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A Comparison of Infraclavicular and Supraclavicular Approaches to the Brachial Plexus

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ABSTRACT

Objective

Infraclavicular and supraclavicular brachial plexus blocks are widely used in upper limb surgery. This study was performed to compare clinical effect of both the blocks using nerve stimulation technique in upper limb surgery.

Methods

Fifty patients receiving upper limb surgery under infraclavicular or supraclavicular brachial plexus block were enrolled in this study. The infraclavicular brachial plexus block was performed using the vertical technique with 30 ml of 0.5% ropivacaine . The supraclavicular brachial plexus block was performed using the plumb bob technique with 30 ml of 0.5% ropivacaine. The block performance-related pain was evaluated. This study observed onset of sensory and motor block, the duration of the sensory and motor block as well as the complications.

Results

There were no significant differences in the block performance-related pain, evolution of sensory and motor block quality, or the success of the block. There were no significant differences in the duration of the sensory and motor block. There was a significant difference in the incidence of Horner's syndrome. One patient had pneumothorax in the supraclavicular approach.

Conclusion

Both infraclavicular and supraclavicular brachial plexus block had similar effects. The infraclavicular approach may be preferred to the supraclavicular approach when considering the complication,ease of technique and patient satisfaction.

Introduction

There are essentially four approaches to a brachial plexus block:

- interscalene,
- supraclavicular,
- infraclavicular
- axillary.

Compared to the axillary approach, a brachial plexus block at the level of the clavicle can anesthetize all four distal upper extremity nerve territories without a requirement for a separate block of the musculocutaneous nerve.

The supraclavicular approach has an additional anatomical advantage of a blockade at a level where the brachial plexus elements are tightly grouped, which facilitates a single point injection and is believed to result in very rapid onset.

Anatomically, the infraclavicular approach should be feasible in almost all patients. It also has the theoretical advantages of both the supraclavicular and axillary approaches: a compact anatomical distribution of plexus structures allowing single injection of local anaesthetics and a reduced risk of pneumothorax.

Both supraclavicular and infraclavicular approaches have similar distributions of anaesthesia.

This study compared the supraclavicular and infraclavicular approaches using neurostimulation in a prospective randomized manner for a brachial plexus block in patients undergoing upper limb surgery.

Materials and Methods

After gaining written informed consent from the subjects, 100 patients who were ASA grade 1,2,. , Aged between 18 to 60 yrs, and scheduled to undergo surgery of the elbow, forearm, or hand under brachial plexus anaesthesia were prospectively included.

The exclusion criteria included the following: coexisting lung, heart, liver, or kidney disease; pregnancy; inability to understand the information provided; allergy to local anaesthetics; chest deformities; previous clavicle fractures; and neurological disorders.

The patients were randomized to receive either a vertical infraclavicular plexus block (group I, n = 50) or supraclavicular plexus block (group S, n = 50).

All blocks were performed by the same anaesthesiologist. Standard monitoring (non-invasive blood pressure, pulse oximetry and ECG) was commenced upon arrival to the preoperative holding area. A 22-gauge 50-mm insulated short bevel needle connected to a nerve locator was used for all blocks. The initial nerve stimulator settings were 2.5 mA with an impulse duration of 0.1 ms. The needle position was considered to be adequate when the motor response in the hand or wrist was obtained and remained visible with a current of 0.5 mA. The local anesthetic, 30 ml 0.5% ropivacaine was injected slowly (60 s) with intermittent aspiration.

The vertical infraclavicular approach was performed on the supine position with the upper arm along the side, but with the elbow flexed and the hand resting on the lower chest or abdomen. The needle is inserted 2 cm below the midpoint of the inferior clavicular border and advanced laterally, and a nerve stimulator is used to identify the plexus. Marking line between the C6 tubercle and the axillary artery with the arm abducted is helpful in visualisating the course of the plexus.

The supraclavicular brachial plexus block was performed according to the original procedure. The patient was placed in the supine position with their head turned toward the opposite side. The point at which the lateral border of the sternocleidomastoid muscle joins the superior aspect of the clavicle was marked, and a needle was inserted at this point in a direction that is directly posterior (perpendicular to the table). The

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needle was advanced until a motor response was elicited. If a motor response in the hand or wrist was not obtained during the initial insertion, or if the first rib was not contacted, the needle was redirected cephalad in small steps until a motor response in the hand or wrist was obtained or until it was angled approximately 30°. If contact with the brachial plexus was still not made, the needle was redirected caudal in small steps until a motor response was obtained or until an angle of 30° caudal was reached.

Block performance-related pain was evaluated immediately after removing the needle by asking the patient to verbally quantify the level of pain using a score between 0 and 10

0 meaning no pain and 10 meaning excruciating pain.

The sensory block for each nerve (radial, median, ulnar, musculocutanoeus, and media cutaneous of forearm) of interest was performed using alcohol-soaked gauze

graded as follows: 0 = no difference from an unblocked extremity; 1 = less cold than unblocked extremity; and 2 = no sensation of cold.

