success rates and reducing complications. Among the various approaches, the supraclavicular (SCL), infraclavicular (ICL), and axillary (AX) methods are widely employed. This study aimed to compare these three approaches under ultrasound guidance. **Objectives**: To compare the effectiveness, onset time, duration, safety, and complications associated with ultrasound - guided BPB using SCL, ICL, and AX approaches in patients undergoing upper limb surgeries. **Material and Methods**: This prospective, randomized, double - blinded study included 210 patients aged 18–60 years, ASA Grade I or II, scheduled for elective upper limb surgeries. Participants were randomized into three groups (SCL, ICL, AX) receiving 25 mL of 0.5% bupivacaine via ultrasound - guided BPB. Outcomes assessed included sensory and motor block onset and duration, imaging and needling parameters, block success rates, and complications. Data were analysed using SPSS v24.0 with $p < 0.05$ considered statistically significant. **Results**: Demographic variables were comparable across groups. Onset and duration of sensory and motor blocks showed no significant differences. Block performance time was significantly shorter in Group SCL ($p<0.00001$), with shorter preoperative preparation time ($p=0.004$). Imaging time was lower in Groups SCL and ICL, but needle depth was greater in Group ICL. Block - related pain was higher in Group ICL ($p=0.032$). Success rates were comparable across groups, with SCL showing a slightly higher appropriate block rate (92.8%). Complication rates were minimal, with no significant differences among groups. **Conclusion**: Ultrasound - guided SCL, ICL, and AX approaches for BPB are effective and safe, offering comparable success rates and minimal complications. Each approach has unique advantages, emphasizing the role of ultrasound in optimizing BPB outcomes.*

Keywords: Ultrasound - guided brachial plexus block, Supraclavicular approach, Infraclavicular approach, Axillary approach, regional anaesthesia techniques

1. Introduction

The evolution of regional anaesthesia, particularly brachial plexus blocks (BPB), represents a key advancement in pain management. The origins of BPB date back to the late 1800s when Halsted and Hall first experimented with cocaine for nerve blocks [1]. Since then, BPB has gained popularity as a preferred technique over general anaesthesia for upper extremity procedures, providing benefits such as reduced opioid use, fewer side effects, and enhanced postoperative pain control [2 - 5]. Traditional BPB methods, however, rely on surface anatomy and nerve stimulation, often resulting in higher failure rates and potential nerve injury due to the lack of direct nerve visualization [6].

The integration of ultrasound (US) technology has revolutionized BPB by enabling real - time visualization of the nerves, needle, and surrounding structures, which enhances precision and safety [7, 8]. US - guided BPB has demonstrated improved block success rates compared to conventional approaches, as it allows anaesthetists to adjust needle placement more accurately and ensure adequate anaesthetic spread [9, 10]. Among the primary techniques, the supraclavicular, infraclavicular, and axillary approaches are commonly utilized based on the surgical site.

Each approach presents unique advantages and considerations. The supraclavicular approach is beneficial for surgeries below the shoulder but carries a risk of pneumothorax, particularly for less experienced practitioners. The infraclavicular approach is versatile and, with ultrasound, addresses technical challenges more effectively [10]. Meanwhile, the axillary approach is optimal for elbow, forearm, and hand surgeries, benefiting from ultrasound - guided precision in needle placement and reduced anaesthetic volume requirements [11].

Despite the benefits of US guidance, there is limited recent literature directly comparing the supraclavicular, infraclavicular, and axillary approaches using modern ultrasound techniques. Therefore, this study was undertaken as a prospective, randomized, observer - blinded trial to compare these three approaches in ultrasound - guided BPB for surgical anaesthesia. The study aims to identify the most effective approach, focusing on block success, onset time, and safety [7, 12, 13].

2. Material and Methods

Study Design and Setting: This was a prospective, randomized, double - blinded, non - placebo study conducted over a 1 - year period at the Department of Anaesthesiology & Critical Care, Moti Lal Nehru Medical College, Prayagraj.

Study Participants and Eligibility Criteria: Participants were patients scheduled for ultrasound - guided brachial plexus block (BPB) for elective upper limb surgeries below the mid - shaft of the humerus. Inclusion criteria were patients aged 18 - 60, ASA Grade I or II, and those who provided informed consent. Exclusion criteria included refusal to participate, infection at the block site, ASA Grade III or above, coagulopathies, severe cardiovascular or respiratory disease, known allergy to the study drug, pregnancy, disorientation, and peripheral neuropathy.

