Original Article

Vibration sensation as an indicator of surgical anesthesia following brachial plexus block

ABSTRACT

Background: Local anesthetic instillation in close vicinity to nerves anywhere in body blocks sensations in the same order as in central neuraxial blockade. The main purpose of this study was to evaluate the efficacy of vibration sense as criteria to determine the onset of surgical anesthesia following brachial plexus block and its correlation with loss of sensory and motor power.

Materials and Methods: This prospective study included fifty patients of American Society of Anaesthesiologist physical status I and II, aged between 18 and 45 years, undergoing elective upper limb surgery under brachial plexus block by supraclavicular approach. The baseline values of vibration sense perception using 128 Hz Rydel–Seiffer tuning fork, motor power using formal motor power of wrist flexion and wrist extension, and sensory score by pinprick method were recorded preoperatively and every 5 min after giving block till the onset of complete surgical anesthesia.

Results: The mean ± standard deviation of time (in minutes) for sensory, motor, and vibration block was 13.33 ± 3.26, 21.10 ± 3.26, and 25.50 ± 2.02, respectively ($P < 0.05$). Although all the patients achieved complete sensory and motor block after 25 min, 14% of the patients still had vibration sensations intact and 100% of the patients achieved complete sensory, motor, and vibration block after 30 min.

Conclusions: Vibration sense serves as a reliable indicator for the onset of surgical anesthesia following brachial plexus block. Vibration sense testing with 128 Hz Rydel–Seiffer tuning fork along with motor power assessment should be used as an objective tool to assess the onset of surgical anesthesia following brachial plexus block.

Key words: Brachial plexus; nerve blocks; supraclavicular; vibration

Introduction

Local anesthetics block various nerve fibers in the central neuraxial blockade. Autonomic preganglionic B-fibers are the first to be blocked followed by fibers carrying temperature (cold before warm), pinprick, pain, touch and deep pressure, vibration sense, and proprioceptive impulses are the last to be blocked. The recovery from blockade occurs roughly in reverse order.[1] We as anesthesiologists usually assume that lack of sensation to simple stimuli such as touch, pinprick, or cold predicts the absence of pain during surgery, but it does not represent accurate or reliable assessment method of nociceptive block during surgery as they cannot predict the complete blockade of small diameter C fibers and Aδ fibers.[2,3] Traditionally, the nongraduated tuning fork is

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used for the evaluation of vibration sense, but unfortunately, it does not quantitatively provide the degree of dysfunction.[4] A 128 Hz Rydel–Seiffer graduated tuning fork fulfils all the needs in providing an ideal instrument which is easy to apply, inexpensive, and reliable for quantifying the impairment of vibration sense.[5] Assessment of vibration sensation is easier than that of sensory and motor power as pinprick and movement of limb adds discomfort to patients. Hence, our prospective study endeavored to evaluate if vibration sensation could be used as an indicator of surgical anesthesia in correlation with loss of motor strength following brachial plexus block by supraclavicular approach.

Materials and Methods

After approval from the Hospital Ethics Committee, this prospective study was conducted on a total of fifty American Society of Anaesthesiologist Grade I and II patients aged between 18 and 45 years, undergoing elective upper limb surgery. Patients with peripheral neuropathy, myopathy, bleeding diathesis, or coagulation abnormalities, and those with inadequate block were excluded from the study. Baseline vibration score was recorded using 128 Hz Rydel–Seiffer tuning fork preoperatively [Figure 1]. The tuning fork has calibrated weights at the extremities of its arms, which has a triangle with an arbitrary scale from 0 to 8. It is a semi-quantitative measurement of the intensity of applied vibration. When tuning fork vibrates, weight appears double and two virtual triangles appear. Their intersection point moves upward with decreasing amplitude of arms. Patients were instructed to inform as soon as they no longer felt the vibration, and the score visible at that time was considered as the nearest value to the apparent point of intersection of virtual triangles [Figure 2].[4] Vibration sense was tested twice at each time of measurement at styloid process of radius and their mean was documented by a single investigator using 8-point numeric scale, vibration score of 7 or 8 was taken as normal. Sensory block was analyzed by pinprick method using a 25-gauge sterile needle at medial and lateral aspect of forearm on a three-point scale (2 = normal sensation, 1 = blunted sensation, and 0 = absence of sensation).[6] The modified grading system of formal motor power testing (British Medical Research Council) was used for the assessment of motor power [Table 1]. It involves both subjective and objective factors. Subjective factors include the examiner's impression of the amount of resistance to be given before the actual test and differences in perception of this resistance by each patient. Objective factors are the ability of the patient to complete a full range of motion or to hold the position once placed there and to move apart against gravity or an inability to move it at all.

