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Original Research Article

Ultrasound guided supraclavicular block versus combined infraclavicular and Suprascapular block: A randomized controlled trial

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ABSTRACT

Background: The infraclavicular block (ICB) can avoid some of the side effects of the supraclavicular block (SCB) like hemi-diaphragmatic palsy. This study aimed to analyze the comparative efficacy of supraclavicular block versus combined infraclavicular block and suprascapular block.
Materials and Methods: Patients undergoing upper limb surgery under general anaesthesia were randomized into group S (to receive supraclavicular brachial plexus block) and group I (to receive infraclavicular brachial plexus block and suprascapular nerve block). Onset times and the duration of both sensory and motor block was noted in both the groups. Postoperative pain as assessed by NRS score and total fentanyl requirement was noted for 24 hours.
Results: The group S showed a significantly faster onset of both sensory (8.47±3.12) vs. 13.75±4.69; p<0.001) and motor blocks (15.56±5.32 vs. 24.17±5.67; p<0.001). The duration of sensory block was significantly greater in the group I, with no significant difference in the duration of motor block. We also noted hemi diaphragmatic paresis (27.8%) and paralysis (8.3%) only in the SCB group.
Conclusions: For the patients undergoing upper limb surgeries, the use of ICB+SSB block as compared to the SCB block resulted in increased duration of sensory block; however, the fentanyl consumption was not significantly reduced.

1. Introduction

Though cocaine for upper limb blocks was used in the late 1800s by William Halsted and Richard Hall,[1] first available description of brachial plexus block anaesthesia for upper limb surgeries was from 1929.[2] Since then, various sites, techniques, and methods have been described. Most commonly used among these sites is the supraclavicular block (SCB), also known as the "Spinal of the arm" has been proven to be advantageous as the brachial plexus nerve roots are tightly packed in this approach, which results in rapid achievement of nerve block. Though the SCB stands to be the most widely used techniques with invariable advantages, it has side effects like the phrenic nerve involvement, Horner's syndrome, pneumothorax, intraarterial injection and neuropathy.[3]

The infraclavicular block (ICB) is a regional anaesthesia technique that blocks the brachial plexus below the clavicle.[4] The ICB avoids some of the side effects and complications of SCB like hemi-diaphragmatic palsy.[5] The disadvantage of ICB is that it spares the shoulder nerves, leading to pain during perioperative positioning and post operative pain in the shoulder.[4] The suprascapular

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nerve covers about 70% of the sensory supply of the shoulder region, and variably, the overlying skin. The suprascapular nerve can be precisely targeted to provide shoulder analgesia while avoiding phrenic nerve blockade.[6] The combined use of ICB and SSB has been successfully employed for analgesia in arthroscopic shoulder surgeries.[7,8]

This study was aimed to study the relative efficacy of ultrasound-guided supraclavicular block versus combined infraclavicular block and suprascapular block in patients undergoing upper limb surgery under general anaesthesia (GA).

2. Materials and Methods

It was a prospective randomized controlled study conducted from April 2022 to April 2023. The protocol was approved by the institutional ethics committee (468/IEC/PGM/2021) and Clinical Trial Registry India (CTRI/2022/03/041359). We followed the CONSORT (Consolidated Standards of Reporting Trials) guidelines of 2010 while conducting our study.

Patients, both male and female, 18-60 years of age, American society of Anesthesiologists (ASA) class I-III, posted for upper limb (humerus and elbow) surgeries under general anaesthesia were considered for our study. Patients with bleeding disorders, infection, or hematoma at the site of the block, any known allergy to local anaesthetics, fracture or dislocation involving clavicle or shoulder, pre-existing neurological deficits in the limb to be operated, pre-existing hemi diaphragmatic palsy as assessed by ultrasound were excluded from this study.