Sample Size: Based on time differences in block effectiveness between the supraclavicular (SCL), infraclavicular (ICL), and axillary (AX) approaches from previous studies, a sample size of 210 patients (70 per group) was determined to achieve 95% confidence and 80% power.

Randomization: Randomization was conducted via a computer - generated table, with allocation concealed using sequentially numbered opaque envelopes.

Data Collection and Intervention

- **Pre - anaesthetic Evaluation:** Patients underwent thorough pre - anaesthetic assessment, including medical history, general and systemic examination, and lab investigations.
- **Block Techniques:** Patients received BPB through SCL, ICL, or AX approaches using a linear 12 MHz ultrasound probe and a 22 G insulated needle. Each group received 25 mL of 0.5% bupivacaine, with administration techniques tailored to each approach.

Outcome Assessment: Sensory and motor block onset, duration, imaging, needling time, and needle passes were documented. Sensory and motor block assessments were performed at 5 - minute intervals over 30 minutes, and pain was assessed using a Visual Analogue Scale (VAS). Postoperative pain was managed with paracetamol and, if needed, tramadol.

Data Analysis: Data were entered in Microsoft Excel and analysed using SPSS version 24.0. Descriptive statistics, chi - square tests, and one - way ANOVA were used to assess categorical and continuous variables, respectively. Significance was set at $p < 0.05$. The chi - square test was applied to analysed categorical variables, with the Fisher exact test for categories with fewer than five values.

3. Results

Table 1 presents demographic data across three groups: supraclavicular (SCL), infraclavicular (ICL), and axillary (AX) approaches. The mean age is similar across the groups (p=0.515). Most patients in each group were male, with no significant difference in sex distribution (p=0.938). ASA Grade I was predominant across all groups, though slightly lower in Group AX (p=0.292). Types of surgery (elbow, forearm, wrist - hand) were evenly distributed, with no statistically significant difference among the groups (p=0.990).

Table 2 compares the onset and duration of sensory and motor blocks among the three groups. The onset times for sensory and motor blocks were similar across groups, with a non - significant difference (p=0.860 for sensory; p=0.052 for motor). The duration of sensory and motor blocks also showed no significant variation (p=0.144 for sensory; p=0.379 for motor). However, block performance time was significantly shorter in the SCL group compared to others (p<0.00001), and the time between the end of the block and the start of the operation was significantly lower in Group SCL (p=0.004).

Table 3 examines imaging and needling parameters for each approach. Image visualization time was significantly shorter in Groups SCL and ICL compared to AX (p=0.0001). There was no significant difference in needling time across groups (p=0.325). However, needle depth was significantly deeper in Group ICL compared to SCL and AX (p<0.00001). The number of needle passes was also significantly higher in the AX group (p=0.032), and the VAS pain score for block - related pain was highest in the ICL group (p=0.032).

Table 4 reports on the success rate of the blocks. The “appropriate block” rate was slightly higher in Group SCL (92.8%) compared to Groups ICL and AX (both 85.71%), though this difference was not statistically significant (p=0.540). The incidence of failed blocks was low across all groups, with the highest rate observed in Groups ICL and AX.

Table 5 outlines the side effects observed in each group. Paraesthesia was slightly more common in Groups SCL and ICL, though the difference was not statistically significant (p=0.572). Vascular puncture occurred most frequently in Group SCL (8.57%), but this difference was also not statistically significant across groups.

4. Discussion

The use of ultrasound (US) - guided nerve blocks has recently gained prominence over traditional techniques that relied on peripheral nerve stimulators and anatomical landmarks. US guidance offers enhanced visualization of the nerves and surrounding structures, which facilitates more precise needle placement and distribution of local anaesthetic, especially in patients with limited twitch responses [8, 14, 15]. Our study aimed to compare the supraclavicular (SCL), infraclavicular (ICL), and axillary (AX) approaches to US - guided brachial plexus block (BPB) in terms of onset, duration, visualization, needle passes, and block success.

