Research Paper Medical Science

Peripheral Blood Flow Assessment by Using Pulse Oximeteric As Plethysmographic Waveform Guide to Success of Subarachniod Block

Dr Jitendra Kumar	Assistant Professor, Department of Anaesthesiology, Peoples Medical College ,Bhopal 462042 INDIA
*** Dr Sheetal Songir**	Associate Professor, Department of Anaesthesiology, Peoples Medical College ,Bhopal 462042 INDIA. * Corresponding Author
Dr Vaishali waindeskar	Professor, Department of Anaesthesiology, Peoples Medical College, Bhopal 462042 INDIA
Dr Krishan Kumar	Resident, Department of Anaesthesiology, Peoples Medical College, Bhopal 462042 INDIA
Dr Ritu shukla	Resident, Department of Anaesthesiology, Peoples Medical College, Bhopal 462042 INDIA

ABSTRACT

Background: Spinal anesthesia is a very common and routine procedure. There are different clinical parameters to assess the onset and duration of effect. Pulse Oximeter is a universally available tool and can be used at bedside to access the effect of spinal anesthesia due to peripheral vasodilatation.

Methods: fifty patients were posted for surgery under spinal anesthesia. Plethysmographic Waveform analysis was done just before the procedure and immediately 1 min ,5 min, 10 min, 15 min and 20 min after procedure. Changes in waveform were recorded in all patients and analysis was done.

Results: In our study we recorded mean pulse oximetry waveform amplitude after -. The mean rise of oximetry waveform amplitude was 6.42,8.2, 9.48, 9.78, 10.02 at 1min, 5min, 10min, 15min, 20 min after sub arachnoid block as compared to preblock value which is 3.32. Sensitivity, specificity, positive predictive value and negative predictive value of those for the plethysmographic waveform test were 97.67%, 28.57%, 89.36% and 66.67% respectivey.

Conclusion:The result suggested that plethysmographic amplitude changes just after spinal block has taken its effect ., This method may be easier to use without any additional technology of pulse oximeter. It as a supplemental diagnostic tool to predict successful subarachnoid block in the limited situation, where verbal communication with patient is difficult.

KEYWORDS :

INTRODUCTION

Spinal anestheisa is a simple reliable, safe and cost effective anesthesia technique for verities of surgery on lower abdomen and lower limb. Spinal subarachnoid block causes preganglionic block of sympathetic fibres resulting in increase in peripheral blood flow in blocked areas. Compensatory vasoconstriction results in unblocked areas.The pulse oximeter is widely used oximetry monitor during anesthesia and other procedures, because it provides a simple means of estimating arterial oxygen saturation. Pulse oximeter readings are affected by many factors. Increase in blood flow at the measurement site due to vasodilatation has been a focus of research because during anaesthesia especially in regional subarachnoid block, peripheral vascular tone changes over a wide range. Assessment of peripheral blood flow using pulse oximeter changes as an early indicator to guide success of subarachnoid block. The amplitude of the plethysmograph signal is directly proportional to the vascular distensibility.If the vascular compliance is low the pulse oximeter waveform amplitude is also low, with vasodilatation the pulse oximeter waveform amplitude is increased. Once a baseline measurement has been established, the pulse oximeter amplitude can be followed as a gauge of sympathetic tone.Pulse wave monitoring or plethysmography has proven to be useful in visualizing changes in skin blood flow due to sympathetic blockade. The pulse wave monitor is a noninvasive device and can be applied easily and rapidly.Most of the anaesthesiologists have easy access to a pulse oximeter and weather cost effective pulse Oximeter can be usefully employed to ascertain block success early.

