

# Evaluation of the accuracy of vibration sense with VibraTip™ as a tool to determine the level of anesthesia following subarachnoid block and its correlation with the pinprick sensation

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## Abstract

**Background and Aims:** Assessment of level of anesthesia after subarachnoid block (SAB) is essential. We aimed to evaluate the efficacy of vibration sense as a criteria to determine the level of surgical anesthesia.

**Method and Materials:** The study included patients, scheduled for various surgeries under SAB. The baseline values of vibration sense perception using VibraTip™, motor power using the modified Bromage scale, and sensory block by pinprick method were recorded preoperatively and at 5 and 7 min after administration of SAB. The correlation between vibration sense, loss of pinprick sensation, and level of anesthesia were assessed.

**Results:** The concordance correlation coefficient between the pinprick and vibration sense at 5 min and 7 min showed poor strength of agreement with Pearson  $\rho$  (precision) being 0.4192 at 5 min and 0.4701 at 7 min.

**Conclusion:** Vibration sense serves as a reliable indicator to assess the level of surgical anesthesia following SAB. Vibration sense testing with VibraTip™ along with motor power assessment can be used as a tool for assessment of level of block. There is a poor correlation between level of vibration sense and pinprick.

**Keywords:** Block height, spinal anesthesia, vibration sense

## Introduction

Subarachnoid block (SAB) is the most commonly employed procedure for lower abdominal surgeries.<sup>[1]</sup> Assessment of level of anesthesia is important prior to initiating surgery. There are numerous methods available to examine the level of anesthesia after SAB,<sup>[2]</sup> of which loss of pinprick sensation using a hypodermic needle, loss of touch, and cold sensation

are among the commonly preferred.<sup>[3]</sup> One study has suggested that block to light touch is the most reliable method for checking the level of block.<sup>[4]</sup> Testing the loss of vibration sense to assess the level of anesthesia could also be a simple alternative to these practices.

This study has evaluated the efficacy of checking the vibration sensation after administration of SAB, and its correlation with pinprick sensation.

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Access this article online	
Quick Response Code:	Website: www.joacp.org
	DOI: 10.4103/joacp.JOACP_258_18

**How to cite this article:** Dhana Lakshmi SK, Ramakrishna CK, SatyaSree D, Prakash PV. Evaluation of the accuracy of vibration sense with VibraTip™ as a tool to determine the level of anesthesia following subarachnoid block and its correlation with the pinprick sensation. *J Anaesthesiol Clin Pharmacol* 2021;37:97-101.

**Submitted:** 16-Aug-2018 **Revised:** 07-Apr-2019

**Accepted:** 20-Jun-2019 **Published:** 10-Apr-2021

VibraTip™ is a small device that can be used to check the vibration sense, without causing pain and discomfort. It has been used in the assessment of peripheral sensory neuropathy in diabetes.<sup>[5]</sup> The instrument vibrates at 125 Hz frequency, which is equivalent to biothesiometer value of 25 Volts. The vibration produced by this instrument is reliable, reproducible, and effective.

## Material and Methods

After obtaining approval from the Hospital Ethical Committee, this prospective study was conducted on 76 consenting patients. They belonged to either gender, between the ages of 18-70 years undergoing various surgical procedures under SAB. There was no blinding done, and patients who gave verbal consent were considered for the study.

Patients with evidence of cardio-respiratory, neurological, psychiatric, metabolic, infective, and coagulation disorder or on chronic analgesic medication were excluded from the study. All the patients were interviewed a day before to ensure intelligent verbal communication and to explain about the procedure of testing different parameters of the study. After taking appropriate consent for the usage of VibraTip™ from the patients, vibration sense was tested on the ventral aspect of the forearm to check the perception of vibration sense before administration of SAB. This helped to sensitize the patient and aided in further monitoring after administration of spinal anesthesia. Similarly, the pinprick sensation was also tested on the forearm for the patient to appreciate the change after SAB.

After wheeling the patient into the operating room, on the day of surgery, ECG, pulse oximeter, and non-invasive blood pressure were connected to the patient, and monitoring was commenced. All patients were pre-loaded with Hartmann's solution 500 ml using an 18G intravenous cannula. The SAB was administered with patients in a sitting position in the L3-L4 interspace with 26G spinal needle, and 0.5% hyperbaric solution of bupivacaine (3 ml) was administered intrathecally. Consequently, the patient was turned to a supine position, and the position was not changed till after the 7<sup>th</sup> min testing of different parameters. The motor blockade was assessed by the modified Bromage scale at 5<sup>th</sup> and 7<sup>th</sup> min. The patient was tested at 5 min for pinprick and vibration sense on both sides, starting from the level of T2 (angle of the sternum) till the level where the sensation being tested was not appreciable, and that level was noted. The site for checking was in the mid-clavicular line at each level on both sides.