The onset of sensory block was slightly shorter in the axillary approach, but the differences across groups were not statistically significant (p=0.860) (Table 2). Previous studies by Vazin et al. [16] and Rathod et al. [17] reported similar findings, with faster onset times noted in the SCL and ICL approaches, though some results reached significance. Similarly, for the onset of motor block, we found no significant differences across groups (p=0.052). In our study, the duration of both sensory and motor blocks was comparable across all groups, aligning with findings from

Yang et al. [18] and Brenner et al. [19], who also reported no significant differences.

The visualization time was significantly longer in the AX group compared to SCL and ICL ($p<0.00001$) (Table 3). This result aligns with Vazin et al. [16], who observed reduced visibility of neural structures in the AX approach. Luo et al. [20] also noted that the SCL approach provided better needle visualization, supporting our finding of shorter imaging times for SCL.

We found no significant differences in needling time across groups ($p=0.325$), but needle depth was significantly greater in the ICL approach ($p<0.00001$) (Table 3). This is consistent with findings by Rathod et al. [17] and Techasuk et al. [21], who reported similar trends. Additionally, the number of needle passes required was highest in the AX approach ($p=0.032$), which may be due to the more complex visualization and positioning challenges in this approach, as noted by Luo et al. [20].

Our study showed no statistically significant differences in block success rates across the three approaches, with success rates around 85 - 92% ($p=0.540$) (Table 4). These findings are consistent with those of Kilic et al. [22] and Stav et al. [23], who also found high success rates with minimal variation across approaches.

In terms of side effects, there were no statistically significant differences among the groups in the occurrence of paraesthesia and vascular puncture ($p=0.572$) (Table 5). Other studies, such as those by Vazin et al. [16] and Rathod et al. [17], have similarly noted that side effects are relatively infrequent and tend to vary minimally between approaches. Our use of high - resolution US - guidance likely contributed to minimizing complications such as vascular puncture and paraesthesia, as reported by Yang et al. [18] and Brenner et al. [19].

Overall, our study highlights that while each BPB approach has unique visualization and needle placement characteristics, the success and safety of blocks across SCL, ICL, and AX are comparable when performed under US guidance. The minimized complication rates and consistent success with US - guided techniques suggest this approach as a safe, effective option for brachial plexus blocks in upper extremity surgeries.

This study is one of the first in the region to employ rigorous randomization for participant selection, reducing selection bias and enhancing result credibility. The use of high - resolution ultrasound guidance improved the precision of needle placement, minimizing complications and enhancing block effectiveness. The sample size, though sufficient, could have been larger to improve statistical power and generalizability. Additionally, time constraints limited the scope for a more extensive sample, which could have further validated the findings.

5. Conclusion

The study demonstrates that ultrasound - guided brachial plexus blocks using supraclavicular, infraclavicular, and axillary approaches are effective and safe for upper extremity surgeries. While each approach has distinct visualization and needle placement characteristics, all three offer comparable success rates and minimal complications. Ultrasound guidance enhances the precision, safety, and quality of the blocks across approaches.

