Original Article

Efficacy of intertruncal and corner-pocket approaches of ultrasound-guided supraclavicular block in terms of ulnar nerve blockade: A randomised controlled study

Address for correspondence:
Dr. Saurabh Trivedi,
H/43 ESSARJEE Campus,
BDA Road BHEL, Berkhera
Bhopal - 462 022,
Madhya Pradesh, India.
E-mail: drst23@gmail.com

Submitted: 18-Jan-2023
Revised: 27-Jun-2023
Accepted: 09-Jul-2023
Published: 06-Sep-2023

Access this article online

Website: https://journals.lww.com/ijaweb

DOI: 10.4103/ija.ija_45_23

Quick response code

Saurabh Trivedi, Srishti Gupta[1], Hemendra Bhardwaj, Tapan Kumar Sahoo, Seema Gupta, Gaurav Trivedi[2]

Department of Anaesthesia and Critical Care, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, [1]Department of Emergency Medicine, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, [2]Department of Radiation Oncology, Command Hospital, Lucknow, Uttar Pradesh, India

ABSTRACT

Background and Aims: The incidence of ulnar nerve sparing has declined with the corner-pocket approach of the supraclavicular block (SCB), however, it continues to persist. A recent technique of SCB, the intertruncal approach, separately blocks each trunk of the brachial plexus. Thus, we hypothesised that the intertruncal approach results in a complete ulnar nerve blockade. **Methods:** Eighty-eight patients were randomised to undergo SCB using an ultrasound (USG)-guided corner-pocket or intertruncal approach and were compared primarily regarding the complete sensory and motor blockade of the ulnar nerve and all four nerves (ulnar, radial, median and musculocutaneous nerves) at 15 min. Secondary objectives included time required for block performance, patient discomfort score, time to readiness for surgery and duration of sensory blockade of the ulnar nerve. Continous data were compared using an independent *t*-test, and categorical data were compared using the Chi-square test. **Results:** The proportion of participants with complete sensory (30/44 vs. 14/44, $P < 0.001$) and complete motor (22/44 vs. 7/44, $P < 0.001$) blocks in the ulnar nerve and all four nerves at 15 min was significantly higher in the intertruncal group. Block performance time and patient discomfort score were higher in the intertruncal group ($P < 0.001$). The total duration of sensory blockade in the ulnar nerve was more in the corner-pocket group ($P < 0.001$). **Conclusion:** USG-guided intertruncal approach is superior to the corner-pocket approach of SCB regarding a complete ulnar nerve blockade.

Key words: Brachial plexus block, corner-pocket approach, supraclavicular block, intertruncal approach, ulnar nerve, ultrasonography

INTRODUCTION

Supraclavicular block (SCB) is quite effective for most upper limb surgeries but is associated with complications like ulnar nerve sparing and pneumothorax. The main reasons for these complications are the deep location of the lower trunk within the neural clusters and the location of nerve trunks in the vicinity of the pleura.[1,2] Precise deposition of local anaesthetics under ultrasonographic (USG) guidance can reduce the occurrence of ulnar nerve sparing and local anaesthetic requirements with lesser complications.[3]

The USG-guided corner-pocket approach of SCB, wherein the local anaesthetic is deposited between

How to cite this article: Trivedi S, Gupta S, Bhardwaj H, Sahoo TK, Gupta S, Trivedi G. Efficacy of intertruncal and corner-pocket approaches of ultrasound-guided supraclavicular block in terms of ulnar nerve blockade: A randomised controlled study. Indian J Anaesth 2023;67:778-84.

