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Effectiveness of USG Guided Axillary Ring Block in Reducing Tourniquet Pain in Patients Undergoing Upper Extremity Surgery With Supraclavicular Brachial Plexus Block

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Abstract

Background: Brachial plexus block has evolved as an important tool in the anaesthesiologists armamentarium as a safe alternative to general anaesthesia for upper limb surgery, providing complete muscle relaxation, stable intraoperative haemodynamic and smooth transition to postoperative pain relief[1] reducing the need for opioid analgesics. But it has been observed that the brachial plexus block alone doesn't prevent the tourniquet pain entirely because of varied mechanisms. The primary aim of this study was to determine whether a subcutaneous ring of local anaesthetic (0.5% ropivacaine) on the inner aspect of the upper arm just distal to axillary crease will significantly decrease tourniquet pain.

Approach of hypothesis: In this study 100 patients with comparable demographics in Group A (ASA I and II) underwent USG guided subcutaneous axillary ring injection with 15 ml of local anaesthetic 0.5% ropivacaine for supraclavicular block and 5 ml of 0.5% ropivacainefor axillary ring block. Group B (ASA I and II) also included 100 patients who received only USG guided supraclavicular block using 15 ml of 0.5% ropivacaine prior to inflation of an upper arm tourniquet.

Result: It was observed that Group A who receivedboth supraclavicular block and axillary ring block tolerated the upper arm tourniquet for a longer period than those who received only supraclavicular block (mean of 36.9 min vs. 6.9 min) ($p = 0.014$) respectively.

Conclusion: We demonstrated that axillary ring block will decrease tourniquet pain which leads to discomfort is a common obstacle in anaesthetic managementand increase tourniquet tolerance period even with excellent regional anaesthesia of the upper extremity.

Keywords: Axillary ring block; Brachial plexus block; Tourniquet pain; Visual analogue scale.

Introduction

Supraclavicular brachial plexus block is a common regional anaesthesia technique and is used to provide anaesthesia to the hand, forearm and arm sparing the shoulder[6] for a wide range of orthopaedic and reconstructive surgeries. Besides anaesthesia SBPB provides postoperative analgesia and improves regional blood flow owing to sympathetic blockade without producing systemic side effects.[7] SBPB carries the risk of pneumothorax and also the development of transient horner's syndrome, however the ultrasound guidance has facilitated its performance with minimal adverse effects.

Axillary Ring Block: Tourniquet used for limb surgery leads to discomfort is a common obstacle in anaesthetic management. Prior studies have shown

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that awake volunteers experience a vague, dull pain after tourniquet inflation that is tolerated for an average of 30 minutes extended to 45 minutes with sedation.[8,9] Prolonged tourniquet inflation (>30–60 min) leads to gradual increase in heart rate and blood pressure, the incidence of which is related to the type of anaesthesia.[8] The leading hypothesis for the mechanism of tourniquet pain is the loss of inhibition of unmyelinated, slow conducting C fibers. These fibers are usually inhibited by fast, myelinated A-delta fibers which are blocked after approximately 30 minutes of tourniquet inflation and mechanical compression.[8]

After brachial plexus anaesthesia the anatomy and innervation of the upper arm has led to an additional subcutaneous infiltration of local anaesthetic on the medial aspect of the upper arm.[10] This is called the "Axillary Ring Block" and it targets the intercostal brachial nerve and the medial cutaneous nerve of the arm. The intercostal brachial nerve is the lateral cutaneous branch of the ventral primary ramus of T2. It provides innervation to the skin of axilla and the medial aspect of the proximal arm. The intercostal brachial nerve communicates with the medial cutaneous nerve of the arm, which is a branch of the medial cord of the brachial plexus. Both of these nerves are routinely missed with supraclavicular and infra-clavicular brachial plexus anaesthesia. It is hypothesized that the axillary ring block will decrease tourniquet pain and increase tourniquet tolerance period even with excellent regional anaesthesia of the upper extremity.

Tourniquet pain from an upper arm tourniquet can limit the ability to use regional anaesthesia as the primary anaesthetic for surgical procedures on the upper extremity. The aim of this study is to determine whether a subcutaneous ring of local anaesthetic on the inner aspect of the upper arm just distal to axillary crease will significantly decrease tourniquet pain. If it does, peripheral nerve blocks distal to the tourniquet (i.e., nerve blocks at the elbow) could be used as the primary anaesthetic for the surgery of the hand and forearm. These distal peripheral nerve blocks have fewer complications than brachial plexus blocks performed at higher levels and postoperatively patient has better control of his or her arm when distal nerve blocks are used.