The procedures were explained to all patients and a written consent was obtained. Patients were randomized into 2 groups. Group S (received supraclavicular brachial plexus block with 30 ml of 0.25% bupivacaine) and Group I (to receive infraclavicular brachial plexus block with 20 ml of 0.25% bupivacaine and suprascapular nerve block with 10 ml of 0.25% bupivacaine). By a computer-based program. For that we used Random Allocation Software version 2.0 (Informer Technologies, Inc.) using simple randomization with 1:1 allocation.

The investigator assessing the onset time of blocks, intraoperative vitals, and postoperative pain score, as well as analgesic requirements, the type of block the patient had received.

On the day of surgery, patients were transferred to the operation theatre one hour prior to the surgery, pre-operative vitals were noted after attaching the routine non-invasive monitors. A 20 G peripheral cannula was secured on the non-operating hand and intravenous fluids (crystalloids) was started. A 5-13 Mhz linear ultrasound probe with a portable ultrasound machine (SonoSite Edge II Ultrasound System, Fujifilm Inc.) was used for giving all the upper limb blocks in both the groups.

In both groups, vitals were monitored at 0, 10, 20 and 30 minutes following the administration of the block in the preoperative room. The time of onset of both sensory (loss of pin prick sensation) and motor (using Modified Bromage Scale) block assessed immediately after the block, and then every 5 minutes for 30 minutes. Any patient who did not develop loss of pin prick sensation or motor weakness in the upper limb within 30 minutes was classified as block failure and the same was excluded from our study.

After the block, all the patients received general anaesthesia with 2 mcg/kg fentanyl, 1.5 to 2.5 mg/kg propofol and 0.1mg/kg of vecuronium as induction agents following which the airway was secured with an appropriate size cuffed endotracheal tube. Following that, the patient was positioned for the surgery. At the end of surgery, if the patient had adequate spontaneous respiratory efforts, neuromuscular blockade was reversed with injection neostigmine (50mcg/kg i.v.) and inj. glycopyrrolate (10 mcg/kg i.v.). After adequate reversal, the patients were extubated and transferred to the post anaesthesia care unit (PACU).

All patients were monitored in PACU. Pain scores assessed by NRS score at the end of surgery, hourly up to 6 hours, 2-hourly up to 12 hours and 4-hourly up to 24 hours after surgery. NRS score of 4 or more was the criteria to administer fentanyl in 25 micrograms i.v. The total fentanyl requirement was noted at the end of 24 hours by counting the number of bolus doses. The duration of the block, by the return of sensory (pin prick sensation) and motor (elbow flexion/figure movements) response was noted. Patients were assessed for the hemi diaphragmatic paresis, hemi diaphragmatic palsy, development of pneumothorax local anaesthesia systemic toxicity (LAST) or any nerve injury before and after induction and at the end of the procedure.

Our primary objective was to compare the total postoperative requirement of intravenous fentanyl in the first 24 hours after surgery in two groups. The secondary objectives were to compare the time of onset of sensory block (loss of pin prick sensation) and motor block (Modified Bromage Scale 3 or below), the postoperative pain as measured by NRS score, and the relative incidence of complications in the two groups.

Since we were not able to find any similar study done previously so the sample size was based on an assumed effect size of 0.6 (medium effect size) (using Cohen's Convention) for our primary objective i.e. total postoperative requirement of intravenous fentanyl in the first 24 hours. Power analysis for mean was conducted in G-POWER software version 3.1.9.7, for an effect size of 0.6, an alpha error 0.05, and a power of 0.80. Based on the above parameters, a sample size of 72 was obtained with 36 participants in each group.

Data analysis was done on statistical package for the social sciences version 23 (IBM Corp.). For categorical data 't' test was used if it was normally distributed or Wilcoxon-

Mann-Whitney U Test was used if the data was skewed. Chi-squared test or Fisher's Exact Test was used for group comparisons for categorical data. A p value <0.05 was considered statistically significant.

3. Results

We assessed 89 patients for eligibility, of these 17 patients were excluded and the remaining 72 patients were included in our study (Diagram 1). Both groups were comparable in terms of patient characteristics and the duration of anaesthesia and surgery (Table 1).