the lower trunk and the subclavian artery (SCA) by targeting the needle between the inferolateral side of SCA and the first rib, is considered to be effective in the prevention of ulnar nerve sparing.[4] Although local anaesthetic is deposited near the lower trunk in the corner-pocket approach, ulnar nerve sparing may occur in up to 30% patients.[5] In a recent technique of USG-guided SCB [2], which is a single-needle puncture, a dual-injection technique termed the intertruncal approach, the local anaesthetic is deposited in the investing adipose layers between the upper-middle trunk and the middle-lower trunks. Since each trunk is separately blocked in this approach, we hypothesise that the intertruncal approach would be more efficient in providing a complete ulnar nerve blockade than the corner-pocket approach. The primary objective was the proportion of participants with complete sensory blockade of the ulnar nerve at 15 minutes. The secondary objectives were the proportion of participants with complete motor blockade of the ulnar nerve, sensory and motor blockade of all four nerves (ulnar, radial, median and musculocutaneous nerves) at 15 minutes, block performance time, patient discomfort score, time to readiness for surgery, duration of sensory blockade in the ulnar nerve and association between change in perfusion index (PI) values in the little and middle fingers and thumb with clinical detection of ulnar nerve blockade.

METHODS

This randomised, double-blinded study was conducted in a tertiary teaching hospital between November 2022 and January 2023 on patients undergoing elective upper limb surgery under USG-guided SCB after obtaining approval from the Institutional Ethics Committee (vide approval number CMCH/IEC/2022/82, dated 28 October 2022) and registration of trial with the Clinical Trial Registry-India (vide registration number CTRI/2022/11/047502, www.ctri.nic.in). Written informed consent was obtained from all the participants to use their data for research and educational purposes. The study was conducted in accordance with the declaration of Helsinki, 2013 and adherence to the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Patients aged 18–65 years of either gender and belonging to American Society of Anesthesiologists-Physical Status (ASA-PS) I or II were included in the study. Patients having contraindications to regional anaesthesia due to a history of allergy to local anaesthetics, procedure site infection, coagulation disorder or mental health issues were excluded.

Patients were randomised to receive USG-guided SCB by either the intertruncal approach (Group IT, $n = 44$) or the corner-pocket approach (Group CP, $n = 44$). Simple block randomisation was done using a computer-generated random number table with a block size of four. Allocation concealment was done using a sequentially numbered sealed opaque envelope technique and was opened on the day of surgery before administration of the block. This study was double-blinded. All other individuals who participated in the surgery, including the observer who assessed and recorded the study parameters, were blinded to the group assignment. After wheeling the patient into the theatre, intravenous (IV) access was secured, and standard monitors were attached. Strict aseptic precautions were followed. All the blocks were performed by a single operator (author S.T. having experience performing >50 SCBs under USG guidance) using a high-frequency linear array probe (6–13 MHz) of USG system (FUJIFILM Sonosite M-turbo, Inc, Bothell, WA, USA), with the patient lying supine and head tilted to the opposite side, in both the study groups.

Each patient was administered IV midazolam 1 mg, and supplemental oxygenation was administered via a simple face mask at the rate of 5 L/min before performing the block. Blocks in both groups were performed using a local anaesthetic solution containing 10 mL of 2% lignocaine with adrenaline and 15 mL of 0.5% bupivacaine. In the transverse orientation, the probe was placed in the supraclavicular region, approximately 3 cm above the midclavicular point. At this site, the third part of SCA was visible. The probe was toggled in the cephalocaudal direction to see SCA in its cross-section, along with the three trunks of brachial plexus (hyperechoic structures) resting on the first rib. After obtaining an adequate sonographic view, a 5-cm, 22-gauge, echogenic needle (Pajunk, Geisingen, Germany, or B. Braun, Bethlehem, PA, USA) was inserted in line from the lateral to medial orientation through a single skin puncture. In the intertruncal group, the needle was targeted first to the intertruncal plane between the upper and middle trunks and 12.5 mL of local anaesthetic solution was deposited. The needle was then carefully redirected towards the intertruncal plane between the middle and lower trunks, and the remaining 12.5 mL of local anaesthetic solution was injected after negative

aspiration for blood [Figure 1a]. In the corner-pocket group, the needle was advanced between the first rib and the inferolateral surface of SCA and 25 mL of local anaesthetic solution was slowly injected after negative aspiration for blood [Figure 1b].

