ORIGINAL ARTICLE

Comparative evaluation of interscalene and interscalene plus infraclavicular brachial plexus block for elbow surgery using nerve stimulator

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ABSTRACT

Objective: This study was conducted to compare interscalene block and interscalene plus infraclavicular brachial plexus block for elbow surgery using nerve stimulator.

Methodology: Sixty male patients, age 20-60 years, ASA physical status I or II, scheduled for above right elbow surgery under brachial plexus block, were included in this prospective, randomized study. Patients were randomly allocated into two groups. Block was performed via the interscalene approach in the Group I and combined approach of interscalene with infraclavicular approach in the Group II, using a peripheral nerve stimulator. Total volume of 0.25% bupivacaine was kept 40 ml in both the groups. Onset and duration of sensory and motor blocks, quality of block and complications were noted. Evaluation of sensory and motor blockade onset were performed every 5 min after needle withdrawal and then up to 30 min. Primary outcome was satisfactory block (in terms of complete block, partial failure of block and complete failure of blocks).

All statistical analyses were performed using INSTAT for windows. Continuous variables were tested for normal distribution by the Kolmogorov-Smirnov test. Data was expressed as either mean and standard deviation or numbers and percentages. Demographic data were compared using student's unpaired t test. The monitored and calculated parameters were analyzed using Student's t-test and χ^2 test. A p value ≤ 0.05 was considered significant.

Results: There was quick onset of sensory (C7-T1 dermatome) and motor block as well as prolonged sensory and motor block was observed in Group II as compared to Group I ($P < 0.05$). Number of rescue analgesic requirement in Group I was significantly higher than Group II. Incidence of hoarseness of voice was more in Group I.

Conclusions: We conclude that combined approach of interscalene and infraclavicular brachial plexus block is clinically and statistically superior as compared to interscalene brachial plexus block alone in elbow surgery.

Keywords: Anesthetics, Local; Anesthetics, Conduction-Blocking; Elbow; Elbow Joint; Brachial plexus; Brachial plexus block; Peripheral Nerves: Nerve stimulator; Anesthesia, Spinal; Anesthesia, Epidural

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INTRODUCTION

A well conducted regional anesthesia technique has much to offer for patients, surgeons and anesthesiologists owing to its obvious advantages over general anesthesia (GA). Successful block not only reduces morbidity and mortality associated with GA but also provides excellent postoperative pain relief and reduction in hospital stay.[1]

Winnie[2] initially popularized the technique of interscalene

brachial plexus block (BPB) in 1970. This block is used for providing anesthesia or analgesia during shoulder and upper arm surgery. Interscalene block frequently leads to incomplete analgesia of the supply area of the nerves arising from the more caudad region of the plexus (medial cord, ulnar nerve, cutaneous nerve of the arm, medial cutaneous nerve of the forearm).[3]

The infraclavicular vertical BPB developed by Kilka and is a simple, easy to perform, safe and carries very low risk to the patient. This technique also does not give complete surgical anesthesia in elbow surgery and is associated with a number of complications which is also related to volume of drug.[4] Anatomically the infraclavicular BPB is favorable, as it carries a lower risk of pneumothorax, and advantages of both supraclavicular as well as axillary approach, allowing single injection of the local anesthetic.[5,6]

To the best of our knowledge there have been no studies comparing interscalene block with interscalene plus infraclavicular BPB in patients undergoing elbow surgery using nerve stimulation. We conducted this study to compare two block techniques using nerve stimulation in a prospective randomized fashion for patients undergoing elbow surgery.

METHODOLOGY

This prospective, randomized study was conducted after approval from the ethical committee and written informed consent from the patients. Patients aged between 20-60 years, ASA physical status I or II of male sex, scheduled for above right elbow surgery under brachial plexus block were included in this study. The exclusion criteria were any patient refusal, any systemic diseases, pregnancy, allergy to local anesthetics, chest deformities and history of previous clavicle fracture etc.

Patients were randomized into two groups. Group I (interscalene BPB, N=30): received total 40ml 0.25% bupivacaine and Group II (interscalene with vertical infraclavicular BPB, N = 30): received total of 40ml (0.25% bupivacaine 20 ml in interscalene and 20 ml in infraclavicular approach). Procedures were performed by the same anesthesiologist. All patients were premedicated with oral alprazolam 0.5 mg on the evening and in the morning 2 hrs before surgery and kept nil per oral as per protocol. Intravenous line was secured in preoperative area in left hand and all standard monitors (non-invasive blood pressure, pulse oximetry and ECG) were attached. A 22 gauge 50 mm insulated stimulation short bevel needle (Stimuplex® A, B/Braun Medical, Germany) was connected to a nerve stimulator (Stimuplex®-DIG, B/Braun, Germany).