The pinprick was tested with a sterile 18G needle with care being taken to be gentle. The VibraTip™ was used for testing the vibration sense and wiped clean with spirit swab after testing each patient. At 7<sup>th</sup> min, the tests were repeated. One patient could not appreciate the loss of vibration sense, but the surgery could be completed without any change in anesthetic technique as the pinprick was lost, and there was complete motor paralysis.

The levels of block to pinprick and vibration sense were noted according to dermatomal distribution.

### Sample size

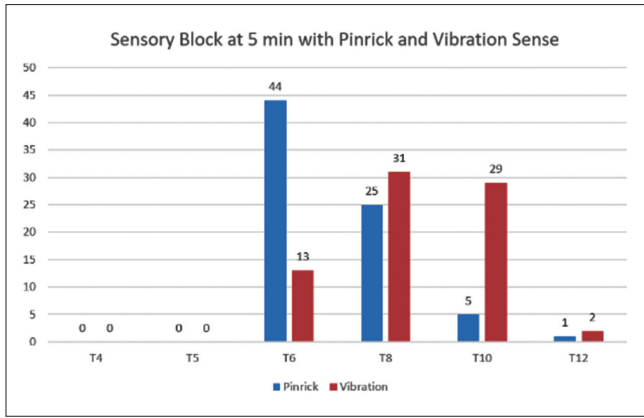
To calculate the sample size, with an  $\alpha$  error of 0.05 power of study 99, and standard deviation of 1.47 and 1.8 as seen in previous studies,<sup>[6,7]</sup> a number of 57–85 was calculated. Study of 76 patients was decided on, to anticipate attrition to failure of spinal or any other causes.

## Results

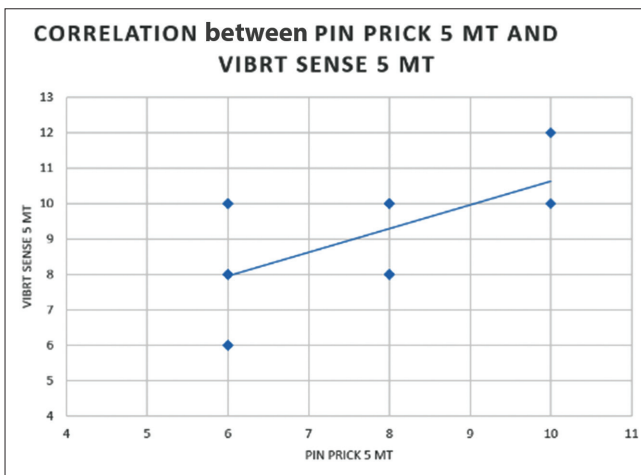
The statistical analysis of the data was done in Microsoft Excel and Social Science Statistics ([www.socscistatistics.com](http://www.socscistatistics.com)). The surgeries performed under SAB included orthopedics (15), general surgery (30), and gynecology (30). The level of block based on loss of pinprick or vibration sense according to the dermatomal levels is depicted in Figures 1 and 2. The mean value of pinprick level at 5 min was 6.9 (Standard deviation = 1.3) (6.9 dermatomal level) and at 7 min 6.21 (1.17). The mean value of vibration sense at 5 min was 8.58 (1.5) and at 7 min was 7.8 (1.5). The scatter plot is represented in Figures 3 and 4. There were no differences in level between the right and left sides in our study.

At 5 min and 7 min, the lowest achievable level was T12 by vibration sense, and the widest margin between pinprick and vibration sense was 6 segments. In our study group, no patient had inadequate analgesia, and there was no change in anesthetic management or conversion to general anesthesia.

The concordance correlation coefficient of 0.25, with Pearson  $\rho$ , (precision) of 0.42 between the pinprick and vibration at 5 min indicates a poor strength of agreement between the two. Similarly, at 7 min, the concordance correlation coefficient of 0.27, with Pearson  $\rho$ , (precision) of 0.47 shows again a poor strength of agreement between the two modalities of testing. This infers that increasing level of the block with pinprick may or may not be associated with an increase in the level of vibration. The mean value of the modified Bromage scale was 3 (0) (complete motor block of the lower limb) in all of the study group at both 5 min and 7 mins. One patient did not have a loss of vibration sense at any time, but the surgery