A significant difference was noted between the two groups in terms of sensory block onset time (p<0.001, Table 2), with the median sensory block onset time higher in the I group. In terms of motor block onset time, the two groups were significantly different (p <0.001), with the median motor block onset duration being higher in the Group I. The onset times of both sensory and motor block was lesser in group S as compared to group I (Table 2).

The mean duration of motor block in the S group was 6.03±0.94 and in I group was 6.21±1.48. No significant difference was noted between the groups in terms of duration of motor block (W = 551.500, p = 0.266). The mean duration of sensory block in the group S was 7.03±0.99 and in the group I was 7.64±1.44. The difference was statistically significant (p = 0.045), with the median duration sensory block being higher in the Group I.

In the postoperative period the NRS score was significantly less in group I as compared to the group S at time points, 3 hours, 4 hours, 5 hours, 6 hours (Table 3). Though the mean NRS score was lower in group I at 8, 10 and 12 hours, the difference was not statistically significant (Table 3). In terms of total dose of rescue analgesia, no significant difference was noted between the two groups (p=0.238), though the dose was less in group I as compared to the group S.

In terms of distribution of complications, a significant difference was noted between the two groups (p <0.001) (Table 6). 36.1% of the patients in the group SCB had complications while 0.0% of the patients in the group ICB+SSB had complications. There was no significant difference between the two groups in the incidence of hemi diaphragmatic paralysis ($\chi 2$ = 3.130, p = 0.239). There was a significant difference between the two groups in the incidence of hemi diaphragmatic paresis ($\chi 2$ = 11.613, p = <0.001) (Table 5). Strength of association between the two variables (Cramer's V) = 0.4 (Moderate Association).

4. Discussion

We conducted a randomized controlled study in which 72 patients posted for upper limb surgeries under general anaesthesia were included. For our primary objective, we found that the mean dose of fentanyl during the first 24 hours was lesser in the ICB+SSB group; however, it was not statistically significant (63.64±29.61 vs. 53.12±28.69; p = 0.238). For the block onset time, the SCB group showed a significantly faster onset of both motor and sensory blocks. The duration of sensory block was significantly greater in the ICB+SSB group, with no significant difference in the duration of motor block. In terms of NRS scores, the group I had much lower scores during the first 6 hours post-operatively. There was no significant difference in the NRS score after six hours or for up to 24 hours. We noted a significant incidence of hemi diaphragmatic paresis (27.8%) and paralysis (8.3%) only in the group S, with no incidence in the group I. No other complication was noted in any patient in our study.

We found that the cumulative consumption of fentanyl during the first 24 hours was lower in the ICB+SSB group but it was not statistically significant. In a study by Kukreja P et al., authors compared supraclavicular block versus infraclavicular block and reported that the average post-operative morphine consumption was higher in the infraclavicular group, though it was statistically not significant.[9] The reason for this difference could be due to the lack of additional use of suprascapular blocks in our study. In another study, authors performed combined ICB and SSB on twenty patients who underwent shoulder arthroplasty. The author demonstrated an effective post-operative analgesia and a lower incidence of complications such as hemi diaphragmatic paralysis.[10]

The onset of sensory and motor block was faster in the S group as compared to the group I in our study, both of which were statistically significant. Arcand G et al. in a similar study compared the performance times and block quality of infraclavicular and supraclavicular ultrasound-guided blocks on 80 patients and concluded that the block onset times did not differ between the groups and ultrasound-guided ICB was performed at least as rapidly as ultrasound-guided SCB.[11] While Abhinaya RJ et al. in a similar study observed that the onset of sensory block was earlier in the ICB group than the SCB group.[12] The difference may be due to different approaches to giving the block in these studies (we used the corner pocket approach for brachial plexus block). Since we planned to assess postoperative analgesia, only 0.25% of bupivacaine was used in our study.