Materials and Methods

The main aim of this study was to determine the effectiveness of axillary ring block in decreasing tourniquet pain in patients undergoing upper extremity surgeries.

This study was conducted at Bone and Joint Hospital, which is one of the associated hospitals of Government Medical Collage, Srinagar. After obtaining approval from Institutional Ethical Committee and informed consent of the patients for participation in the study, sixty (60) patients scheduled to undergo upper extremity surgeries of elbow and forearm were enrolled in this study.

Inclusion Criteria:

1. Age from 18 to 60 years

2. American Society of Anaesthesiologists (ASA) grade I – II undergoing elective surgeries of elbow and forearm.

Exclusion Criteria:

1. Age less than 18 years and more than 60 years.
2. Patient refusal.
3. Morbid obesity (Body Mass Index > 35kg/ m2).
4. Local infection at the site of block.
5. Coagulopathy.
6. Local anaesthetic allergy and significant neurological, cardiac, renal, hepatic and respiratory disease.
7. Local site anatomical abnormality
8. Inability to understand the information provided.
9. American society of Anaesthesiologists (ASA) grade III & IV.

Patients scheduled for the study were kept fasting for 6 hours. On arrival to the operation theatre, all patients were kept in supine position. 18–20 G intravenous cannula was placed in the contralateral arm to be operated in all patients. Supplemental oxygen at 4L/min was given to all the patients during surgery. Standard ASA monitoring was done throughout the procedure. Both supraclavicular and axillary ring blocks were performed under USG guidance by an experienced anaesthesiologist. Patientswere randomly divided into two groups (A and B) using a computer generated double blinded coupon system. Group A received 15 ml of local anaesthetic 0.5% ropivacaine for supraclavicular block (using a 1.5 inch, 25 gauge needle to inject the drug) and 5 ml of 0.5% ropivacaine for the axillary ring blockto raise a subcutaneous wheal. Group B received only supraclavicular block using 15 ml of 0.5% ropivacaine prior to inflation of an upper arm tourniquet. The extremity prior to the application of tourniquet was wrapped with soft gauze to prevent

discomfort and skin bruising and was elevated to allow passive exsanguination and a 5 inch (12.7 cm). Esmarchbandage was applied from the distal part of the extremity to the tourniquet. The exsanguination of the extremity is combined with a tourniquet to create almost a bloodless surgical field. Tourniquet pressure was kept around 100 mm Hg more than the systolic blood pressure in both the groups. Sensory and motor block assessment was done at 5 minutes intervals up to 30 minutes after injection. First assessment was performed after 5 minutes of completion of injection. The sensory score was assessed using alcohol soaked gauze by testing the individual nerves: Radial nerve (posterior part of wrist and of the three first fingers), Median nerve (anterior part of wrist and of the first three fingers), ulnar nerve (medial part of wrist and of the hand), musculocutaneous nerve (lateral part of forearm), axillary nerve (shoulder), medial brachial nerve (medial part of arm) and medial antebrachial nerve (medial part of forearm): responses were compared with the opposite corresponding areas and graded as follows:

0 – no difference from an unblocked extremity

1 – Less cold than unblocked Extremity

2 – No sensation of cold.

Regarding motor nerves, the radial (elbow extension), median (third finger flexion), ulnar (fifth finger flexion), musculocutaneous (elbow flexion) and axillary nerves (arm abduction), the quality of motor block was observed on a four point scale:

0– Flexion and extension in both the hand and arm against resistance 1– Flexion and extension in both the hand and arm against gravity but not against resistance 2– Flexion and extension movements in the hand but not in the arm 3 – No movement in the entire upper limb.

The onset of sensory block was defined as the time elapsed between injection of drug and complete loss of sensation (score 2), whereas onset of motor blockade was outlined as the time elapsed from injection of drug to complete motor block (score 3). The quality of the block was evaluated in the intraoperative time as:

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

(b) Unsatisfactory block: a sensory region involved in the surgery is not completely anesthetized and the block is supplemented by strong Opioid analgesic.

(c) Complete failure: if the patient still experiences pain despite supplementation, needs general anaesthesia.

