Original Article

Pleth Variability Index Measured in the Sitting Position before Anesthesia Can Predict Spinal Anesthesia-Induced Hypotension in Cesarean Section: An Observational Study

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Abstract

Background: Hypotension induced by spinal anaesthesia during caesarean section can have devastating effects on the parturient and foetus. This study investigated the ability to predict spinal anaesthesia-induced hypotension via the perfusion index and pleth variability index in the sitting position caesarean section. **Materials and Methods:** We enrolled 46 patients undergoing elective caesarean section in this study and used standard anaesthetic management in all patients. The haemodynamic parameters, perfusion index and pleth variability index of the patients were recorded at specific time points. **Results:** Hypotension occurred in 61.4% of the patients. There was a difference in the pleth variability index values between patients with and without hypotension at baseline as well as in the sitting position and after spinal anaesthesia (P = 0.023, 0.001, and 0.040, respectively). According to the receiver operating characteristic curve analysis, the pleth variability index value of the patients in the sitting position was a predictor of spinal anaesthesia-induced hypotension (area under the curve = 0.780, 95% confidence interval [CI]: 0.633–0.927, P = 0.001). The cut-off value of the pleth variability index (in the sitting position) for predicting hypotension was 20.5% (sensitivity: 76.5%, specificity: 70.4%). Multivariate logistic regression analysis revealed that an increased pleth variability index in the sitting position before spinal anaesthesia was an independent risk factor of spinal anaesthesia-induced hypotension (odds ratio: 0.78, 95% CI: 0.62–0.98, P = 0.034). **Conclusion:** The pleth variability index in the sitting position before spinal anaesthesia is a useful tool for predicting spinal anaesthesia-induced hypotension during caesarean section.

Keywords: *Caesarean section, hypotension, perfusion index, pleth variability index, spinal anaesthesia*

Introduction

Spinal anaesthesia is the frequently preferred anaesthetic method for caesarean section.[1] Systemic vascular resistance decreases due to sympathetic blockage caused by spinal anaesthesia.[2] Blood congestion in the blocked areas contributes to the decrease in blood pressure.[3] Moreover, because of increased sensitivity to local anaesthetics and high intraabdominal pressure in pregnant women, the frequency of hypotension increases by up to 70%.[4] Spinal anaesthesia-induced hypotension is a serious problem owing to its several adverse effects, including nausea, vomiting, foetal distress and acidosis. In addition, the improper management of the hypotension may lead to serious maternal and foetal complications.[4-7]

The use of devices that measure blood pressure intermittently during caesarean section may lead to a delay in managing hypotension.[8] With the help of dynamic measurements, including heart rate variability, perfusion index (PI) and pleth variability index (PVI), spinal anaesthesia-induced hypotension during caesarean section can be detected early.[5,9-11]

PI is the ratio of pulsatile to non-pulsatile blood flow in peripheral tissues that is measured by pulse oximetry.[12,13] PI correlates with blood flow changes in the fingertip and reflects the vasomotor tone.[14] An increase in PI occurs as a result of sympathectomy and decreased vascular tone after spinal anaesthesia.[11]

PVI is based on PI and reflects the respiratory variations in pulse oximeter plethysmographic waveform

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amplitude.[9,15] It is used to measure the response to fluid therapy dynamically in mechanically ventilated patients.[16,17] Because a relationship exists between intravascular volume and the risk of developing hypotension, it was suggested that PVI can predict spinal anaesthesia-induced hypotension.[9]

As per the few studies on PI and PVI in the literature, the anaesthesia technique used in patients who underwent caesarean section was either spinal anaesthesia or combined spinal-epidural anaesthesia in the lateral decubitus position.[5,9-11,15] However, there is a paucity of data regarding the use of PI and PVI in caesarean sections in which spinal anaesthesia is performed in a sitting position. Therefore, this study investigated the ability of PI and PVI to predict spinal anaesthesia-induced hypotension during caesarean section.

Materials and Methods

Study design

The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) guidelines were followed for reporting this study. We included patients who were scheduled to undergo elective caesarean section and had given their written informed consent. Exclusion criteria included age of <18 or >40 years, pre-eclampsia, cardiovascular disorders, foetal abnormality and morbid obesity (body mass index >40 kg/m^2). Moreover, parturients who were not administered spinal anaesthesia or were switched to general anaesthesia during surgery were excluded from the study. Observational study was conducted in accordance with the Declaration of Helsinki, approved by the Local Ethics Committee (11/21/2019 – 25/1), and registered in the ClinicalTrails.gov Protocol Registration and Results System (NCT04195087).