References

[1] Lopez - Valverde A, De Vincente J, Cutando A.2011. The surgeons Halsted and Hall, cocaine and the discovery of dental anesthesia by nerve blocking. Br Dent J 211: 458–487.
[2] Malik KM, Imani F, Beckerly R, Chovatiya R. Risk of Opioid Use Disorder from Exposure to Opioids in the Perioperative Period: A Systematic Review. Anesth Pain Med.2020; 10 (1). e101339.
[3] Edinoff AN, Kaplan LA, Khan S, Petersen M, Sauce E, Causey CD, et al. Full Opioid Agonists and Tramadol: Pharmacological and Clinical Considerations. Anesth Pain Med.2021; 11 (4). e119156.
[4] Rupniewska - Ladyko A, Malec - Milewska M. A High Dose of Fentanyl May Accelerate the Onset of Acute Postoperative Pain. Anesth Pain Med.2019; 9 (5). e94498.
[5] Behnaz F, Soltanpoor P, Teymourian H, Tadayon N, Mohseni GR, Ghasemi M. Sympatholytic and Anti - Inflammatory Effects of Ropivacaine and Bupivacaine After Infraclavicular Block in Arterio Venous Fistula Surgery. Anesth Pain Med.2019; 9 (1). e85704.
[6] Neal JM, Gerancher JC, Hebl JR, Ilfeld BM, McCartney CJL, Franco CD, Hogan QH.2009. Upper extremity regional anesthesia: Essentials of our current understanding, 2008. Reg Anesth Pain Med 34: 134–170. Orebaugh SL, Bigeleisen PE. Ultrasound - Guided Supraclavicular Block. In: Bigeleisen PE, editor. Ultrasound - Guided Regional Anesthesia and Pain Medicine. Philadelphia (PA): Lippincott Williams & Wilkins; 2010. pp.53–7.
[7] Orebaugh SL, Groen GJ, Bigeleisen PE. Ultrasound - Guided Infraclavicular Block. In: Bigeleisen PE, editor. Ultrasound - Guided Regional Anesthesia and Pain Medicine. Philadelphia (PA): Lippincott Williams & Wilkins; 2010. pp.58–64.
[8] Sites BD, Beach ML, Spence BC, et al. Ultrasound guidance improves the success rate of a perivascular axillary plexus block. Acta Anaesthesiologica Scandinavica 2006; 50: 678–84.
[9] 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 Mar; 102 (3): 408 - 17.
[10] Antonakakis JG, Ting PH, Sites B. Ultrasound - guided regional anesthesia for peripheral nerve blocks: an evidence - based outcome review. Anesthesiol Clin 2011; 29: 179–91.
[11] P. Marhofer, M. Greher, S. Kapral, Ultrasound guidance in regional anaesthesia†, British Journal of Anaesthesia, Volume 94, Issue 1, 2005, Pages 7 - 17, ISSN 0007 - 0912.
[12] Arcand G, Williams SR, Chouinard P, Boudreault D, Harris P, Ruel M, Girard F. Ultrasound - guided

infraclavicular versus supraclavicular block. Anesth Analg 2005; 101: 886–90.
[13] Kapral S, Krafft P, Eigenberger K, Fitzgerald R, Gosch M, Weinstabl M. Ultrasound - guided supraclavicular approach for regional anesthesia of the brachial plexus. Anesth Analg.1994; 78: 507Y513.
[14] Miller RD, Eriksson LI, Fleisher LA, Wiener - Kronish JP, Cohen NH, Young WL. Miller's Anesthesia.8th ed. Philadelphia: Elsevier Saunders; 2015.
[15] Butterworth JF, Mackey DC, Wasnick JD. Morgan & Mikhail's Clinical Anesthesiology.6th ed. New York: McGraw - Hill; 2018.
[16] Vazin M, Jensen K, Kristensen DL, Hjort M, Tanggaard K, Karmakar MK, Bendtsen TF, Børglum J. Low-volume brachial plexus block providing surgical anesthesia for distal arm surgery comparing supraclavicular, infraclavicular, and axillary approach: a randomized observer blind trial. BioMed research international.2016; 2016 (1): 7094121.
[17] Rathod, J. D., Patel, B. B., & Patel, D. L. (2022). Comparison of infraclavicular brachial plexus block with supraclavicular brachial plexus block in upper limb surgeries using peripheral nerve stimulator. *International Journal of Research in Medical Sciences*, *10* (10), 2197–2202.
[18] Yang CW, Kwon HU, Cho CK, Jung SM, Kang PS, Park ES, Heo YM, Shinn HK. A comparison of infraclavicular and supraclavicular approaches to the brachial plexus using neurostimulation. Korean journal of anesthesiology.2010 Mar 1; 58 (3): 260 - 6.
[19] Brenner D, Iohom G, Mahon P, Shorten G. Efficacy of axillary versus infraclavicular brachial plexus block in preventing tourniquet pain: a randomised trial. European Journal of Anaesthesiology| EJA.2019 Jan 1; 36 (1): 48 - 54.
[20] Luo Q, Yao W, Chai Y, Chang L, Yao H, Liang J, Hao N, Guo S, Shu H. Comparison of ultrasound - guided supraclavicular and costoclavicular brachial plexus block using a modified double - injection technique: a randomized non - inferiority trial. Bioscience reports.2020 Jun; 40 (6): BSR20200084.
[21] Techasuk W, González AP, Bernucci F, Cupido T, Finlayson RJ, Tran DQ. A randomized comparison between double - injection and targeted intracluster - injection ultrasound - guided supraclavicular brachial plexus block. Anesthesia & Analgesia.2014 Jun 1; 118 (6): 1363 - 9.
[22] Tarıkçı Kılıç E, Akdemir MS. Comparison of supraclavicular, infraclavicular, and axillary approaches for ultrasound - guided brachial plexus block for upper limb surgeries: A retrospective analysis of 182 blocks. Dubai Medical Journal.2019 Jan 14; 1 (1 - 4): 33 - 7.
[23] Stav A, Reytman L, Stav M - Y, Portnoy I, Kantarovsky A, Galili O, Luboshitz S, Sevi R, Sternberg A. Comparison of the Supraclavicular, Infraclavicular and Axillary Approaches for Ultrasound - Guided Brachial Plexus Block for Surgical Anesthesia. Rambam Maimonides Med J 2016; 7 (2): e0013.