The duration of sensory and motor block was assessed. The duration of sensory block was defined as the time interval between the onset of sensory block to first requirement of postoperative analgesia. The duration of motor block was defined as the time between the end of the local anaesthetic injection and the total recovery of motor functions. Patients who did not tolerate the tourniquet pain despite giving adequate sedation and rescue analgesics were given general anaesthesia and excluded from the study. Patients werealso observed postoperatively for 24 hrs. Post-operative pain at the incision site was assessed by visual analogue scale (VAS) and a score of more than 3 when recorded was taken as end point for duration of block and the patientswere given supplementary rescue analgesics accordingly. Patient's satisfaction with the anaesthetic technique was assessed postoperatively using a 2-point scale (0 = unsatisfied; 1 = satisfied). The patients were asked to mark it as satisfied only if they will be happy to accept the same block in future.

Results

In this study 100 patients with comparable demographics (Table 1 and 2) in Group A (ASA I and II) underwent USG guided subcutaneous axillary ring injection with 15ml of local anaesthetic 0.5% ropivacaine for supraclavicular block and 5 ml of 0.5% ropivacaine for axillary ring block. Group B (ASA I and II) also included 100 patients who received only USG guided supraclavicular block using 15 ml of 0.5% ropivacaine prior to inflation of an upper arm tourniquet. It was observed that Group A who receivedboth supraclavicular block and axillary ring block tolerated the upper arm tourniquet for a longer period than those who received only supraclavicular block (mean of 36.9 min vs. 6.9 min) ($p = 0.014$) respectively (Table 3).

The axillary ring injection also decreased pain at the tourniquet site by 1.0 pain scale unit ($p = 0.025$) and pain below tourniquet by 1.1 units ($p = 0.001$). So, Group A could tolerate tourniquet inflation for a longer duration (mean of 76.5 vs 62.9 mins) respectively (Table 4). Pain score at the end of tourniquet deflation in two groups was also lower in Group A as compared to its counterpart (mean of 2.7 vs 7.4 mins) respectively (Table 5). Post-operative pain at the incision site was assessed by visual analogue scale (VAS) and a score of more than 3 when recorded was taken as end point for duration of block although clinically not significant but lower in Group A (mean of 8.7 vs 7.5 hrs) respectively (Table 6).

Haemodynamic variables measured in terms of both HR and Systolic Blood pressure in both the groups remained clinically insignificant (Table 7 and 8).

Demographics

Table 1: Age distribution of study patients.

Age (Years)	Group A	Group B
< 30	30.0	33.3
30–44	46.7	43.3
45–59	13.3	20.0
≥ 60	10.0	3.3
Total	100	100

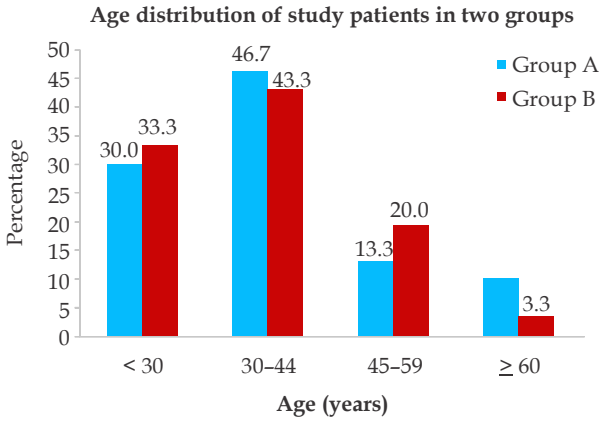


Table 2: Gender distribution of study patients.

	Male	Female
Group A	47	53
Group B	57	43

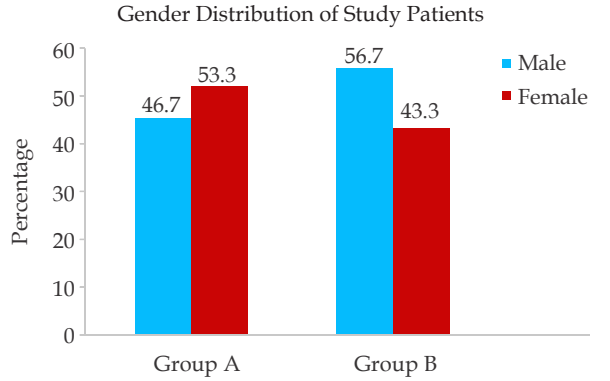


Table 3: Time of onset of pain after tourniquet inflation (Minutes) in two groups.