After the performance of the block, a blinded observer (who was not present during the SCB procedure) assessed for patient discomfort during block performance on a scale of 0–10 (0 indicates no discomfort, and 10 indicates the worst discomfort imaginable). The same observer assessed for sensory and motor blockade in the areas of ulnar, radial, median and musculocutaneous nerves every 5 min after the needle removal for at least 30 min. Sensory evaluation was done using pinprick stimulation in the areas supplied by the radial nerve – dorsum of the hand, median nerve – thenar eminence, ulnar nerve – hypothenar eminence and musculocutaneous nerve – lateral aspect of the forearm. At each point of assessment, a score (0–2) was given to each territory (0- implying normal sensation, 1- loss of pain sensation, but pressure sensation intact, 2- loss of both pain and pressure sensations). A complete sensory blockade of each nerve was defined as a pinprick score of 2.

The motor evaluation was done by elbow flexion (musculocutaneous nerve), third finger flexion (median nerve), thumb abduction (radial nerve) and little finger flexion (ulnar nerve). At each point of assessment, a three-point scale (normal = 3, mildly reduced = 2, markedly reduced = 1, unable to move = 0) was used to grade motor blockade. A complete motor blockade for each nerve was defined as a score of 0.

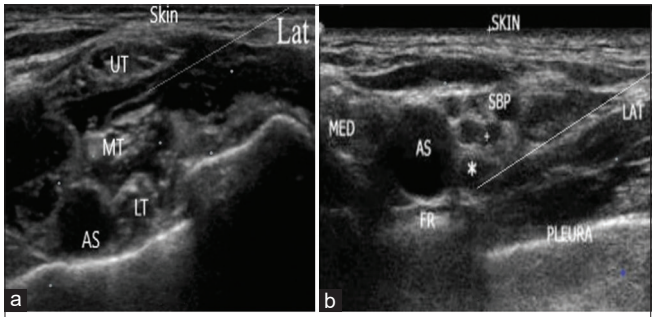

Figure 1: (a) Ultrasonography image of the IT approach of SCB after injection of LA in two IT planes. (b) Ultrasonography image of CP approach of SCB showing point (*) of LA deposition. CP = **c**orner pocket, SCB = supraclavicular block, IT = **i**ntertruncal, LA = local anaesthetic

Block performance time was defined as the time (in minutes) from the point of needle insertion till the removal of the needle after drug deposition. We considered the block successful and the patient ready for surgery when a complete sensory blockade was achieved in all four nerve territories and time to readiness for surgery was recorded. In case of block failure or insufficient block, the patients were administered general anaesthesia with standard institutional protocol, and surgery proceeded, and such cases were excluded from statistical analysis.

The same blinded observer also recorded PI at the baseline, every 5 min after the needle removal till 30 min in the little finger, middle finger and thumb using three Sed-Line pulse oximeters (Root, Masimo Corporation®, Irvine, CA, USA).

After the surgery, patients were instructed to repeatedly pinch the little finger of each hand using their non-blocked hand and report for the time of sensory normalisation in the anaesthetised hand by comparison with the opposite hand. Patients were followed up for 24 h post-surgery and looked for residual blockade or neurological deficits.

A complete sensory blockade of each nerve was defined as a pinprick score of 2, and a complete motor blockade for each nerve was defined as a score of 0. Block performance time (minutes) was the time from the point of needle insertion till the removal of the needle after drug deposition. Time to readiness for surgery was defined as the time required to achieve a complete sensory blockade in all four nerve territories. The duration of sensory blockade of the ulnar nerve was the time from block performance till sensory normalisation in the little finger of the anaesthetised hand, as reported by the patient.

The primary outcome of this study was to compare the proportion of participants with complete sensory blockade of the ulnar nerve 15 min after block performance.