In our study, the mean duration of sensory block (hours) was higher in the group I. However, no significant difference was noted in the duration of the motor block, though both the motor and sensory block durations were longer in the ICB+SSB group. In a study on distal Arm Surgery, authors randomized 120 patients for ultrasound-guided brachial plexus block to either the supraclavicular, infraclavicular, or axillary groups, they concluded that the duration of block was significantly increased in the infraclavicular group, which favored the results of our study.[13]

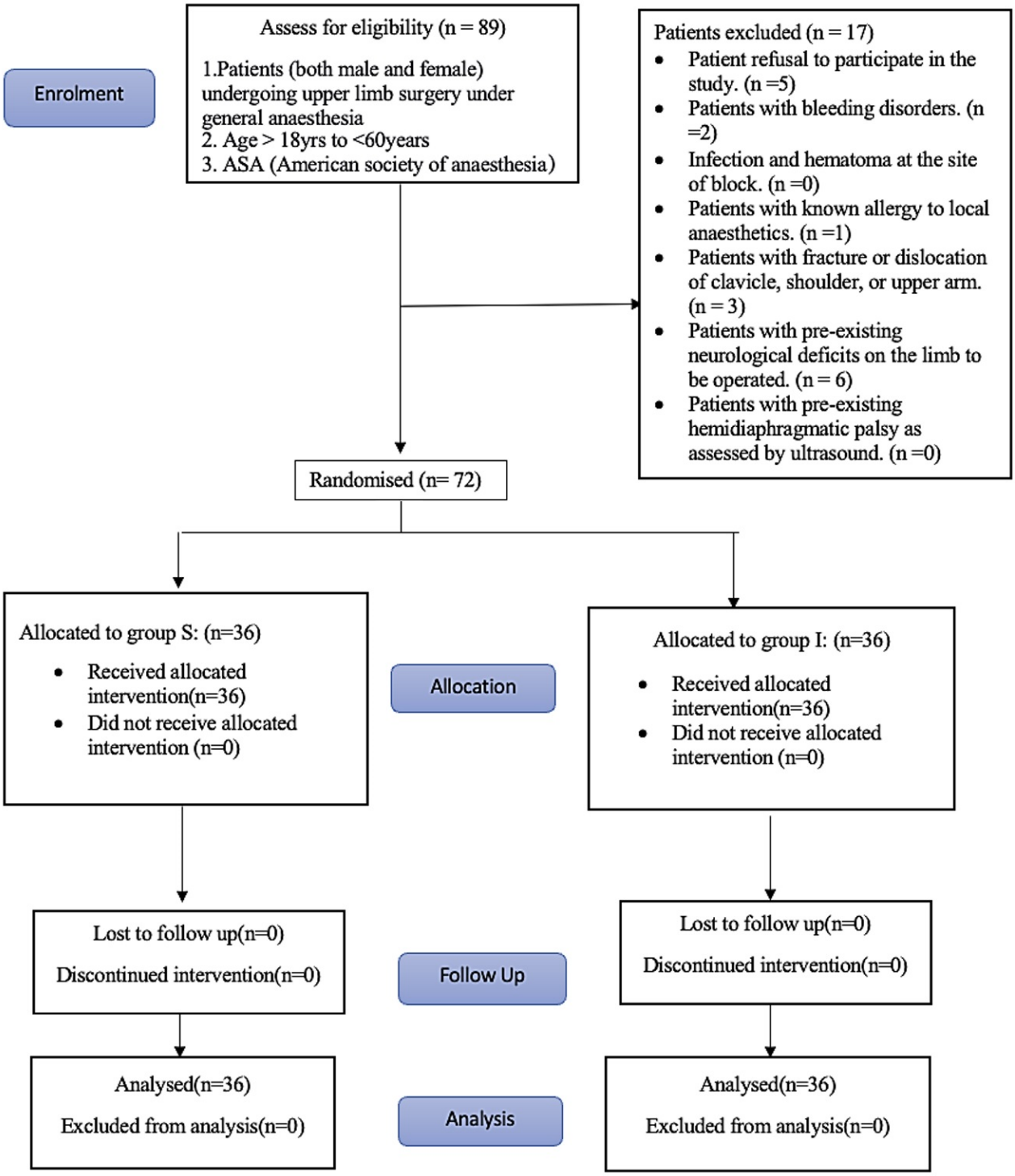

Diagram 1: Consort flow diagram

Table 1: Demographic profile of patients in Group S and I

Parameters	Group S(n = 36)	Group I(n = 36)	p value
Age (Years)	31.86 ± 11.64	32.19 ± 8.57	0.543*
Gender			0.276Ě
Male	25 (69.4%)	29 (80.6%)	
Female	11 (30.6%)	7 (19.4%)	
BMI (kg/m^2)	21.25 ± 2.82	21.22 ± 2.32	0.815*
ASA, n(%)			0.257Ě
I	26 (72.2)	30 (83.3)	
II	10 (27.8)	6 (16.7)	
Duration of Surgery (Hours)	0.07 ± 0.02	0.08 ± 0.03	0.089*
Duration of Anesthesia (Hours)	0.08 ± 0.02	0.09 ± 0.03	0.106*

*: Wilcoxon-Mann-Whitney U Test, Ě: Chi-Squared Test, 4: t-test

Table 2: Sensory and motor block onset time and duration in Group S and Group I

Onset Time (Minutes)		Group S	Group I	Wilcoxon-Mann-Whitney U Test W	p value
Sensory block	Mean ±SD	8.47±3.12	13.75±4.69	249.000	<0.001
Motor block	Mean ±SD	15.56±5.32	24.17±5.67	191.500	<0.001