Group	Mean
Group A	36.9
Group B	6.1

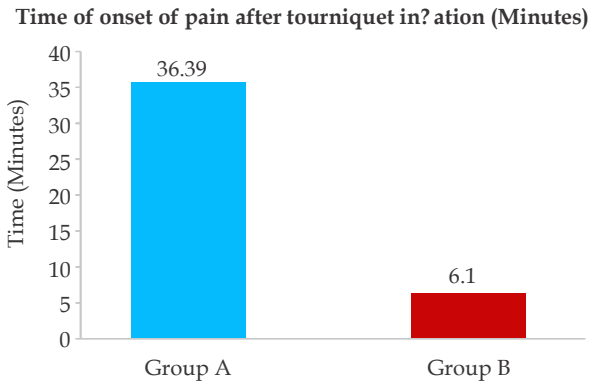


Table 4: Time in minutes that tourniquet remained inflated in two groups.

Group	Mean
Group A	76.5
Group B	62.9

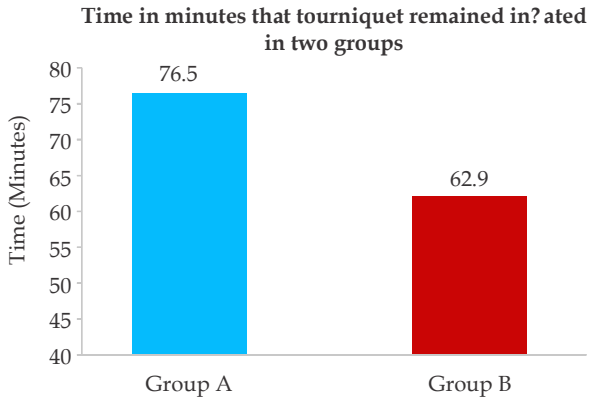


Table 5: Pain score at the end of tourniquet deflation in two groups.

Group	Mean
Group A	2.7
Group B	7.4

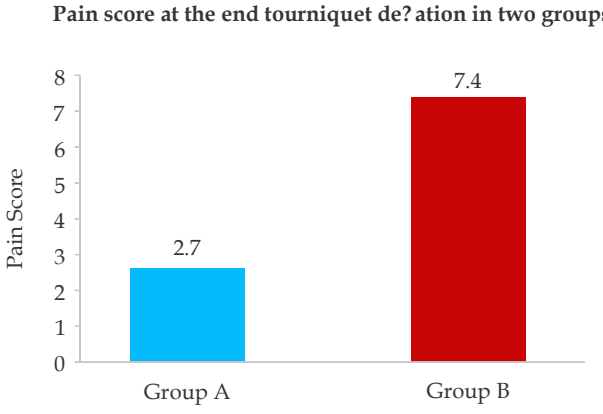


Table 6: Onset of pain after surgery was completed (Hours) in two groups.

Duration of surgery (Minutes)	Mean
Group A	8.7
Group B	7.5

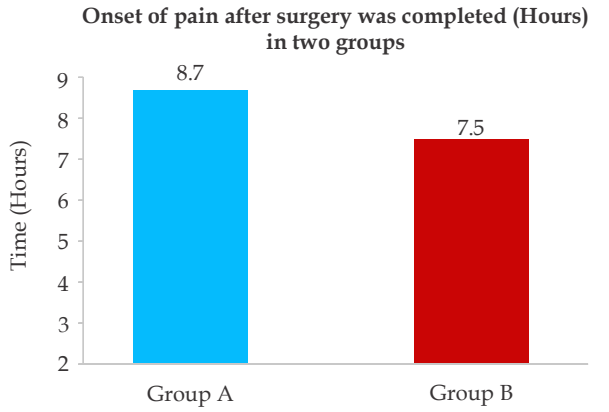


Table 7: Comparison based on interoperative HR (beats/min) in two groups.

Time (Minutes)	Group A	Group B
0 Min	75.90	75.97
5 Min	78.23	77.30
15 Min	80.00	78.67
20 Min	81.23	80.57
25 Min	80.90	79.77
30 Min	81.70	79.87
40 Min	82.83	81.30
50 Min	81.63	80.27
60 Min	79.60	78.67