Jo *et al*.[6] compared the intertruncal and corner-pocket approaches of USG-guided SCB. They found that 75.9% of patients in the intertruncal group achieved complete sensory block in the ulnar nerve at 15 min, whereas only 43.3% achieved the same in the corner-pocket group. Using G*Power 3 software for Windows (University of Kiel, Kiel, Germany)

for calculation of the sample size, and based on the differences in a complete sensory block of the ulnar nerve at 15 min between the intertruncal and corner-pocket approaches in the study by Jo *et al*.,[6] a sample size of 44 participants in each group was required to achieve an alpha error of 0.05 and with 90% as the power of the study.

The data analysis was conducted using Statistical Package for the Social Sciences (International Business Machines Corporation (IBM), New York) for Windows, version 16. The Shapiro- Wilk test was employed to assess the normality of the data. Variables including age, duration of surgery, block performance time, patient discomfort score, time to readiness for surgery and duration of sensory block in the ulnar nerve territory were presented as median (interquartile range [IQR]) and compared using the Mann–Whitney U-test. The variable PI was represented as mean ± standard deviation (SD) and compared using an independent Student's *t*-test. Categorical variables such as ASA-PS, gender, type of surgery and proportion of participants with nerve block were expressed as numbers (%) and analysed using the Chi-square test. A $P < 0.05$ was considered statistically significant.

RESULTS

Ninety-three patients were assessed for eligibility to participate in the study [Figure 2]. The demographics and surgical characteristics of the study participants were comparable between the two groups [Table 1]. The proportion of participants with a complete sensory block (30/44 vs. 14/44, $P < 0.001$) and complete motor block (22/44 vs. 7/44, $P < 0.001$) in the ulnar nerve and all four nerves at 15 min since block administration was significantly higher in the intertruncal group [Figure 3]. The median [IQR] block performance time (278.0 [268.0–298.0] vs. 237.0 [150.0–242.0] seconds in the intertruncal and corner-pocket group, respectively, $P < 0.001$) and the median [IQR] patient discomfort score during block performance (3.5 [3.0–5.0] vs. 1.5 [1.0–2.0] in the intertruncal and corner-pocket group, respectively, $P < 0.001$) were significantly higher in the intertruncal group, whereas the median [IQR] time to readiness