The motor block was evaluated using the forearm flexion, thumb abduction, thumb and second digit pinch and finger abduction (for the musculocuatneous, 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 = incapacity to overcome gravity.

The quality of the block was evaluated in the intraoperative time:

(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 ofpropofol at 50 µg/kg/min and fentanyl 1-2 µg/kg IV; and
(c) complete failure - if the patient still experienced pain despite supplementation, general anaesthesia was induced by the attending anaesthesiologist using his/her preferred technique.

The duration of the sensory and motor block was assessed. The duration of the sensory block was defined as the time between the end of the local anaesthetic injection and the total recovery of sensation. The duration of the motor block was defined as the time between the end of the local anaesthetic injection and the total recovery of motor functions.

The side effects and complications, such as blood vessel puncture, intravascular injection, overdose, dyspnoea, Horner's syndrome, and pneumothorax, were noted.

The patient's satisfaction with the anaesthetic technique was assessed after arrival in the post-anaesthesia care unit using a 2-point scale (0 = unsatisfied; 1 = satisfied).

The values are expressed as the mean ± SD. Group sizes (50 patients per group) were determined using the proportion sample size estimates (type 2 error = 80%, type 1 error = 0.05) to detect a 20% difference in the rates of complete sensory block at 50 min. Statistical analysis was performed using a Mann-Whitney rank sum test, Student's t-test, Fisher's Exact test, and $\chi 2$ where appropriate. A p value < 0.05 was considered significant.

Results

All 100 patients completed the study. There was no statistically significant difference in the demographical data, type of surgery, surgery timebetween the two groups

(Table 1)

	Group S (n= 50)	Group I (n= 50)
Age (years)	48±18	46±18
Male /female	24/26	28/22
Height (cm)	164±8	162±9
Weight (kg)	60±4	60±3
ASA grade (1/ 2)	28/22	32/18
Type of surgery(n) Elbow Forearm Hand	 8 24 18	 9 18 23
Duration of surgery (min)	66±36	70±38

The values are the mean ± SD. Group S: supraclavicular brachial plexus block, Group I: infraclavicular brachial plexus block

Table 2 lists the motor responses elicited. There was no significant difference in the block related pain between group S and I, with pain scores of 3.2 ± 1.5 and 3.0 ± 1.3, respectively.

Table 2
Incidence of Stimulated Nerve Type.

	Group S (n=50)	Group I (n=50)
Radial nerve	6 (12)	12(24)
Median nerve	25 (50)	27(54)
Ulnar nerve	19 (38)	11(22)

The values are the number of patients (%). Group S: supraclavicular brachial plexus block, Group I: infraclavicular brachial plexus block.

Table 3 shows the quality of the block. A satisfactory block was achieved in 44 and 46 patients in group S and I, respectively. An unsatisfactory block was reported 4 patients in both groups. two patients in group S had complete failure and received a vertical infraclavicular brachial plexus block.

Table 3

	Group S (n=50)	Group I (n=50)
Complete failure	2 (4)	0(0)
Unsatisfactory block	4 (8)	4(8)
Satisfactory block	44 (88)	46(92)

Quality of the Brachial Plexus Block

Table 4 lists duration of the sensory and motor block. There were no significant differences between the groups.

Table 4

	Group S (n=47)	Group I (n=49)
Sensory block (min)	755±210	820±180
Motor block (min)	768±232	822±224

Table 5 presents the side effects and complications. Horner's syndrome was observed in 12 and 1 patients in group S (24%) and I (2%), respectively. Vascular puncture while performing the blocks occurred in both groups, 16% (n = 8) in group S and 14% (n = 7) in group I. Three patients from group S experienced mild dyspnea that was resolved after applying 6 L of oxygen by a mask. A pneumothorax was observed in 1patients in group S (2%), but none in group I

Table 5

	Group S (n=50)	Group I (n-50)
Horner syndrome*	12(24)	1(2)
Dyspnea	3 (6)	0(0)
Pneumothorax	1(2)	0(0)
Vascular puncture	8(16)	7(14)

The values are the number of patients (%). Group S: supraclavicular brachial plexus block, Group I: infraclavicular brachial plexus block. *P < 0.05 between the groups.

Table 6 shows the patient's satisfaction. There were no significant differences in the level of patient's satisfaction between the groups. Two of the 97 patients were unsatisfied: one in group S and one group I. One patient in group S had a pneumothorax after the block, and one patient in the group I was unhappy with the prolonged sensory and motor block with ropivacaine.

Table 6

	Group S (n=47)	Group I (n=49)
Unsatisfied	1 (2)	1(2)
Satisfied	46(98)	48(98)

Patient's Satisfaction

Discussion

In our study, the supraclavicular and infraclavicular approach to the brachial plexus showed no important clinical differences, except for the high incidence of Horner's syndrome and the pneumothorax in 1patients with the supraclavicular approach.