In Group I patients, with all aseptic precautions skin was cleaned and draped in supine position with head turned away from the side to be blocked. In interscalene BPB, the posterior border of the sternocleidomastoid muscle was readily palpated by asking the patients to briefly lift the head. The interscalene groove was then palpated by rolling the fingers posterolaterally from this border over the belly of the anterior scalene muscle into the groove. A line was extended laterally from the cricoid cartilage to intersect the interscalene groove indicating the level of the transverse process of C6. After proper sterile precautions and infiltration of 2 ml of 0.5% lignocaine injection; needle was inserted perpendicular to the skin with a 45 degrees caudad and slightly posterior angle. The needle was advanced through the sheath, at which time a facial "pop" was felt. As one of the roots of the plexus neared, a current of 1-1.5 mA was started. Once an appropriate muscle contraction was seen, the current was decreased slowly to determine the threshold (the lowest current at which stimulation still occurred). Once the desired response was found, the needle was stabilized and 40 ml of 0.25% bupivacaine was injected in increments and with frequent aspiration.

In Group II patients, interscalene and infraclavicular BPB was performed in same settings. At first vertical infraclavicular BPB was performed followed by interscalene BPB. Interscalene BPB was performed by same method but dose of 0.25% bupivacaine was reduced to 20 ml. Vertical infraclavicular approach was performed on the supine position with the upper arm along the side, with the elbow flexed and the hand resting on the lower chest or abdomen. The puncture site was marked half way between the jugular notch and the most ventral part of the acromion. After infiltration of 2 ml of 0.5% lignocaine, the needle was introduced absolutely vertical to the horizontal plane. In the presence of finger flexion, current was progressively reduced to 0.5 mA and 20 ml of 0.25% bupivacaine were injected in increments after negative aspiration.

Onset and duration of sensory and motor block, quality of block and complications were observed. Evaluation of sensory and motor blockade onset were performed every 5 min after needle withdrawal and then up to 30 min. Sensory block was initially tested by pinching the skin at different dermatome levels (C5-T1). When a decreased response to pinch was noted, a 22-gauge needle was used to evaluate the sensory block in the tested area. The motor block was evaluated using the forearm flexion, thumb abduction, thumb and second digit pinch and finger abduction (for the musculocutaneous, radial, median, and ulnar nerves, respectively) and scored as follows: 0 = no loss of force; 1 = reduced force compared with the contralateral arm; and 2 = inability to overcome gravity. Onset of block was defined as the time from the last injection to diminished response to pinch at any of these dermatome level and

motor weakness. Anesthesia was considered to be at surgical level when the patient could not feel pain from the needle in tested area of the upper extremity and was unable to move the shoulder, elbow and/or wrist.

Duration of sensory block was the time interval from onset of sensory block till the patient first complained of pain. Duration of motor blockade was duration between the times of loss of finger movements to first regain of finger movements. The quality of the block was evaluated in the intraoperative period:

(a) Satisfactory block- surgery without patient discomfort or the need for supplementation;

(b) Unsatisfactory block - a sensory region involved in the surgery was not completely anesthetized and the block was supplemented by the continuous infusion of propofol @ 50 μg/kg/min and fentanyl 1-2 μg/kg IV; and

(c) Complete failure - if the patient still experienced pain despite supplementation, general anesthesia was induced.

The side effects and complications, such as blood vessel puncture, intravascular injection, overdose, dyspnea, Horner's syndrome, pneumothorax, hoarseness of voice and convulsion were noted. Patients who needed general anesthesia at any time during surgery (because of patchy block or prolongation of surgery) were dropped from the study.

Primary outcome was satisfactory block (in terms of complete block, partial failure of block and complete failure of blocks). Intraoperative analgesic requirement, onset of blockade, duration of blockade, rescue analgesic requirement during first 24hrs postoperative and side effects if any were considered as secondary outcomes.

Statistical analyses: Power analysis (alpha = 0.05 and beta = 0.02) suggest that a sample size of 24 per group was needed to detect 30% increase success in interscalene with vertical infraclavicular BPB as compared to interscalene BPB, by using power (sample size) calculator with superiority trial. We enrolled 30 patients in each group to negate for any drop out at any stage.

All statistical analyses were performed using INSTAT for windows. Continuous variables were tested for normal distribution by the Kolmogorov-Smirnov test. Data was expressed as either mean and standard deviation or numbers and percentages. Demographic data were compared using student's unpaired t test. The monitored and calculated parameters were analyzed using Student's t-test and χ^2 test. A p value ≤ 0.05 was considered significant.