Tables

Table 1: Demographic data in studied cases (N=210)

Parameters		Group SCL (n=70)	Group ICL (n=70)	Group AX (n=70)	t value	P value
Mean Age (in years)		35.76± 10.667	38.10± 11.458	37.41± 13.183	.667[1]	0.515
Sex	Male	45 (64.28%)	47 (67.14%)	46 (65.71%)	0.126[2]	0.938
	Female	25 (35.72%)	23 (32.86)	24 (34.29%)		
ASA Grade	I	64 (91.4%)	62 (88.57%)	58 (82.85%)	2.459[2]	0.292
	II	6 (8.6%)	8 (11.43%)	12 (17.15%)		
Type of surgery	Elbow	13 (18.5%)	12 (17.1%)	14 (20.0%)	.296	.990
	Forearm	26 (37.1%)	25 (35.7%)	24 (34.2%)		
	Wrist - Hand	31 (44.2%)	33 (47.1%)	32 (39.0%)		

Table 2: Comparison of Various Outcome measures across the three groups

Parameters	Group SCL (n=70)	Group ICL (n=70)	Group AX (n=70)	F Value	P value
Onset to Sensory Block (in minutes)	19.53± 5.956	20.07± 5.470	9.89± 6.385	0.151	0.860
Onset to Motor Block (in minutes)	28.74± 5.999	31.11± 5.704	30.37± 5.864	3.002	0.052
Duration of Sensory Block (in minutes)	209.40± 66.780	230.40± 67.50	225.6± 66.54	1.955	0.144
Duration of Motor Block (in minutes)	175.80± 50.40	184.2± 48.24	173.40± 51.60	0.976	0.379
Block performance (in minutes)	20.79± 3.040	22.43± 4.617	26.86± 4.233	42.715	**<.00001**
Time b/w end of block and start of operation (in minutes)	41.30± 5.804	45.50± 9.124	45.01± 8.998	5.601	**0.004**

Table 3: Comparison of Various Outcome measures across the three groups

Parameters	Group SCL (n=70)	Group ICL (n=70)	Group AX (n=70)	F Value	P value
Image Visualization Time (in minutes)	12.00± 4.875	12.54± 4.481	17.83± 4.403	34.430	**0.0001**
Needling time (in minutes)	7.17± 1.523	7.60± 1.813	7.40± 1.714	1.130	.325
Needle Depth (in cm)	3.00±.885	4.97±.780	2.99±.860	128.695	**<.00001**
Needle passes	1.44 ± 0.500	1.56 ± 0.500	3.94 ± 0.832	3.493	**.032**
Block Pain Related VAS score	1.96± 0.786	2.46± 0.402	2.00± 0.816	11.241	**.032**

Table 4: Comparison of block success (N=210)

Parameters	Group SCL (n=70)	Group ICL (n=70)	Group AX (n=70)	$\chi 2$ value	P value
Appropriate block	65 (92.8%)	60 (85.71%)	60 (85.71%)	1.23	.540
Failed Block	5 (7.14%)	10 (14.28%)	10 (14.28%)		

Table 5: Comparison of Side effects (N=210)

Parameters	Group SCL (n=70)	Group ICL (n=70)	Group AX (n=70)	$\chi 2$ value	P value
Paresthesia	4 (5.71%)	3 (4.28%)	1 (1.42%)	2.914	.572
Vascular puncture	6 (8.57%)	5 (7.14%)	3 (4.28%)		