**Figure 1:** Comparison of dermatomal levels at 5 min of pinprick and vibration sense



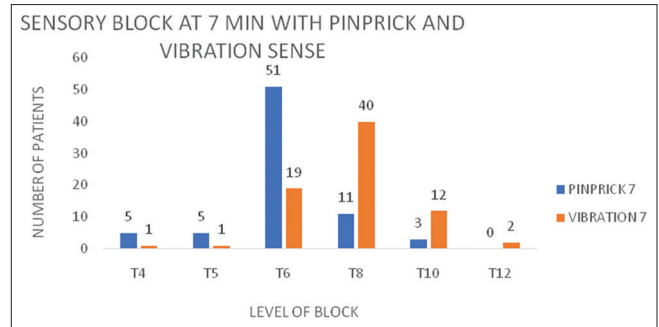
**Figure 3:** Correlation between vibration sense and pinprick dermatomal level at 5 min

proceeded uneventfully as loss of pinprick was at T6 level. However, in our study group, there was no patient who had a loss of vibration sense but no loss of pinprick sensation.

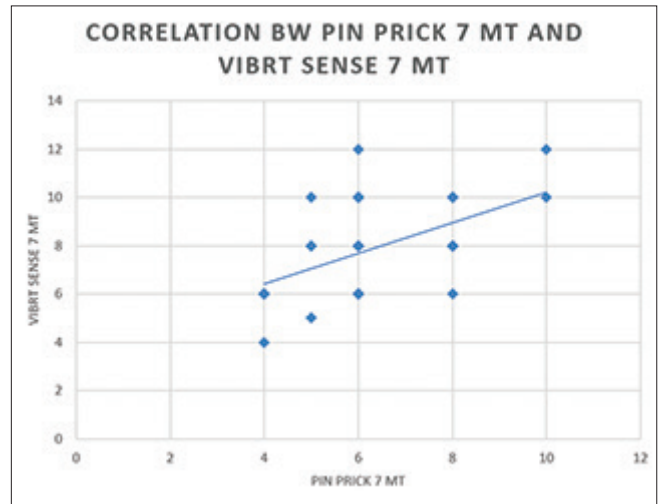
Our results conclude that, the pinprick sensation using 18G needle is 100% sensitive for identifying the level of SAB, whereas it is 98% (Confidence interval of 95% is 92.89% to 99.97%) for the vibration sensation. The difference between the two modalities has not been constant and cannot be predicted, varying from at least 2 segments to 6 segments between patient to patient.

## Discussion

Current practice in anesthesia for testing of level after SAB using vibration sense is not done, and we wanted to study the effectiveness of using this technique in regular work. After inducing SAB, we usually assume that lack of sensation to touch, pinprick, or cold represents an adequate level of anesthesia, but it does not represent accurately the level of nociceptive block during surgery, as they cannot predict



**Figure 2:** Comparison of dermatomal levels at 7 min with pinprick and vibration sense



**Figure 4:** Correlation between pinprick and vibration dermatomal levels at 7 min

the complete blockade of small diameter C fibers and A  $\delta$  fibers.<sup>[8,9]</sup>

Among the sensory nerves, the C fibers (0.3 to 1  $\mu$ m, un-myelinated), which conduct cold temperature sensation, are blocked more readily or earlier than A fibers (1-4  $\mu$ m myelinated), which conduct pinprick. The A $\beta$  fibers (5-12  $\mu$ m myelinated), which conduct touch sensation, are the last to be affected among the sensory fibers. The larger A $\alpha$  motor fibers (12-20  $\mu$ m, myelinated) are more resistant than any of the sensory fibers.<sup>[10]</sup> Thus, the dermatomal block height varies with the method utilized to assess. In general, peak height measured is most cephalad using cold and is measured lower with pinprick and lowest with touch.<sup>[11]</sup> The vibration sense is carried by A $\alpha$  and  $\beta$  fibers which is more resistant to block and this is reflected in the mean values - level of vibration sense is consistently lower than the mean pinprick level at 5 and 7 min after SAB.

The efferent nerve function that is commonly assessed is motor block which is evaluated by the modified Bromage scale but is not sensitive as it gives only an imprecise mix of information on the spread and degree of a motor blockade

in the lumbosacral area.<sup>[12]</sup> All patients developed complete motor block in our study.

The primary outcome of this study is to assess the effectiveness of loss of vibration sense as a modality to be checked in grading the level of the block after SAB. The secondary outcome was to compare it to the pinprick sensation and see for any correlation between the two.

Vibration sense assessment for SAB level was 98% sensitive, thereby serving as a good alternative to pinprick. The difference between pinprick and vibration sense was variable from patient to patient varying from 2 segments to a maximum of 6 segments. There is a wide variation in practice among researchers with no clear gold standard for assessing regional blocks. There are multiple methods for assessing the block, and surveys have regularly demonstrated a marked variation in techniques among anesthetists. We have found the loss of vibration sense to be a reliable indicator for assessing the level of block.