RESULTS

Two patients from each group dropped out from the study so total fifty six patients completed the study. There was no statistically significant difference in the demographical data (Table 1).

Table 1: Demographic characteristics. (Data given as mean ± SD except where specified)

Parameters	Group 1 (n= 30)	Group 2 (n=30)	P value
Age (yr)	49.3 ± 15.01	51.0 ± 13.4	0.6392
Weight (kg)	64.0 ± 4.1	63.0 ± 3.5	0.3153
Height (cm)	158.9 ± 5.6	159.7 ± 5.9	0.5628
ASAI/II (Number)	14/16	17/13	0.6054

P >0.05 = Insignificant. There were no significant differences regarding the demographic characteristics.

Hemodynamic parameters between the two groups were also comparable. The insertion and manipulation of needle were well tolerated by all patients. The difference in time for onset of sensory block to dermatomes C-5 and C-6 was not significant between the groups ($p > 0.05$); whereas time for onset of sensory block in C-7, C-8 and T-1 dermatome was faster in Group II as compared to Group I ($p < 0.05$)(Table 2). The time for onset of motor block, mean duration of sensory block and mean duration of motor block in Group II was significantly faster when compared to Group I ($p < 0.05$) (Table 3).

Table 2: Time for onset of sensory block (min)

Level	Group I (n=28)	Group II (n=28)	P value
C-5	12.1 ± 2.5	11.4 ± 2.3	0.2728
C-6	12.1 ± 2.5	11.9 ± 2.5	0.7906
C-7	13.8 ± 3.2	11.4 ± 2.7	0.0049
C-8	18.2 ± 2.5	13.8 ± 3.8	0.0010
T-1	18.3 ± 2.5	13.7 ± 3.7	0.0010

P > 0.05 =Non significant, P ≤0.05 = Significant, P ≤ 0.01 = Highly significant, P ≤ 0.001 = Very highly significant. Time for onset of sensory block at dermatomes C-5 and C-6 was insignificant between both the groups (p > 0.05) whereas time for onset of sensory block in C-7, C-8 and T-1 dermatome was faster in Group II as compared to Group I (p < 0.05).

Table 3: Parameters of motor block in two groups

Parameters	Group I (n=28)	Group II (n=28)	P value
Time for onset of motor block (min)(mean ± SD)	15.6 ± 2.2	13.7 ± 1.5	< 0.0003
Mean duration of sensory (hrs) (mean ± SD)	5.8 ± 0.6	9.0 ± 0.6	< 0.001
Mean duration of motor block (hrs) (mean ± SD)	5.1 ± 0.5	8.2 ± 0.5	< 0.001

The time for onset of motor block, mean duration of sensory block and mean duration of motor block in

Group II was significantly faster when compared to Group I. ($p < 0.05$)

A satisfactory block was achieved in 36.66% of patients in Group I compared to 93.33% in Group II. Partial block requiring additional sedation/analgesia was 56.66% in Group I and 6.66% in Group II. Total failure of block occurred in 2 (6.66%) patients in both groups and were given general anesthesia (Table 4). The number of doses of rescue analgesic requirement was lower in Group II as compared to Group I (Table 5).

Table 4: Block characteristics

Parameters	Group I (n=30)	Group II (n=30)
Complete block	11 (36.7%)	26 (93.3%)
Partial block	17 (56.7%)	2 (6.7%)
Total failure of block	2 (6.7%)	2 (6.7%)

Higher percentage of complete block in Group II and higher percentage of partial block was in Group I.

Table 5: Number of rescue analgesic requirements (RAR) in first 24 hrs postoperative period

No. of RAR in first 24hrs postoperative period	Group I (n=28)	Group II (n=28)
One dose	0	20 (71.4%)
Two doses	17 (60.7%)	8 (28.6%)
Three doses	11 (39.3%)	0

The number of doses of rescue analgesic requirement was lower in Group II as compared to Group I.

Horner's syndrome was observed in two patients in Group I only. Vascular puncture while performing the blocks occurred in both groups, 20% (n = 6) in Group I and 26% (n = 8) in Group II. Three patients from Group I experienced mild dyspnea that was resolved after applying 6 L of oxygen by a mask. Incidence of hoarseness of voice was 30% (n = 9) in Group I compared to 10% (n = 3) in Group II which was clinically and statistically significant. No systemic reactions to the local anesthetic were reported (Table 6). Overall higher incidence of side effects in Group I.