After obtaining baseline values, brachial plexus block was performed by a single anesthesiologist using supraclavicular approach in the supine position with head turned away from the side to be blocked. After eliciting paresthesia, negative aspiration for blood was performed before incremental injections of total volume of the solution (30 ml of 1.5%

Figure 1: 128 Hz Rydel–Seiffer Tuning Fork (source: www.tuning-fork.info)

Table 1: Modified grading system for formal motor power testing (British Medical Research Council, 1978)

Grade	Description
0	No muscle contraction at all
1	Visible muscle contraction, but no movement
2	Movement without influence of gravity
3	Movement against gravity
4	Movement against resistance
5	Normal strength

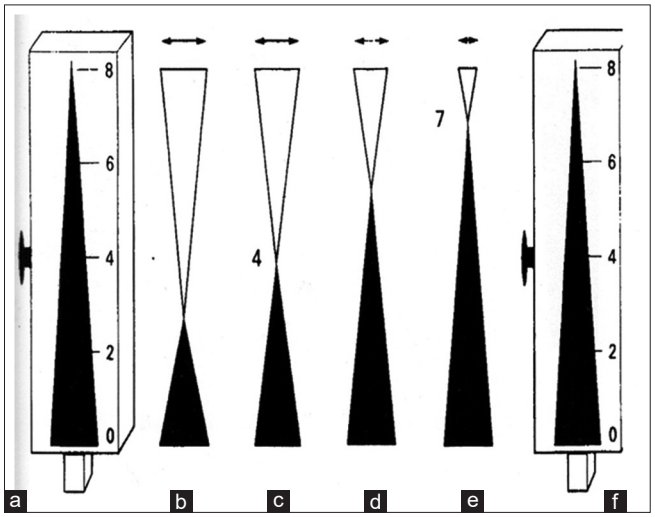

Figure 2: Extremities of the tuning fork at rest (a) and during vibration (b-f). Intersection between lower and upper triangles moves from 0 (minimum score) to 8 (maximum score) with decreasing amplitude. (Source: www.neurology.org)

lignocaine with epinephrine (1/200,000).[7] Raizada *et al*. reported that the extent of blockade following injection into the sheath surrounding the brachial plexus may depend on the volume and concentration of local anesthetic used. They concluded that 1% lignocaine with adrenaline was not suitable for conducting surgery under brachial plexus block due to high failure rate and poor analgesia.[8] In this study, we used 1.5% lignocaine (30 ml) with adrenaline 1/200,000. We achieved 100% success rate in all the patients with our study drug as none of the patients required any supplementation of the block with general anesthesia.

The assessment of sensory, motor, and vibration block was done every 5 min from the time of injection of local anesthetic till the onset of complete surgical anesthesia (S_0, M_0, and V_0) which defined the end of the study, and surgery was then allowed to be commenced. Onset of sensory block (S_0) is defined as time between injection of drug and loss of pinprick sensation, onset of motor block (M_0) is defined as time between injection of drug and complete loss of motor power, and vibration block (V_0) is defined as time between injection of drug and obtaining vibration score of 0. Intravenous fentanyl in the dose of 50–100 micrograms was given to all patients to ensure comfort while maintaining a conscious and conversant state.

Statistical analysis

The mean time of onset of motor block and loss of vibration sensation, which was taken as primary outcome variable, showed that a minimum number of patients should be 41 so as to achieve a power of 80% and an alpha error of 5%. Thus, we took 50 patients for the study. All the results were tabulated and analyzed using Kruskal–Wallis test followed by Mann–Whitney U-test. $P < 0.05$ was considered to be significant.

Results

After supraclavicular block, mean ± standard deviation of time (in minutes) for the onset of sensory, motor, and vibration block was 13.33 ± 3.26, 21.10 ± 3.26, and 25.50 ± 2.02, respectively [Figure 3]. The difference between the mean time taken for S_0, M_0, and V_0 was statistically significant ($P < 0.05$). All the patients achieved complete sensory blockade after 20 min, 38% of patients had intact motor power, and 4% of the patients had loss of vibration sensation. All the patients achieved complete sensory and motor blockade after 25 min, but 14% of the patients still had vibration sensation intact. All the patients achieved complete sensory, motor, and vibration sense blockade after 30 min [Figure 4].