MATERIALS AND METHOD

In an observational study fifty patients admitted in surgical, gynaecological and orthopaedic wards undergoing surgery on lower abdomen and lower limb under spinal anaesthesia were approached. Low risk patients with ASA grade I and II , aged between 18 to 60 years willing to participate were included. High risk cases with ASA grade III or more , patients undergoing emergency procedures and pregnant women were excluded from the study After securing intravenous access with appropriate Cannula, all the patients were preloaded with 10 ml/kg of ringer's lactate within30 min of block. Patient was positioned sitting and block was given. After subarachnoid injection of bupivacaine 0.5%, patients were observed for Amplitude changes in plethysmograh wave form, time of onset of sensory block, time of onset of motor block and highest dermatomal level of sensory block achieved. The plethysmographic waveform amplitude was measured as the vertical distance between the curve base and apex of curve. The average values of the first 5 readings of POP waveform amplitude at each evaluation interval were obtained for analysis. A two-fold increase in POP waveform amplitude from baseline was defined as a test criterion of successful block**.** Medication was done on occurrence of significant bradycardia or hypotension

Data Processing and analysis: Ordinal categorical data were analyzed by calculating mean and standard deviation to express the range of observation. The data on demographic characters of study subjects, onset time of block were analyzed by these methods.

Ethical Consideration: After obtaining approval for conducting this study from institutional ethics committee, present study was conducted in Dept of Anesthesiology RD Gardi Medical College, Ujjain MP. Informed consent was obtained after properly explaining the procedure. IHEC issue number.

OBSERVATIONS AND RESULTS

Total 50 patients were registered for the study. Mean age of the patient was 35.66 years, the youngest patient was 18 years old and oldest was 60 year old. 34 were males and 16 were females.[TABLE 1] Maximum number of patient's i.e (%)31/50 were admitted for general surgical procedures like hernia repair, appendectomy. (%)10/50 underwent finding of the table in two to three lines) hysterectomy. In (%)9/50 patients' orthopaedic surgery for external or internal fixation of fractured bones of lower limb. A two-fold increase in POP waveform amplitude from baseline was defined as a test criterion of successful sympathetic block Table No.4 shows 42/50 cases are positive, 5/50 cases negative, 3/50 cases are failed. Height of Preblock POP waveform was recorded as per protocol. Change in Height of POP waveform at different times with is shown in table 2. The onset time of sensory block recorded in minutes, calculated from the time of intrathecal injection of 4 ml of 0.5 % hyperbaric bupivacaine till insensitivity to pin prick. Mean time for onset was 2.42 min. Sensitivity, specificity, positive predictive value, and negative predictive value of the plethysmographic waveform test were calculated as100% (95% CI:91.5–100.0%), 37.50 % (95% CI: 8.97–75.30%), 89.36 % (95% CI: 76.88-96.41%), and 100 % (95% CI: 30.48-100.0%). Kappa value at 1 min was 1.00 with SE of 0.00 hence strength of agreement was perfect. Kappa value at 5 min was 0.516 with SE o 0.162 hence strength of agreement was moderate. At 10 mins kappa value was 0.502 wit SE of 0.183 and hence strength of agreement was moderate**.**

Plethysmographic waveform test – A two-fold increase in POP waveform amplitude from baseline was defined as a test criterion of successful sympathetic block Table No.4 shows 42/50 cases are positive, 5/50 cases negative, 3/50 cases are failed.

Table 1: DEMOGRAPHIC DATA

Para meters	Group R Mean ± SD	Group RD 1 Mean ± SD	Group RD 2 Mean ± SD
Age yr	46.2 ± 13.65	45.6 ± 10.2	42.2 ± 9.99
Weight (kgs)	62.3 ± 6.78	59.7 ± 8.57	63.9 ± 10.77
Height in cm	136.2 ± 10.78	140.3 ± 9.25	139.7 ± 10.94

Table No 2 :RESULT OF BLOCK

	Positive (%)	**Negative (%)**
Successful block n (%)	42(84%)	5(10%)
Failed block n (%)	1(2%)	2(4%)

TABLE No 3 :Pre block POP waveform height –

Time	Maximum	Minimum	Mean	SD
Pre	4 mm	2 mm	3.32	1.74
1 min	10 mm	3 mm	6.92	2.06
5 min	12 mm	4 mm	8.2	2.37
10min	13 mm	4 mm	9.48	2.35
15min	13 mm	4 mm	9.78	2.27
20min	14 mm	4 mm	10.02	2.16

Table Shows the height of preblock POP waveform shows in the monitor before intrathecal block is given. Height was measured in millimetres. Highest was 6mm and lowest was 1mm.It was taken at various time intervals.