Table 6: Adverse effects of blocks

Adverse effects	Group I (n= 30)	Group II (n=30)
Horner's Syndrome	2 (6.7%)	0
Mild dyspnea	3 (10%)	0
Vascular puncture	6 (20%)	8 (26.6%)
Hoarseness of voice	9 (30%)	3 (10%)
Systemic reactions to drugs	0	0

DISCUSSION

Combined approach of interscalene and infraclavicular to brachial plexus using neurostimulation improved success rate as compared to interscalene technique only. It might be due to complete blockade of brachial plexus fiber which is spared in interscalene approach. Early onset, intense and prolonged blockade could be due to blocking of spared area of interscalene block (medial cord, ulnar nerve, cutaneous nerve of the arm, medial cutaneous nerve of the forearm)[3] by addition of infraclavicular BPB.

BPB can be performed by various approaches but decision depends on surgical site, complication associated with each approach and also anesthesiologist's preference. Interscalene block is an excellent technique but has some drawbacks like high complication rate and sparing of nerve fiber. Hence, it is not very effective block in elbow surgery.[7,8]

Ultrasound-guided interscalene BPB results in fewer respiratory and other complications with no change in postoperative analgesia as compared with the standard-volume technique.[9] Keeping this in mind, we used 40 ml of 0.25% bupivacaine for interscalene approach in Group I patients and only 20 ml of 0.25% bupivacaine for interscalene approach and 20 ml of 0.25% bupivacaine for infraclavicular approach in Group II patients. This combined approach also reduces the complications of interscalene block because of less volume of drug used in interscalene approach.

Infraclavicular BPB is as safe and effective as any other BPBs, regardless of whether ultrasound or neurostimulation guidance is used. In this approach, blockade occurs at the level of the cords and offers the theoretical advantages of avoiding pneumothorax while affording block of the musculocutaneous and axillary nerves. The advantages of infraclavicular BPB as compared to a single-injection axillary block include lower chances of tourniquet pain during surgery, more reliable blockade of the musculocutaneous nerve and a significantly shorter block performance time compared to multi-injection axillary and mid-humeral blocks.[10,11] Both infraclavicular and supraclavicular brachial plexus block had similar effects. The infraclavicular approach may be preferred due to reduced complications rates.[12-14] The vertical Infraclavicular BPB is simple to perform with just a nerve stimulator and has a high success rate with just one injection. It anesthetizes the upper arm and the forearm, with high levels of tourniquet tolerance (97%), probably because of reliable anesthesia of the axillary (81%) and intercostobrachial (71%) nerves.[15-17]

In this study, C8 - T1 were incompletely blocked in Group I due to incomplete blockade of the inferior trunk in interscalene BPB but in Group II, complete surgical

anesthesia in all dermatomes level because of addition of infraclavicular BPB. Duration of sensory and motor block is longer in Group II compared to Group I. Our results showed that sensory block tended to last longer as compared to motor block which agrees with the observation by de Jong.[18] These authors explained that large fibers require a higher concentration of local anesthetic than small fibers. The minimal effective concentration of local anesthetic for large (motor) fibers is greater than for small (sensory) fibers. Thus, motor function return before pain perception and duration of motor block is shorter than the sensory block.

In our study, the number of patients who required rescue analgesia was also significantly lower in patients in Group II. Prolonged analgesia in Group II could be due to all the nerve blocked. This block was successful in 36.66% of patients in Group I compared to 93.33% in Group II. Surgical anesthesia success was higher in the patients receiving an infraclavicular block as a result of the more complete blockade in the distribution of the ulnar nerve of the remaining patients. Partial block requiring additional sedation/analgesia was 56.66% in Group I and 6.66% in Group II. Total failure of block occurred in 6.66% in Group I compared to 6.66% in Group II. These were comparable both clinically and statistically. Incidence of hoarseness of voice was 30% in Group I compared to 10% in Group II which was clinically and statistically significant. One patient in Group I, pupil asymmetry was noted. None of them resulted in serious complications, such as seizures or hematoma. This might be due to the slow injection technique with repeated aspiration and the use of atraumatic needles.

LIMITATIONS

There are certain drawbacks of this study. Firstly, although performance of all blocks by a single anesthesiologist eliminates the inter-operator variability, it might limit generalizing the results. Second, the block performance time was not assessed in the groups because of two different approaches in Group II patient. Third, we could not analyze diaphragm function due to lack of portable ultrasonography machine. However, we analyzed oxygen saturation and respiratory rate and its pattern.

CONCLUSION

We conclude that combined approach of interscalene and infraclavicular BPB is clinically and statistically superior as compared to interscalene approach of BPB alone in elbow surgery.

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Conflict of interest: None declared

Author contribution: BKG, GY & NK: Study design, statistical analysis and manuscript preparation

All authors took part in the conduct of study.

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