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USE OF ULTRASOUND IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK COMPARED TO CONVENTIONAL TECHNIQUE USING ANATOMICAL LANDMARKS

Anaesthesiology

KEYWORDS: Supraclavicular brachial plexus block; ultrasound; Bupivacaine

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ABSTRACT

Introduction: Supraclavicular brachial plexus block is an effective nerve block for upper limb surgery. This block has been classically performed using the anatomical landmark technique. This study was designed to evaluate the effectiveness of Ultrasound guidance in performing the block and comparing the results with anatomical landmark technique.
Methods: Sixty patients ASA grade I/II in the age group 16-60 scheduled for upper limb surgery were evaluated. Thirty were administered 0.25% Bupivacaine solution under ultrasound guidance (group A) while a similar number were performed under anatomical landmark technique(Group B). Sensory block onset time, duration and any side effects/complications were noted.
Results: Shortened sensory block onset times (17.83 ± 5.2 min 20.67±4.69 min sec in Group A and Group B respectively, P < 0.05) and duration (291.0±79.62 min and 190.02±57.53 min in Group A and Group B respectively, P < 0.05) was significantly longer in Ultrasound guided group.
Conclusions: We conclude that ultrasound guidance not only increases duration of analgesia but also decreases onset time of Supraclavicular brachial plexus block.

Introduction

The concept of regional nerve blocks is based on the fact that pain is conducted by nerve fibers which are amenable to interruption in their pathway. Regional anaesthesia as a modality of providing adequate analgesic conditions for surgical procedures has been in clinical practice ever since the later half of nineteenth century. Brachial plexus block as a modality of anaesthesia for upper limb surgery was first described in the year 1888 when **Halstead** [1] used cocaine to anaesthetize the brachial plexus under direct vision after performing a surgical exposure. The growing concern for patient safety and reduction in failures of block prompted the development of gadgets for performance of regional blocks.

The invention of nerve stimulator provided the advantage of localizing nerves yet the regional anaesthesia still remained 'blind' with added complications of nerve stimulator. The use of ultrasound had so far been described in diagnostic and therapeutic applications. Use of ultrasound equipment for performance of Supraclavicular Brachial plexus block was described for the first time in 1978 [2]. This heralded a new era in regional anaesthesia wherein successive anaesthesiologists established its advantages in their clinical practice [3].

The easy availability of ultrasound equipment and lesser time required to have a working knowledge of the equipment has established the role of ultrasound in regional anaesthesia practice. The aim of the study is to evaluate and compare the relative efficacy of Supraclavicular Brachial plexus nerve block done under ultrasound guidance to that done using anatomical landmarks. It would also establish operative advantages of performing Supraclavicular Brachial plexus block under ultrasound guidance vis a vis landmark technique. The incidence of side effects with ultrasound guided nerve block versus landmark technique have also been studied.

Material and Methods

After the Institutional Ethics Committee approval and written informed consent, this prospective, randomized study was conducted on 60 ASA Grade I/II patients of either sex in the age group of 16-60 years admitted for elective surgery on upper limb. Exclusion criteria were age less than 16 yrs, presence of coagulopathy, local infection and history suggestive of neuropathy. Patients were randomly allocated into two groups of thirty each. All the blocks were performed with standard monitoring in place (pulse oximetry, non invasive blood pressure and electrocardiogram.

In group A supraclavicular brachial plexus block was given under ultrasound guidance. In group B block was given using conventional landmark technique. In both groups block was performed by the same operator. The ease of performing block, incidence of vascular punctures, quality of block, and requirement of any supplemental anaesthesia were studied in both the groups. Patient were placed supine with the head end slightly elevated and turned away from the side of block.

The area was prepared with lotions savlon, betadine and methylated spirit. The patient was then draped with a sterile towel (Fig. 1) Supraclavicular region 1-1.5 cm above the mid point of clavicle was infiltrated with Inj Lignocaine 2%. The Site-Rite IV probe (9.0 MHZ) head was layered with ultrasound gel and then covered with a ultrasound compatible sterile sheath. Ultrasound gel was liberally applied to the supraclavicular region. Image of Subclavian artery in short axis (cross-sectional view) were obtained, subclavian vein is usually not visible as it is hidden behind the clavicle.

The nerve bundles of brachial plexus appear as 3-4 hypoechoic (dark) circles in groups above and behind the subclavian artery. A scout scan prior to needle insertion (Fig. 2) shows the exact nerve location, its size and depth from the skin, and is thus helpful in defining the desired site, angle and path of needle penetration.Teflon coated five cm long needle 21 Gauge in size was then taken to which a ten ml syringe filled with 0.25% bupivacaine solution was attached.