As we know, the supraclavicular approach to the brachial plexus can provide very good anesthesia for upper-extremity surgery. Compared with the axillary block, the supraclavicular approach to the brachial plexus offers a distinct advantage, particularly a faster onset of a dense block with a single injection using less local anesthesia [4]. However, many anesthetists prefer not to perform this technique for fear of causing a pneumothorax. The supraclavicular approach using the plumb-bob technique was also selected to avoid pneumothorax.

In our study, both approaches showed similar results in relation of complete sensory block rates and quality of block. At 50 min, complete analgesia of all territories was achieved in 82% (n = 41) and in 82% (n = 41) of patients in group I and S, respectively. Sufficient surgical analgesia in the vertical infraclavicular approach was reported by Kilka et al. [5] in 95% of patients at 30 min using 40 ml of prilocaine 1.5% and 10 ml of bupivacaine 0.5%. Neuburger et al. [6], without specifying the time of assessments, reported sufficient surgical anesthesia in 87% and 88% of patients.

In the supraclavicular block, Franco et al. [1] reported a 97.2% success rate using the subclavian perivascular technique in 1,001 patients. Possible reasons for the lower success rate observed in both groups include the lower volume of local anesthesia used, operator's inexperience, different local anesthetics used or the definition of success.

In our study, the ulnar (n = 9) and medial cutaneous of the forearm nerve (n = 6) were frequently incompletely blocked in group S. It is possible that depositing the local anesthetic close to the lower trunk will increase the likelihood of blocking it directly, thereby overcoming the obstacle to diffusion that the closely located pulsatile artery might exert on this trunk. However, this remains speculative and will require more study. Interestingly, the ulnar (n = 8) and medial cutaneous of the forearm nerve (n = 7) were also incompletely blocked in group I. This might be explained by the anatomical barrier [8].

Several studies compared the supraclavicular approach with the infraclavicular approach with ultrasound. Arcand et al. [9] compared ultrasound-guided supraclavicular with infraclavicular blocks and reported no significant difference in either the block performance or onset times or block efficacy.

Koscielniak et al. [10] reported that an ultrasoundguidedinfraclavicular block had a faster onset, better surgical efficacy and fewer adverse events than a supraclavicular block. Recently, Fredrickson et al. [11] compared an ultrasound-guided supraclavicular block using multiple injection with ultrasound-guided triple injection infraclavicular block. They reported that the corner pocket supraclavicular and infraclavicular brachial plexus block were associated with similar onset times and sensory blockade at 30 min. In addition, 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.

The incidence of vessel puncture was similar in both groups. 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.

The diaphragmatic function was studied. The incidence of phrenic nerve block appears to be similar to the incidence of Horner's syndrome because the phrenic nerve is situated on the belly of the anterior scalene muscle and the cervical sympathetic chain medial. According to Rettig et al. [12], Horner's syndrome is a clinically significant sign (100%) that predicts changes in hemidiaphragmatic movement. However, in their patients, changes in hemidiaphragmatic movement were also observed without Horner's syndrome. In our study, Horner's syndrome was encountered in 12 and 1 patients in group S (24%) and group I (2%), respectively. When the complication rates between the supraclavicular and infraclavicular approaches are compared, an impairment in diaphragmatic movements can be rated as 100% for interscalene [13], 50% to 77% for supraclavicular [14,15], 24% to 26% for proximal infraclavicular [12], and 0% for more distal infraclavicular blocks [16,17].

In our study, pneumothorax occurred in one patients with supraclavicular approach but in none using infraclavicular approach. A pneumothorax is a serious complication associated with the supraclavicular approach. This has also been reported after interscalene [18], coracoid and vertical infraclavicular blocks [19,20]. The reported incidence of pneumothorax after a supraclavicular block is 0.5% to 6.1%. The plumb-bob and subclavian perivascular approaches were designed in part to reduce the risk of pneumothorax. The risk of pneumothorax in tall, thin patients might be reduced further by initially directing the needle 45° cephalad during the supine plumb-bob technique, rather than directly toward the floor. This magnetic resonance imaging finding has not been confirmed clinically. The incidence of pneumothorax is likely to be reduced by the operator's experience, using shorter needles, and taking extra care with tall, thin patients who are more likely to have high apical pleural reflections or in patients with emphysema. An ultrasound-guided supraclavicular block might reduce the risk of pneumothorax because the pleura and first rib are often easy to visualize.

Perlas et al. [21] reported that an ultrasound-guided supraclavicular block is associated with a high success rate and low complication rate with no pneumothorax in a series of 510 consecutive patients.

In conclusion, these results suggest that both the supraclavicular and infraclavicular approach to the brachia plexus had similar clinical efficacy but the supraclavicular block caused a pneumothorax. These results suggest that the infraclavicular approach might be preferable for hand, forearm, and/or elbow surgery for ease of technique, patient satisfaction and low rate of complications. However, more large scale studies will be needed to compare the supraclavicular block with the infraclavicular block using neurostimulation.

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