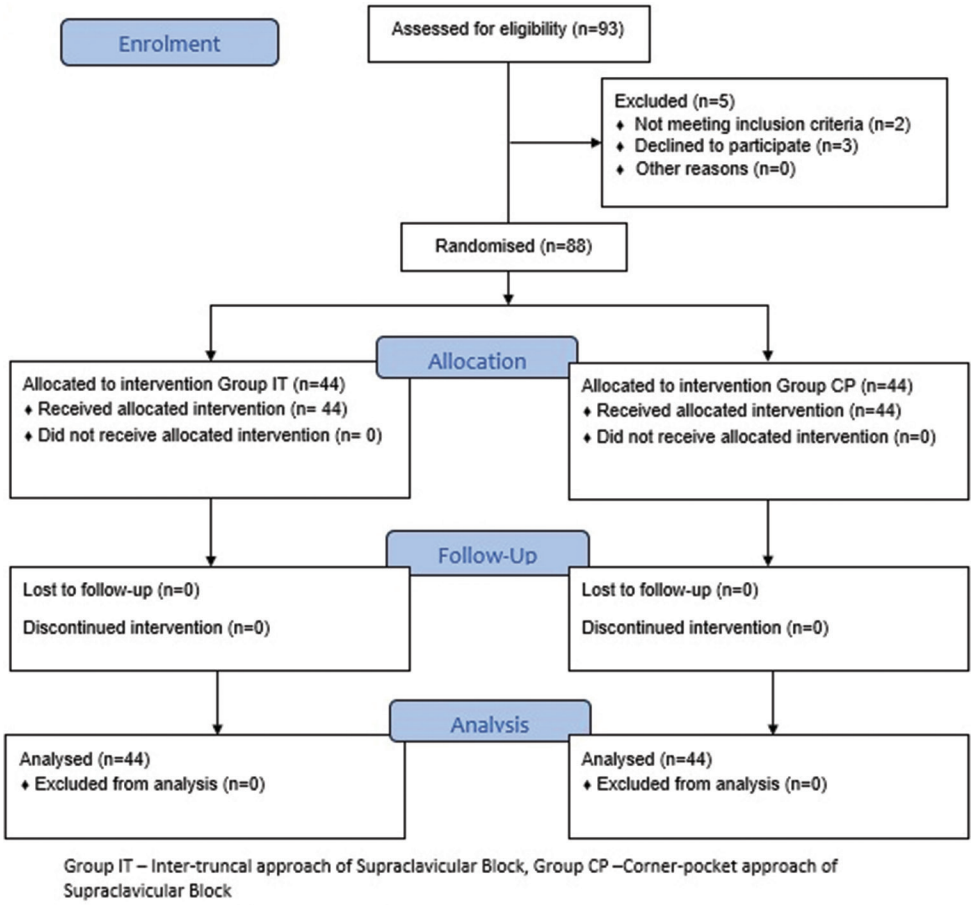

Figure 2: CONsolidated Standards of Reporting Trials flow of participants

for surgery (duration after which complete block occurred)(20.0 [15.0–25.0] vs. 25.0 [20.0–25.0] min in the intertruncal and corner-pocket group, respectively, $P = 0.059$) was relatively more in corner-pocket group, but was statistically insignificant. The total duration of the sensory blockade (median [IQR]) in the ulnar nerve was significantly more in the corner-pocket group (318.0 [289.0–364.0] min) compared to the intertruncal group (278.0 [268.0–298.0] min), $P < 0.001$ [Table 2]. None of the patients had any severe perioperative complications.

The mean PI in the little finger was significantly less compared to the mean PI in the middle finger and thumb of the anaesthetised hand at 5, 10 and 15 min in the intertruncal group [Table 2] and at 5, 10, 15 and 20 min in the corner-pocket group [Table 2].

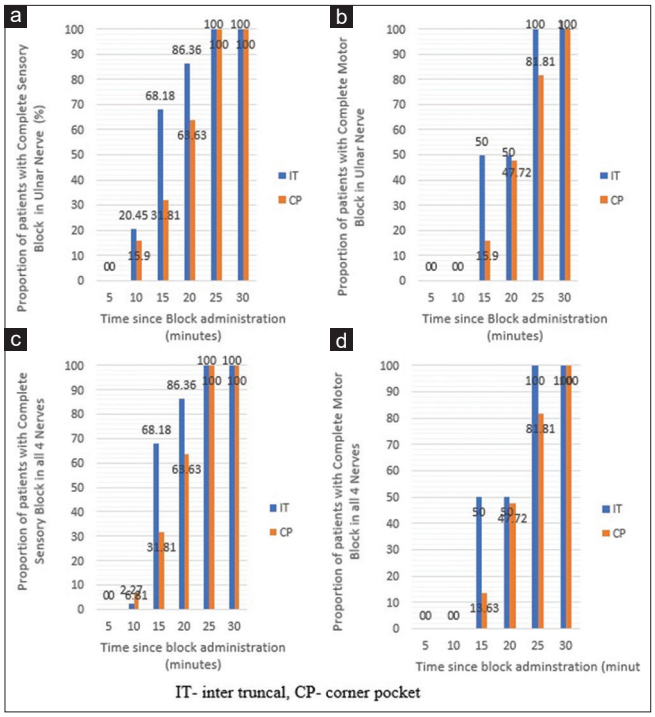

Figure 3: Proportion of participants with complete sensory (a) and complete motor block (b) in ulnar nerve territory with time. The proportion of participants with complete sensory (c) and complete motor block (d) in all four nerve territories with time

DISCUSSION

We observed that the proportion of participants with the complete sensory and motor blockade of the ulnar nerve at 15 min was significantly higher in the intertruncal than in the corner-pocket group. The intertruncal group had significantly higher block performance time and patient discomfort scores. The total duration of sensory blockade in the ulnar nerve was significantly more in the corner-pocket group, while the time to readiness for surgery was comparable between the two groups.