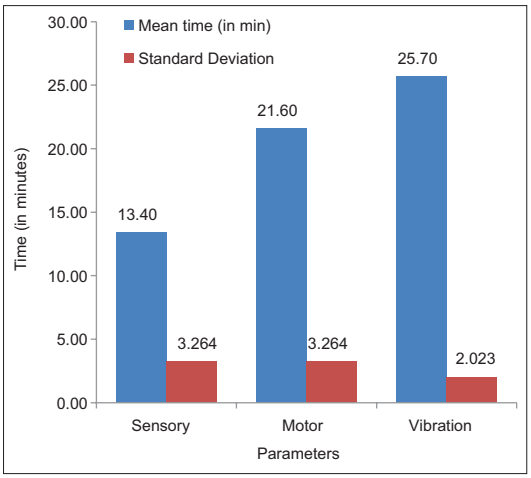

Figure 3: Comparison of mean time of onset of sensory, motor, and vibration block

Discussion

Many studies have evaluated the order of blockade of various sensations taking only sensory perception and motor strength as criteria, but number of studies in which the order of blockade using vibration sense following brachial plexus block has been studied are limited.[9,10] This prompted us to evaluate the sequence of blockade using vibration sense as criteria along with sensory and motor power following supraclavicular brachial plexus block.

In the present study, the sensory block occurred earlier than motor block and there was a regression of vibration sensation as sensory block progressed to motor block reflecting the order of blockade of nerve fiber, which is sensory followed by motor and the last to be blocked were the fibers carrying vibration sense. Our results correlate with a study done by Parry *et al*. in which they reported that onset of regional block anesthesia depends on the diameter of nerve fibers involved with a particular modality of sensation.[11] The fibers with a lesser diameter (pain, cold, and touch) are the earliest to be blocked whereas the thicker fibers (proprioception and vibration) are the last to be blocked.[12] Similar results were found by Adnan *et al*. in which sensory block occurred earlier than motor block after brachial plexus block.[13] On comparison of sensory, motor, and vibration block at 5 min intervals, it was also observed that there was a continuous decline in the scores of all the three parameters. These findings further validate the proposed hypothesis that the order of blockade in brachial plexus block is sensory followed by motor and vibration sense.

As complete sensory blockade was achieved after 20 min, 38% patients still had intact motor power and only 4% patients had

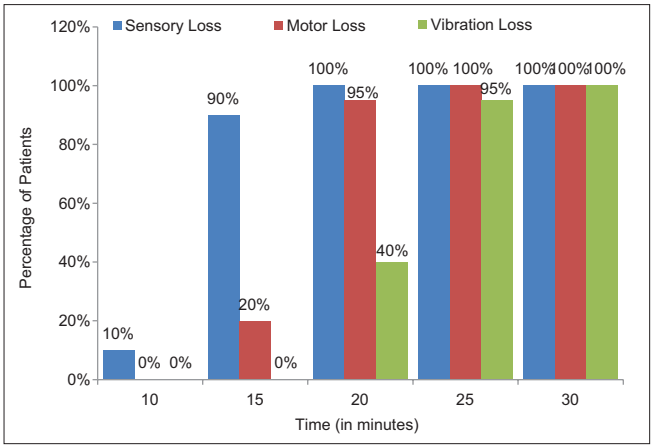

Figure 4: Proportion of subjects according to time for different parameters

a complete loss of vibration sense. Whereas after 25 min, all the patients had a complete loss of motor power, there were still 14% of patients who had partial loss of vibration sense and they achieved a complete loss of vibration sense after 30 min. Thus, loss of vibration sense correlates well with the loss of motor power. We conclude that the loss of vibration sensation as evaluated by 128 Hz Rydel–Seiffer tuning fork corresponds well with complete motor block and hence is an effective indicator of the onset of surgical anesthesia following supraclavicular type of brachial plexus block.

Conclusions

We conclude that following supraclavicular brachial plexus block, sensory fibers carrying pinprick sensation were the first to be blocked followed by motor fibers and fibers carrying vibration sense were the last to be blocked. Only lack of sensation to pinprick and loss of motor power does not predict the onset of surgical anesthesia. Hence, vibration sense testing with 128 Hz Rydel–Seiffer tuning fork along with motor power assessment may be used as an objective tool to assess the onset of surgical anesthesia following brachial plexus block.

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Conflicts of interest

There are no conflicts of interest.

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