TABLE 4 :Sensitivity and Specificity-

Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
100.00 % confidence interval (CI) 95% **91.51%** to **100.00%**	**37.50 %** confidence interval (CI) 95% **8.97%** to **75.30 %**	**89.36 %** confidence interval (CI) 95% **76.88 %** to **96.41 %**	**100.00 %** confidence interval (CI) 95% **30.48 %** to **100.00%**

shows sensitivity, specificity, positive predictive value, and negative predictive value of the plethysmographic waveform test were calculated as100% (95% CI:91.5–100.0%), 37.50 % (95% CI: 8.97–75.30%), 89.36 % (95% CI: 76.88-96.41%), and 100 % (95% CI: 30.48-1

CONCLUSION: The result suggested that plethysmographic amplitude changes just after spinal block has taken its effect .,This method may be easier to use without any additional technology of pulse oximeter. It as a supplemental diagnostic tool to predict successful subarachnoid block in the limited situation, where verbal communication with patient is difficult.

DISCUSSION

Spinal anestheisa is a simple reliable, safe and cost effective anesthesia technique for verities of surgery on lower abdomen and lower limb. After successful peripheral and neuraxial blockade, local vasodilation and increased local blood flow occur as a result of blockade of sympathetic nerve fibers. Early clinical signs of the onset of epidural or spinal anesthesia include venodilation and increased skin temperature caused by blockade of preganglionic sympathetic-8 fibers[1,2]. In the present study, we prospectively defined a two-fold increase from baseline in POP waveform amplitude as a test criterion of successful block. The reasons why we arbitrarily predetermined such a test criterion were as follows:

1) All the clinicians could easily detect such a large increase in the POPwaveform amplitude on the monitor screen without additionaltechnological supports.
2) Sinha et al. had evaluated the efficacy of POP waveform variation as an indicator of successful lumbar epidural block, and had showed an amplitudeincrease of more than 300% of the baseline after successfulblocks. And they had found that this change of POP waveformamplitude had a sensitivity of 100%[9].

We tested this hypothesis in the present study on 50 patients in which SAB is given. POP waveform height measured after SAB done periodically upto 20 min In the present study, we tested the usefulness POP waveform amplitude measured at 5th toe as indicators of successful SAB. We initially hypothesized that successful SAB resulted in a considerable increase in POP waveform amplitude of 5th toe.

In our study we recorded mean POP waveform Amplitude after SAB. The mean rise of POP waveform amplitude was 6.42,8.2, 9.48, 9.78, 10.02 at 1min, 5min, 10min, 15min, 20 min after SAB as compared to preblock value which is 3.32. Sensitivity, specificity, positive predictive value and negative predictive value of those for the plethysmographic waveform test were 97.67%, 28.57%, 89.36% and 66.67% .

A.D.Foster et al in year 1944 evaluate the effect on peripheral circulation during anesthesia by digital plethysmograph as a clinical guide. Plethysmographic records have been obtained simultaneously from the second toe in group of 28 patients subjected to spinal anesthesia. Plethysmogram obtained before onset of anesthesia, shows relatively small pulse waveform, within2 to 5 minutes after the introduction of anesthetic drug, pulse wave of toe increase from average value of 3.1cu.mm to 9.8cu.mm a threefold increase in pulse waveform.[14] Thomas .K.Beene et al in year 1973 use the pulse monitor for determination sympathetic block of arm by stellate ganglion block. when the block is successful pulse wave amplitude and area incorporated under the curve are increase.[13]

Dr Prabhat K. Sinha et al in year 1999 shows at 10 min after epidural injection, an amplitude increase of 200% was seen in 79 of 82 patients who underwent successful epidural anesthesia. In contrast, loss of cold sensation at this point was noted in only 14 of 82 patient.[9] SEYED J. HASHEMI et al in year 2001 was performed a study to evaluate the effect of digital nerve block on pulse oximetric signal detection during general anesthesia. Mean amplitude of plethismographic wave after digital block was greater in blocked fingers than unblocked fingers ($p<0.05$). Mean amplitude in blocked and unblocked fingers was 16.85±3.40 mm and 12.49±4.50 mm respectively. Maximum difference between blocked and unblocked fingers in lag time and amplitude occurred at 40 mins after digital block (36% and 34% respectively).[16]