Duration of Block (Hours)		**Group**		**Wilcoxon-Mann-Whitney U Test**	
			I	W	p value
Duration of Motor Block	Mean ±SD	6.03±0.94	6.21±1.48	551.500	0.266
Duration Sensory Block	Mean ±SD	7.03±0.99)	7.64±1.44	473.000	0.045

Table 3: Comparison of the two Groups in terms of NRS score after extubation

NRS At Rest	Group S Mean±SD	Group I Mean±SD	p*
After Extubation	0.14 ±0.49	0.08±0.28	0.953
1 Hour	1.22±0.99	0.78±0.93	0.055
2 Hours	1.81±0.47	1.50±0.88	0.121
3 Hours	2.42±0.65	1.97±0.81	0.017
4 Hours	2.75±0.60	2.39±0.77	0.037
5 Hours	3.06±0.79	2.56±0.81	0.013
6 Hours	3.92±1.46	3.08±1.00	0.043
8 Hours	4.42±1.71	3.81±1.28	0.218
10 Hours	4.81±1.88	4.22±1.48	0.211
12 Hours	4.36±1.73	4.03±1.34	0.590
16 Hours	3.89±1.35	3.69±1.01	0.728
20 Hours	3.33±1.10	3.42±1.02	0.635
24 Hours	3.08±0.81	3.22±0.93	0.483

*Mann-Whitney U-test

Table 4: 24-hour Fentanyl (mcg) consumption in Group S vs Group I

Dose of Rescue Analgesia Fentanyl (mcg)	Group S	Group I	Wilcoxon-Mann-Whitney U Test W	p value
Mean±SD	63.64±29.61	53.12±28.69	215.000	0.238

Table 5: Incidence of complications in Group S and Group I

Complications	Group		Total	Test	$\chi 2$	P Value
	S	I				
Any	13 (36.1%)	0 (0.0%)	13 (18.1%)	Chi-Squared Test	15.864	<0.001
Hemi diaphragmatic Paralysis	3 (8.3%)	0 (0.0%)	3 (4.2%)	Fisher's Exact Test	3.130	0.239
Hemi diaphragmatic Paresis	10 (27.8%)	0 (0.0%)	10 (13.9%)	Chi-Squared Test	11.613	<0.001
Pneumothorax	0 (0%)	0 (0%)	0 (0%)	–	–	–
LAST	0 (0%)	0 (0%)	0 (0%)	–	–	–
Nerve Injury	0 (0%)	0 (0%)	0 (0%)	–	–	–