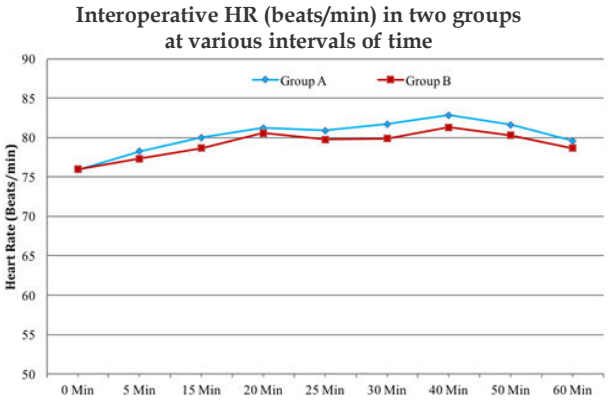
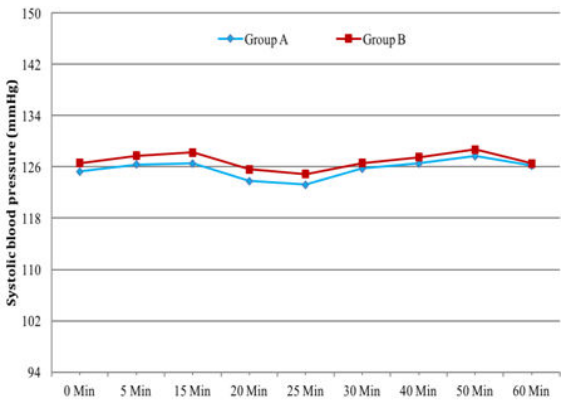


Table 8: Comparison based on interoperative SBP (mmHg) in two groups.

Time (Minutes)	Group A	Group B
0 Min	125.27	126.60
5 Min	126.37	127.73
15 Min	126.53	128.23
20 Min	123.80	125.60
25 Min	123.20	124.90
30 Min	125.73	126.60
40 Min	126.50	127.50
50 Min	127.67	128.70
60 Min	126.17	126.53



Statistical Methods: The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean ± SD and categorical variableswere summarized as frequencies and percentages. Graphically the data was presented by barand line diagrams. Student's independent t-test was employed for comparing continuousvariables. Chi-square test or Fisher's exact test, whichever appropriate, was applied forcomparing categorical variables. A P-value of less than 0.05 was considered statistically significant. All P-values were two tailed. Sample size for this study was determined using the PROC POWER procedure for paired means as implemented in SAS 9.3.

Discussion/Conclusion

Brachial plexus blocks popularity is increasing day by day because of advancements in regional anaesthesia techniques in terms of local anaesthesia drugs, newer adjuvant drugs and use of ultrasound guidance for safe and successful conduct of block, it helps in reduced hospital stay, less financial burden and also leads to avoidance of undesirable side effects of general anaesthesia.

Since the introduction of first Brachial plexus block using Cocaine by Halstead (1884), the technique of brachial plexus block has evolved from classical blind technique to use of nerve stimulators and USG for supraclavicular brachial plexus block.[2] There is without doubt a renewed interest among anaesthesiologists in the inter-scalene/supraclavicular/infra-clavicular/axillary brachial plexus block with increasing use of ultrasound. The brachial plexus block was initially done by identifying anatomical landmarks and

eliciting paresthesias. The introduction of USG technique during the last decade improved the success rate, enhances the ease of performance[3] and when used in combination with a nerve stimulator it provides as of today the highest degree of safety and success.[4,5]

The Ultrasound guided technique helps in visualizing the needle tip and solution injected reduces the risk of side effects, accidental intravenous injections and possibly also trauma to the tissues around. The USG technique has also reduced the volume of drug to be given in order to gain an effective block.

This was a prospective randomized, blinded, controlled clinical trial to study the Effectiveness of an "axillary ring block" in reducing tourniquet pain in patients undergoing upper limb surgery.

Axillary ring block targets the intercostal brachial nerve and the medial cutaneous nerve of the arm. The intercostal brachial nerve is the lateral cutaneous branch of the ventral primary ramus of T2. It is therefore concluded that the axillary ring block will decrease tourniquet pain and increase tourniquet toleranceperiod as compared to supraclavicular block alone even with excellent regional anaesthesia of the upper extremity.

In this study, Group A received both Supraclavicular block and axillary ring block, with loss of sensation to the entire arm. But since Group B received only the supraclavicular block leaving the medial side of arm with intact sensory sensations so it was difficult to determine the exact contribution of the medial upper arm to the overall pain scores from the tourniquet site. The decreased pain score at one point on a 10- point scale may or may not be clinically significant.

Sensory and motor changes of the hand were found to be quite consistent between study participants. The various times required for the tourniquet to produce decreased sensation and grip strength were similar despite axillary ring block in Group A. All the patients in both the groups demonstrated complete resolution of tourniquet related sensory and motor changes within 15 minutes of tourniquet deflation. Patients who received axillary ring block were more likely to have sensory changes (touch and prick) immediately before the tourniquet deflation (Fisher exact test, p=0.042 and 0.041 respectively) but not changes in muscle strength. There were no cases of prolonged sensory changes over the medial upper arm after the axillary ring injection in Group A.

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