An apparently “adequate” block spinal may fail because the block has been tested using a stimulus of significantly different modality or intensity than the planned surgery.<sup>[13]</sup> A simple single stimulus (e.g., pinprick and cold) analysis may be impeded, but spinal cord mechanisms may result in repeated stimuli (temporal summation) or stimuli from adjacent regions (spatial summation), evoking pain, and revealing a “failed block.”<sup>[14]</sup> In addition, demonstration of the segmental extent of block of one modality does not enable accurate prediction of any other.<sup>[15]</sup>

In practice, the combination of sympathetic block with an adequate sensory level and motor block are used to confirm spinal efficacy. Assessment of SAB height, which relies on the subjective experience and perception of the patient, as assessed by touch, pinprick, or cold is variable<sup>[16-18]</sup> and level judged in the same patient differs even between individual anesthesiologist.<sup>[19-21]</sup>

A gentle pinprick is used widely, but, in uneducated and manual workers, it is difficult to elicit and overenthusiastic checking of level may injure the patient during the assessment. The other ways to check for the objective level of anesthesia include transcutaneous electrical stimulation<sup>[22]</sup> and peripheral nerve stimulators,<sup>[23]</sup> which are bulky and expensive. A novel way of checking for level of anesthesia is by using vibration sense by VibraTip<sup>TM</sup>.<sup>[24]</sup> The important advantage being it is easy to use, has the same standard stimulus, and is not painful.

We have found the level of anesthesia to be normally predicted by the vibration sense, except in one patient where there was no loss of vibration sense, which could be the result of patchy block. Patchy block being a block that appears adequate in

extent, but the sensory and motor blocks are incomplete,<sup>[25]</sup> the most likely explanation is that the local anesthetic was at least partially misplaced, or that the dose given was inadequate. Appreciation of vibration sense but loss of other could be a part of the spectrum of the patchy block. There is also a reported study<sup>[26]</sup> where, after receiving SAB patient, reported feeling cold, pinprick, and touch at all levels despite having complete bilateral lower limb block and painless urinary catheter insertion and surgery proceeded uneventfully.

In our study group, all patients had a motor block graded according to the modified Bromage scale as three. Although there was no correlation between the pinprick level and the level of loss of vibration sense, at all times the level of vibration was lower than that of pinprick.

There has been a study using 128 Hz tuning fork to assess vibration sense in 150 patients undergoing Caesarean section.<sup>[27]</sup> They have tested the presence of vibration sense and the modified Bromage score to evaluate the patient’s ability to move in the recovery period whereas we have used the loss of vibration sense with VibraTip<sup>TM</sup> to assess the level of anesthesia after administration of SAB. Similarly, another study was done on 60 male patients using a tuning fork of 128 Hz to determine the timing of analgesia to with the recovery of vibration sense in the postoperative period, whereas we have used the VibraTip<sup>TM</sup> to check for the onset of anesthesia after giving the SAB and its adequacy for a comfortable surgical procedure.<sup>[28]</sup>

The use of VibraTip<sup>TM</sup> has been studied in the identification of diabetic neuropathy.<sup>[29]</sup> National institute for health and clinical excellence (NICE)<sup>[30]</sup> have also recommended this device for early detection of diabetic peripheral neuropathy. This is the first study where VibraTip<sup>TM</sup> has been utilized for assessing the level of anesthesia after the administration of SAB.

The limitation in our study is that the sample size is small, blinding of the assessors was not feasible, and further studies will have to be done to confirm our findings. Another mitigating factor is that this device has to be procured and is not readily available like the 18G needle. although it is not very expensive cost wise (approximately Rs 2000), it is not free. The other limitation of using the loss of vibration sense would be in patients with peripheral neuropathy, wherein the vibration sense could be lost due to the disease process itself.

The strengths of this study are the simplicity, ease of assessment, and comfort of the patient, and repeatability of the test. Ambiguity in answering is reduced with a categorical answer of yes or no to the vibration sense. Further, research

in patients receiving epidural anesthesia can be done and its effectiveness there assessed especially in combined spinal epidural anesthesia, the timing for a further top up through catheter can be gauged.

## Conclusion

Spinal anesthesia involves blocking of pain pathways as well as blocking of vibration pathway. The pain being carried by C and A  $\delta$  fibers, which are sensitive to local anesthetics, whereas vibration is carried by A  $\alpha$  and  $\beta$  fibers, which are more resistant to local anesthetics.<sup>[31]</sup> Vibration sense can be used as an effective pain-free alternative for testing the level of anesthesia after SAB .

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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