The in plane needle was advanced under ultrasound guidance to the brachial plexus. The needle shows up as a hyperechoic (bright) line on the screen. The real-time visual navigation of the needle advancement can be seen as the needle approaches brachial plexus. 10 ml of the 0.25% bupivacaine solution was injected in a graded manner.

After confirming the spread of drug under ultrasound further 20-30 ml of the drug was injected (Fig. 3). Onset of sensory and motor block of radial, ulnar and median nerves was recorded at five minutes intervals for thirty minutes.

In group B, cleaning, draping and local infiltration was done similarly, needle was inserted at 1-1.5 cm above mid-point of clavicle. Additional checks were done by feeling for subclavian artery pulsation and interscalene groove. The needle was placed lateral to subclavian artery pulsation in interscalene groove. The needle was directed backward, inward and downward. 30-40 ml of 0.25% bupivacaine solution was injected after eliciting parasthesia or on hitting the first rib, which ever happened earlier. Onset of the brachial plexus block was recorded in a similar fashion as for group A.For assessment both the sensory and the motor

components were tested. Subjective assessment was done by eliciting anaesthesia of the whole arm upto the shoulder except the inside upper one third of the upper arm, and sympathetic block in the same regions, along with loss of sweating and increased temperature were noted. Motor block was evaluated using forearm flexion-extension, thumb and second digit pinch, and thumb and fifth digit pinch and scored as follows [4]: no loss of force - no block, reduced force compared with contralateral arm - partial block, incapacity to overcome gravity -complete block.

Sensory block was evaluated by comparing the cold sensation elicited by ice in the central sensory region of each nerve with the same stimulus delivered to the contralateral side [5]. Rating was quantified as normal sensation-no block, reduced sensation -partial block and total loss of cold sensation-complete block.However for statistical analysis partial block was recorded as failed block.

A useful test is described by **Piyush Gupta et al** [5]. The author recommends four P's, pull, push, pinch, pinch technique to check for the various components of the block.

These patients were monitored for onset of block and time to achieve analgesia was recorded. These patients were also monitored for any adverse reactions and discomfort after administration of the block. Vascular puncture if any was also recorded. The patients were followed up in the ward for 24 hours to look for residual analgesia and complication of pneumothorax. No postoperative chest radiograph was however taken as routine.

For statistical analysis a software NCSS/PASS 2004 was used.

Efficacy of the Brachial plexus block was taken as the primary outcome variable. Onset of block, duration of block, inadvertent vascular puncture and neurological complications were taken as the secondary outcome variable. Results were expressed as mean ± standard deviation (mean ±SD). Results were evaluated by paired 't' test and Chi square test. A value of $p<0.05$ was considered significant.

Results

In the present study a total of sixty patients were administered supraclavicular brachial plexus block as shown in Table 1.

Of these thirty underwent block using anatomical landmarks and the remaining thirty were administered block using ultrasound guidance. Most patients were in the age group of 16 years to 60 years. The age distribution is shown in table 2. This patient population was predominantly male due to the fact that the hospital being a service hospital and most of the patients are serving personnel of the Armed Forces. The two groups were comparable in age and weight ($p> 0.05$). All patients were scheduled for upper limb surgeries. The details of surgical procedures for which brachial plexus block was administered has been shown in Table 3. In Group A 90 % of patients had developed successful block, compared with 63.33% in Group B as shown in Table 4. Supplementation in the form of fentanyl / ketamine / general anaesthesia was required in 10% and 36.67% of group A and group B respectively. The difference was highly statistically significant ($p <0.05$). The onset of block was faster in the Group A compared to Group B (Table 5). Mean onset time being 17.83±5.2 and 20.67± 4.69 min respectively. This difference was statistically significant ($p<0.05$). However this difference is not clinically significant. The mean duration of the block was generally longer in Group A, 291.0±79.62 min compared to 190.02±57.53 min in Group B (Table 6). This was both clinically and statistically significant ($P < 0.05$). Duration of block in study groups is shown in Table 6. Four patients (13.33%) had vascular puncture in group B which was confirmed by flash of blood in the syringe when aspiration was done. No patient in Group A had any vascular puncture. This difference was clinically significant but was not statistically significant ($p>0.05$).