Duk kyung Kim et al 2007, studied plethysmographic wave form planter aspect of great toe as diagnostic tools of successful caudal block . Findings of their study suggest plethysmographic wave form

test shown high validity in detecting successful block. Data on the sensitivity, specificity, positive predictive value and negative predictive value of those for the plethysmographic waveform test were 86.5%, 100%, 100% and 28.6%.[8]

Yehuda Ginosar et al in year 2009 tested the hypothesis that the development of sympathectomy-mediated vasodilatation sixty subjects receiving lumbar epidural bupivacaine were randomised to one of three groups: A: 10 ml 0.5% (50 mg); B: 10 ml 0.25% (25 mg); and C: 40 ml 0.0625% (25 mg). At baseline and 5, 10, and 20 min following epidural bupivacaine administration, they assessed the following indices of sympathectomy: The results was shows an increase in the pulse oximeter perfusion index by 20 min of 280%, 303%, and 59% in groups A, B, and, C, respectively. The findings of our study suggest that rise of POP waveform amplitude twofold from the baseline value occurred in first 1 minutes and was earlier to loss of pinprick sensation (mean time for sensory block 2.42 minutes) in all patients with surgically successful block. These findings proves that autonomic block revealed by local vasodilation and increased local blood flow occur as a result of blockade of sympathetic nerve fibers occurred earlier to sensory block revealed by insensitivity to pinprick and followed motor blockade revealed by inability to move limb. These finding establishes sequence of block as autonomic, sensory and motor blockade and hence Dixon's Law is proved. The plethysmographic waveform test had a considerablyhigh sensitivity of 97.67% and a positive predictive value of 89.36%. In addition to oxygen saturation values, many pulse oximeters display a photoelectric plethysmographic waveform, which reflects a combination of volume and flow changes in skin microcirculationz respect, the amplitude of the plethysmographic signal depends not only on systemic intravascular pulse pressure, but on local vasomotor tone[25][26].

Awad et al. suggested that POP waveform amplitude predominantly reflected local sympathetic tone rather than central hemodynamic changes, when the sensor was placed on the digits. Considering the small magnitude of sympathetic block in our study, the change of POP waveform amplitude was mainly attributed to the change of local sympathetic tone during SAB.[27] However, in 5 of 50 patients who had a successful block, all POP waveform amplitudes remained at near-baseline values throughout the study period. Failure to demonstrate 100% validity indicates some limitation of the plethysmographic waveform test as a reliable indicator of successful SAB.