Jo *et al*.[6] compared intertruncal and corner-pocket approaches. They found that the rate of complete sensory and motor blockade of the ulnar nerve at 15 min was significantly higher in the intertruncal group, which is consistent with the results of the present study. In contrast to our study outcomes, Jo *et al*.[6] reported a relatively shorter time for readiness for surgery (15.0 [15.0, 20.0] min in the intertruncal group and 20.0 [15.0, 20.0] min in the corner-pocket group). This delayed onset of complete sensory blockade in our study may be due to the intertruncal approach, where local anaesthetic is deposited at two investing adipose layers between the upper and middle trunks and the middle and lower trunks.[2] Jo *et al*.[6] deposited local anaesthetic between the upper trunk, prevertebral fascia and the above plains. Similarly, in the corner-pocket approach, we deposited the local anaesthetic solution between SCA's inferolateral side and the first rib. In contrast, Jo *et al*.[6] deposited the local anaesthetic at the intertruncal planes and corner pockets.

In the present study, the block performance time was significantly higher in the intertruncal group. The

Table 1: Patient demographics and block characteristics

Parameters	IT group (*n*=44)	CP group (*n*=44)	*P*
Age (years)	28.0 (24.0, 50.0)	32.0 (28.0, 46.0)	0.41
Gender (Male:Female)	22:22	29:15	0.64
ASA-PS (I/II)	31/13	29/15	0.64
Surgery duration (min)	180.0 (140.0, 200)	157.5 (150.0, 180.0)	0.17
Type of surgery: Tumour excision/implant removal/fracture	22/14/8	22/15/7	0.95
Patient discomfort score during block performance (0–10)	3.5 (3.0, 5.0)	1.5 (1.0, 2.0)	<0.001
Block performance time (s)	278.0 (268.0, 298.0)	237.0 (150.0, 242.0)	<0.001
Time to readiness for surgery (min)	20.0 (15.0, 25.0)	25.0 (20.0, 25.0)	0.05
Sensory block duration in ulnar nerve territory (min)	278.0 (268.0, 298.0)	318.0 (289.0, 364.0)	<0.001

Values are presented as median (quartile 1, quartile 3) or proportions. ASA-PS=American Society of Anesthesiology-Physical Status, CP=Corner pocket, IT=Intertruncal

Table 2: Comparison of PI in the anaesthetised hand's little finger, thumb and middle finger

Time since block administration	IT Group							
	PI little finger (mean±SD)	PI thumb (mean±SD)	95%CI*	*P*	PI little finger (mean±SD)	PI middle finger (mean±SD)	95%CI*	*P*
0 min	1.41±0.70	1.41±0.70	−0.29–0.29	1	1.41±0.70	1.41±0.70	−0.29–0.29	1
5 min	2.38±1.19	4.27±1.93	1.21–2.56	<0.001	2.38±1.19	3.35±1.64	0.36–1.57	0.002
10 min	4.29±2.47	7.97±2.77	2.56–4.79	<0.001	4.29±2.47	5.96±2.74	0.56–2.77	<0.001
15 min	7.30±3.08	10.68±2.85	2.12–4.63	<0.001	7.30±3.08	8.99±2.52	0.49–2.88	<0.001
20 min	9.77±3.26	11.02±3.02	−0.08–2.58	0.06	9.77±3.26	10.69±2.69	−0.34–2.18	0.15
25 min	10.44±2.48	10.54±2.98	−1.06–1.26	0.85	10.44±2.48	10.41±2.72	−1.13–1.07	0.96
30 min	10.72±2.65	10.25±2.85	−1.63–0.63	0.43	10.72±2.65	9.89±2.64	−1.95–0.29	0.14
Time since block administration	**CP Group**							
	PI little finger (mean±SD)	PI thumb (mean±SD)	95%CI*	*P*	PI little finger (mean±SD)	PI middle finger (mean±SD)	95%CI*	*P*
0 min	1.34±0.702	1.34±0.702	−0.29–0.29	1	1.34±0.702	1.34±0.702	−0.29–0.29	1
5 min	1.89±1.34	4.12±1.85	1.54–2.91	<0.001	1.89±1.34	2.90±1.24	0.46–1.55	<0.001
10 min	2.56±1.70	6.92±2.91	3.35–5.37	<0.001	2.56±1.70	4.31±1.91	0.98–2.51	<0.001
15 min	4.57±2.33	9.67±4.33	3.62–6.57	<0.001	4.57±2.33	7.26±2.29	1.71–3.66	<0.001
20 min	7.76±3.34	9.90±3.20	0.75–3.52	0.003	7.76±3.34	9.23±3.33	0.05–2.88	0.04
25 min	8.53±3.77	9.71±3.25	−0.31–2.67	0.12	8.53±3.37	9.58±3.42	−0.38–2.48	0.17
30 min	8.81±3.19	9.20±2.81	−0.88–1.66	0.540	8.81±3.19	8.97±2.95	−1.14–1.46	0.79