One patient in group A after administration of a successful block complained of mild difficulty in breathing (probably due to phrenic nerve block) for which injection midazolam 2.0 mg was administered. This was considered as a neurological complication but was not statistically significant ($p>0.05$) The time taken to perform block was not taken into consideration. However time taken was more in ultrasound group than in anatomical group. The time taken to perform ultrasound guided block was decreased gradually with increasing experience.

Discussion

This prospective randomized study demonstrates the usefulness of ultrasound in improving the efficacy of supraclavicular brachial plexus block in comparison to the use of classical anatomical landmark technique. Ultrasound guidance enabled clinical improvement in the block procedure which has also been proven statistically. The quality of anaesthesia achieved with the use of ultrasound guidance improved the quality of the block resulting in significantly lesser intraoperative supplementation with other analgesic and anaesthetic techniques.

There are multiple factors which affect the outcome of a block procedure. To name a few would include the motivation of the patient, the experience of the anaesthesiologist, the drug and its concentration used. The definition of success in the particular block procedure also has to be ascertained. In this particular study the success of the supraclavicular block was decided by the anaesthesiologist who performed the procedure and the criteria was a pain free surgery without the need of supplementation for a successful block. The subjects in the study group who required supplementation in the form of systemic analgesia in any form including general anaesthesia were documented as failed blocks.

The success of block with ultrasound in the present study group was 90%. This compared favorably with the studies published in the past. **Stephan R. Williams** et al [4] achieved 85% success while performing the supraclavicular block under ultrasound guidance.

The drug used in the study was bupivacaine which is a long acting local anaesthetic agent. Using the same concentration and volume of drug solution it was found that the onset and duration of anaesthesia were both better in the ultrasound group. This supports the fact that delivery of a drug at a specific site under real-time visualization resulted in a faster and longer anaesthetic action. This was also concluded from the study by **Stephan R. Williams** et al [4]. The authors in their study have taken time to perform block as important variable, that was not considered in our study. The onset of supraclavicular block in our study group was generally 15-20 minutes. This compared favorably with the results of **Stephan Kapral** et al [6] who used two different approaches to brachial plexus block, supraclavicular and axillary approach. They achieved the anaesthetic conditions in 10 – 20 min. In the present study there was a statistical but not a clinical difference between the onset of supraclavicular block using ultrasound guidance.

The duration of anaesthesia was significantly longer in the group A in comparison to the brachial plexus block achieved in group B. This could be ascribed to the more precise delivery of drug to the brachial plexus. The spread of the drug was seen under direct vision.

Ultrasound guidance permits injection of the local anaesthetic solution under direct vision. This may enable the use of lesser volume of the local anaesthetic solution. In the present study group however equal volumes of local anaesthetic were used. Elsewhere in a study **Sáinz López J** et al [7] have assessed the use of ultrasound guidance in reducing the volume of local anaesthetic used. The surgical conditions possible are comparable in quality to those achieved at higher volumes and doses.

Our experience in performance of brachial plexus block was limited. This however did not pose a problem in the identification of the brachial plexus under ultrasound. This correlates with the views

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expressed by **Stephan R. Williams et al** [4] and **Peter Marhofer et** al [8]. **Vincent W. S. Chan** et al [9] in another study evaluated ultrasound technology for supraclavicular brachial plexus blocks. The block was successful after one attempt in 95% of the cases.

Pneumothorax is a well known and dreaded complication of supraclavicular block. Incidence varies 0.6% -5% [6]. There was however no clinical evidence of pneumothorax in our study groups. Chest radiographs were not obtained but all the patients were followed up in the ward. Ultrasound guidance in performance of brachial plexus block has been described to be effective in lowering the incidence of pneumothorax[10] [6].

Vascular puncture is another complication of brachial plexus block. The check aspiration through the needle was performed. The occurrence of vascular punctures in Group B while none in group A suggests that the ultrasound guidance prevents vascular puncture. This is important for the anaesthesiologist as the local anaesthetic solution used can cause toxicity if injected in the vascular channel [11]. Intravascular puncture has been reported yet minimized when using ultrasound for administration of this block [12].

Phrenic nerve block takes place in some patients when supraclavicular block is performed [13]. One patient in ultrasound group in the present study had respiratory difficulty after the procedure was performed This patient could have had phrenic nerve block.