REFERENCES

1. Meijer J, de Lange JJ, Ros HH. Skin pulse wave monitoring during lumbar epidural and spinal anesthesia. Anesthesia & Analgesia. 1988 Apr 1;67(4):356-9.
2. Mather LE, Cousins MJ. Local anaesthetics and their current clinical use. Drugs. 1979 Sep 1;18(3):185-205.
3. Bengtsson M, Nilsson GE, Löfström JB. The effect of spinal analgesia on skin blood flow, evaluated by laser Doppler flowmetry. Acta anaesthesiologica scandinavica. 1983 Jun 1;27(3):206-1
4. Bengtsson M, Löfström JB, MALMQVIST LA. Skin conductance responses during spinal analgesia. Acta anaesthesiologica scandinavica. 1985 Jan 1;29(1):67-71.
5. Alam TA, Seifalian AM, Baker D. A review of methods currently used for assessment of in vivo endothelial function. European journal of vascular and endovascular surgery. 2005 Mar 31;29(3):269-76.
6. Meijer J, de Lange JJ, Ros HH. Skin pulse wave monitoring during lumbar epidural and spinal anesthesia. Anesthesia & Analgesia. 1988 Apr 1;67(4):356-9.
7. Kawana S, Watanabe H, Namiki A, Kokita N. Epidural anesthesia affects pulse oximeter readings and response time. Journal of Anesthesia. 1994 Jun 1;8(2):159-62.
8. Kim DK, Lee KM, Kwon WK, Oh CS, Jang SW. Pulse oximetry and skin temperature gradient as diagnostic tools of successful caudal block. Korean Journal of Anesthesiology. 2007 Dec 1;53(6):S19-25.
9. Sinha PK, Dubey PK, Gaur A, Singh PK, Singh S. Plethysmographic pulse oximeter waveform variation as an indicator of successful epidural blockade: a prospective study. The Journal of the American Society of Anesthesiologists. 1999 Sep 1;91(3):899-.
10. JONG MIN KIM, ANTHONY D. LaSALLE, DDS, RAY T. PARMLEY, MDS Kansas City, Kansas. Sympathetic Recovery Following Lumbar Epidural and Spinal Analgesia. ANESTHESAIAND ANALGESIA. Current Researches **VOL.**5 6, No. 3, MAY-JUNE19, 77
11. Talke P, Snapir A, Huiku M. The effects of sympathectomy on finger photoplethysmography and temperature measurements in healthy subjects. Anesthesia & Analgesia. 2011 Jul 1;113(1):78-83.
12. Masayuki Arakawa, Yukio Aoyama, Yoko Ohe. Epidural bolus injection with alkalinized lidocaine improves blockade of the first sacral segment - a brief report, Second Department of Anesthesiology, Toho University School of Medicine, Tokyo, Japan. CAN J ANESTH 2002 / 49: 6 / pp 566–570
13. BEENE TK, EGGERS GW. Use of the pulse monitor for determining sympathetic block of the arm. The Journal of the American Society of Anesthesiologists. 1974 Apr 1;40(4):412-4.
14. Neumann C, Foster Jr AD, Rovenstine EA. The importance of compensating vasoconstriction in unanesthetized areas in the maintenance of blood pressure during spinal anesthesia. Journal of Clinical Investigation. 1945 May;24(3):345.
15. Ginosar Y, Weiniger CF, Kurz V, Babchenko A, Nitzan M, Davidson E. Sympathectomy-mediated vasodilatation: a randomized concentration ranging study of epidural bupivacaine. Canadian Journal of Anesthesia/Journal canadien d'anesthésie. 2009 Apr 1;56(3):213-21.
16. SEYED J. HASHEMI, HASSAN A. SOLTANI,KHOSROU NAGHIBI.EFFECT OF DIGITAL BLOCK ON PULSE OXIMETER SIGNAL DETECTION DURING GENERAL ANESTHESIA. Department of Anesthesiology and Critical Care, Isfahan University of Medical Science, Isfahan, Iran. Medical Journal of Islamic Academy of Sciences 14:1, 9–13, 2001
17. Squire JR. Instrument for measuring quantity of blood and its degree of oxygenation in web of the hand. Clin Sci. 1940;4:331-9.
18. Millikan GA. The oximeter, an instrument for measuring continuously the oxygen saturation of arterial blood in man. Review of scientific Instruments. 1942 Oct 1;13(10):434-44.
19. Severinghaus JW, Astrup PB. History of blood gas analysis. VI. Oximetry. Journal of clinical monitoring. 1986 Oct 1;2(4):270-88.
20. Aoyagi T. Pulse oximetry: its invention, theory, and future. Journal of anesthesia. 2003 Nov 1;17(4):259-66.
21. Severinghaus JW, Honda Y. History of blood gas analysis. VII. Pulse oximetry. Journal of clinical monitoring. 1987 Apr 1;3(2):135-8.
22. Maughan NM. Simulation of 810 nm Light Propagation Through the Human Finger for Non-Invasive Blood Analysis.
23. Jopling MW, Mannheimer PD, Bebout DE. Issues in the laboratory evaluation of pulse oximeter performance. Anesthesia and analgesia. 2002;94(1):S62-8.
24. Plethysmography Madhavan, Guruprasad *Biomedical Instrumentation & Technology;* Sep/Oct 2005; 39, 5; ProQuest Medical Library
25. Galaxy multipara monitor operating manual Larsen & Toubro Infotech Limited MEDICAL EQUIPMENT & SYSTEMS Mysore Campus KIADB Industrial Area, Hebbal Hootagalli, Mysore
26. Shelley KH, Awad AA, Stout RG, Silverman DG. The use of joint time frequency analysis to quantify the effect of ventilation on the pulse oximeter waveform. Journal of clinical monitoring and computing. 2006 A
27. Kato R, Sato J, Iuchi T, Higuchi Y. Quantitative determination of arterial wall mechanics with pulse oximetric finger plethysmography. Journal of anesthesia. 1999 Oct 1;13(4):197-204.pr 1;20(2):81-7.