*95% CI=95% confidence interval of the difference of means of PI. CI=Confidence interval, CP=Corner pocket, IT=Intertruncal, PI=Perfusion index, SD=Standard deviation

requirement of optimal image conditions with all three trunks distinguished in the intertruncal approach compared to the corner-pocket approach, in which visualisation of SCA with brachial plexus lateral to it is sufficient for drug deposition, may explain the longer block performance time in the intertruncal group.

In the present study, the patient discomfort score was significantly higher in the intertruncal group. A single skin-prick -single injection technique used for the corner-pocket approach[4,5] requires less manipulation of the needle compared to a single-skin prick–dual-injection technique used for the intertruncal approach, where the hand needs more manipulations, resulting in more discomfort to the patient in the intertruncal group. Since, in the present study, single point injection of local anaesthetic solution at the corner pocket of SCA and the first rib was done, more volume and concentration of local anaesthetic near the lower trunk must have resulted in a significantly prolonged duration of sensory blockade in the ulnar nerve in the corner-pocket group compared to the intertruncal group.

Kukreja *et al*.[5] compared USG-guided corner-pocket supraclavicular and infraclavicular block and showed that ulnar nerve sparing might occur up to 30% of the time with the corner-pocket approach. Multiple studies[7-9] reported similar results of ulnar nerve sparing with the corner-pocket approach of USG-guided SCB block.

Lal *et al*.[10] demonstrated that the mean PI is an objective and faster indicator for evaluating the success of USG-guided SCB. In the present study, the mean PI in the little finger was significantly less than the mean PI in the middle finger and thumb of the anaesthetised hand at 5, 10 and 15 min in the intertruncal group and at 5, 10, 15 and 20 min in the corner-pocket group. These significantly lower PI values in the ulnar nerve territory signify that PI can be used to detect the delayed onset of ulnar nerve block compared to other fingers. These findings are consistent with the results of Abdelhamid *et al*.[11]

No procedure-related severe adverse events like pneumothorax, vessel puncture, intravascular injection, haematoma formation and any feature of local anaesthetic toxicity were observed in our study. This is consistent with the results of previous studies in which no anaesthetic technique-associated complications were noted.[2,6]

There are some limitations to this study. First, this was a single-centre study with a small sample size. Multi-centred research with a large sample size is required to achieve a statistical difference. Second, the blocks were performed by a single investigator (S. T.) with a minimum experience of 50 brachial plexus blocks under USG guidance. If a more experienced anaesthesiologist had performed all the blocks, the scan and performance time would have decreased. Also, the results cannot be generalised as only one person performed the block.

CONCLUSION

The proportion of patients with a complete ulnar nerve blockade at 15 min was significantly higher with the intertruncal approach of USG-guided SCB compared to the USG-guided corner-pocket approach. The intertruncal approach can be an alternative for a better outcome of SCB regarding the ulnar nerve blockade.

Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding author) and shall be shared after approval as per the authors' institution policy.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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