There have been reports of using more advanced modalities like CT scan [14] and MRI . However accurate and precise these modalities may be, these modalities have their limitations. CT scan carries the risk of radiation and limited availability. One also should keep into consideration of the cost incurred. Performing this procedure in a radiology suit takes away the element of safety and confidence which an anaesthesiologist perceives in the operating room. With MRI the obvious requirement is of MRI compatible equipment. Establishment of a MRI compatible suit is generally expensive and not feasible in every setting. Limited field of work and access to patient becomes a limiting factor. Ultrasound on the other hand is compact, affordable and does not require any specialized monitoring. Learning the operation of ultrasound machine is comparatively simpler and the operator achieves a decent working knowledge in a short span of time [15]. The ultrasound equipment is generally not subjected to wear and tear and gives a fairly long life. Also to add is that the use of ultrasound is not associated with recurring expenses which one has to when using modalities like CT or MRI.

This study has a number of limitations.

a) The study was not blinded. There is a possibility of operator bias.
b) Site Rite being an older generation equipment did not produce very clear images. Newer generation machines produce very clear imagery.
c) Most patients were young male patients. The results cannot be generalized to the population at large. Females were very much under-represented.
d) The efficacy of the block was assessed by the anaesthesiologist who performed the block. There is a possibility of bias in assessment of the efficacy of the block.

Despite these limitations the present study demonstrates the usefulness of ultrasound guidance for the learning and execution of supraclavicular block. The future of regional anaesthesia can be associated with greater use of ultrasound [14]. Ultrasound should become an integral part of residency training in anaesthesia. The advancement in regional anaesthesia has been linked with the obvious endpoints, adequate block with minimal patient discomfort and complications. Ultrasound definitely achieves these endpoints. With aging population having multiple coexisting systemic disease manifestation this seems to be a procedure of choice.

Figures and tables

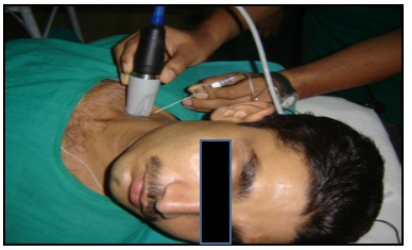

Fig. 1: Position of patient, probe to obtain transverse view and needle in plane

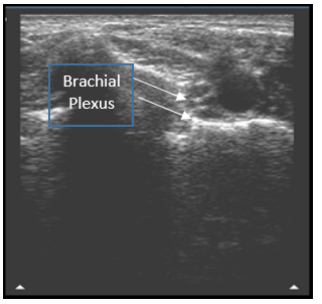

Fig. 2: Scout scan of supraclavicular brachial plexus

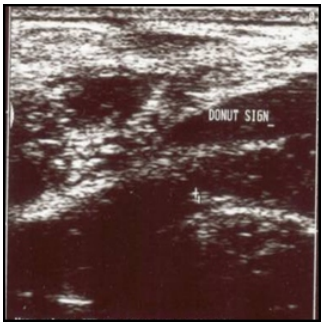

Fig. 3: Needle insertion and formation of 'Doughnut' sign

Table 1 Distribution of cases in study groups

Group	No of cases	Percentage
A	30	50
B	30	50
Total	60	100

Table 2: Age wise distribution of cases in study groups

Age (yrs)	Group A	GroupB	Total
16 – 30	15(50%)	17(56.7%)	32(53.3%)
31 – 45	9(30%)	5(16.7%)	14(23.3%)
46 – 60	6(20%)	8(26.7%)	14(23.3%)
Total	30	30	60

Table 3: Details of surgeries performed in study group

Diagnosis	Group A	Group B
Open reduction and internal fixation for fracture forearm bones	07 (23.3%)	10 (33.3%)
Amputation of digit	08 (26.7%)	05 (16.7%)
Creation of arterio-venous fistula	06 (20%)	07 (23.3%)
Split skin graft	04 (13.3%)	06 (20%)
Crush injury for debridement	03 (10%)	01 (3.3%)
Miscellaneous	02 (6.7%)	01 (3.3%)
Total	**30**	**30**

Table 4: Success of supraclavicular block in study groups

Groups	Supraclavicular block in study groups		Total
	Group A	Group B	
Succeed	27	19	46
Failed	3	11	14
Total	30	30	60

Chi square = 4.56, p < 0.05

Table 5: Onset of block in study groups

Particular	Group A	Group B	t Test	p Value
	Mean±SD(n=30)	Mean±SD(n=30)		
Onset (min)	17.83±5.20	20.67±4.69	2.22	< 0.05
Confidence interval	15.89~19.78	18.91~22.42		

Table 6: Duration of block in study groups

Particular	Group A	Group B	t Test	p Value
	Mean±SD(n=30)	Mean±SD(n=30)		
Duration (min)	291.0±79.62	190.02±57.53	5.63	< 0.05
Confidence interval	261.24~320.70	168.48~211.50		

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