Table 6: Odds ratios and relative risks

Predictor/Risk Factor	Outcome	Odds Ratio (95% CI)	Relative Risk (95% CI)
Hemi diaphragmatic Paralysis	Group: S	7.63 (0.38-153.2)	2.09 (0.89-2.74)
	Group: I	0.13 (0.01-2.63)	0 (0-1.11)
Hemi diaphragmatic Paresis	Group: S	28.92 (1.62-515.68)	2.38 (1.64-3.28)
	Group: I	0.03 (0-0.62)	0 (0-0.48)

The NRS scores were lower in the group I for first 6 hours. There was a significant difference between the two groups in terms of NRS at 6 hours, with the mean NRS at rest being highest in the SCB group. In contrast to our study, Kukreja Pet al. observed that the post-operative pain score as assessed by the visual analogue scale was higher in the infraclavicular block group as compared to the supraclavicular group, though the difference was not statistically significant.[9] They have not used the suprascapular block along with the infraclavicular block in their study, so the addition of SSB to ICB might have resulted in lower pain scores at most time points (but not all time points) both during rest and on movements in our study.

The complications seen in our study were hemi diaphragmatic paralysis and paresis after administration of the block, which were only observed in the SCB group. In a study comparing ultrasound-guided interscalene brachial plexus block (ICB) to supraclavicular brachial plexus block (SCB), it was found that nearly one-third of patients in the SCB group experienced complete hemi diaphragmatic paralysis. In contrast, the ICB group had a significantly lower incidence of this complication.[5] In study done by Mak PH et al., they performed nerve stimulator guided SCB on 30 patients and found 50% of patients had complete ipsilateral diaphragmatic palsy and 17% of patients had reduced diaphragmatic movement.[14] A lower incidence of both hemi diaphragmatic paresis and paralysis in our study may be due to a lower concentration of the drug used in our study and also to the use of ultrasound in all patients.

In a study investigating various volumes of supraclavicular brachial plexus block, the authors concluded that higher volumes of the block were associated with a higher incidence of hemi diaphragmatic paralysis and phrenic nerve involvement.[15] Another study done by Renes SH etal., examined USG versus nerve stimulation SCB in the incidence of hemi diaphragmatic paresis and summarized USG-guided SCB as a safer option with no incidence of hemi diaphragmatic paresis or paralysis.[16] A studyon 6366 patients who received ultrasound-guided brachial plexus block, reported a pneumothorax incidence of 0.06%.[17] Similarly, a study done by Gamo K et al. demonstrated the better efficiency and safety of SBPB under ultrasound guidance for orthopaedic surgeries.[18] In another study comparing conventional and ultrasound-guided supraclavicular brachial plexus blocks for upper limb surgeries, the authors concluded that the ultrasonically guided group had a higher block success rate compared to the conventional group. However, this difference was not clinically significant.[19] Evenduring the COVID-19 era, the effective management of a COVID-19 patient with many coexisting diseases undergoing upper limb emergency vascular surgery while receiving a low-volume supraclavicular brachial plexus block has been reported without any known complications.[20] Similarly, our study was also exclusively done under ultrasound guidance and there was no case of pneumothorax or any other complications like LAST, anaphylaxis, etc., in any of the patients.

Our study had certain limitations. The diaphragmatic assessment was not done by the phrenic nerve stimulator test, which was considered as the gold standard, as we wanted to avoid pain and discomfort preoperatively. All patients were followed up at a predetermined time points only; hence, breakthrough pain between the follow-ups may have been missed. Postoperative analgesic requirements were not met with the PCA pump due to its non-availability, so there might have been a time lag from when the patient had a breakthrough pain to when the rescue analgesia was administered.

5. Conclusion

For patients undergoing upper limb surgeries, the use of Combined Infraclavicular and Suprascapular block, compared to the Suprascapular block alone resulted in increased duration of sensory block and no incidence of hemi diaphragmatic paresis or paralysis. However, the onset time of the block was longer, and 24-hour cumulative fentanyl consumption was not significantly reduced.

6. Sources of Funding

None.

7. Conflict of Interest

None.

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