Anaesthetic management

Patients were subjected to at least 8 h of fasting from solid food and 2 h of fasting from fluids. Twenty minutes before surgery, 15 ml/kg crystalloid infusion was started and continued until the end of the surgery. No patient received any premedication. The operating room temperature was maintained at 22°C. After the demographic data were recorded, the patients were placed on the operating table in the supine position with a 15° left lateral tilt. Electrocardiography, automated non-invasive blood pressure measurement and pulse oximetry were used for standard monitoring. The pulse oximeter probe (Masimo Radical 7® - Masimo Corp., Irvine, CA, USA) was attached to the left index finger, and the cuff of an automated non-invasive blood pressure device (Life scope®, DM-910P - Nihon Koden, Tokyo, Japan) was placed on the right arm. The study period spanned from the start of the anaesthesia until caesarean delivery. After 5 min of rest, baseline measurements, including heart rate, blood pressure, pulse oximetry, PI and PVI values, were recorded (T0). The same measurements were repeated at the following four time points: sitting position (before spinal anaesthesia) (T1), supine position (after spinal anaesthesia) (T2), the start of the surgery (T3) and delivery (T4) [Table 1].

After obtaining the basal measurements, the patients were placed in a sitting position for spinal anaesthesia. Then, 10 mg of 0.5% hyperbaric bupivacaine was administered to the patients via a 27-G pencil-point needle at the L3–4 or L4–5 interspace. After spinal anaesthesia, the patient was placed in a supine position with a left lateral tilt of 15°. The level of sensory block was assessed after the spinal injection using a cold swab. Parturients who did not achieve a T6 sensory block level after spinal anaesthesia were excluded from the study.

The Apgar scores of the new-borns at the first and fifth minutes after delivery were recorded. A 20% decrease in the systolic blood pressure (SBP) of the patients compared with their basal values or SBP <80 mm Hg was considered as hypotension;[10,15] 10 mg of ephedrine was administered when hypotension was observed. In addition, 0.5 mg atropine was administered to patients whose pulse rates decreased to <50 beats/min.

Statistical analyses

In a preliminary study involving 10 patients, 50% of the patients had a 20% increase in PVI values. Hypotension was observed in three of five patients in the high PVI group and one of five patients in the low PVI group. Based on this, a total sample size of 42 patients was required to obtain a 40% difference between groups, with a power of 80% and an alpha of 0.05. Considering possible dropouts, we decided to enrol 46 patients in the study.

The Shapiro–Wilk test for normality was used to analyse the distribution of variables. Group comparisons were performed using independent samples *t*-test and the Mann–Whitney *U* test for normally and non-normally distributed variables, respectively. All results were expressed as means and standard deviations or medians and interquartile ranges. The ability of PI and PVI to predict hypotension after spinal anaesthesia was evaluated using the receiver operating characteristic (ROC) curves. The effect of independent variables on hypotension was analysed using binary logistic regression analysis.

Statistical significance was accepted at $P < 0.05$. Data were analysed using IBM SPSS version 22.0 software (IBM SPSS version 22.0, IBM Corporation, Armonk, New York, United States).

Table 1: Time points of variable measurements

T0	Baseline
T1	In the sitting position before spinal anaesthesia
T2	In the supine position after spinal anaesthesia
T3	Start of the surgery
T4	Delivery

Results

Two of the 46 enrolled patients were excluded from the study; one patient had congestive heart failure and the other patient was switched to general anaesthesia owing to insufficient spinal block [Figure 1]. Of the 44 patients analysed, 27 (61.4%) developed hypotension after spinal anaesthesia. Demographic and surgical data between the patient groups with and without hypotension were comparable [Table 2]. Moreover, there was no difference between the groups in terms of PI [Table 3].

PVI values measured at T0, T1 and T2 time points were higher in the group with hypotension (P = 0.023, 0.001 and 0.040, respectively) [Table 3]. According to the ROC curve analysis, the PVI value of the patients in T1 was a predictor of spinal anaesthesia-induced hypotension (AUC = 0.780, 95% CI 0.633–0.927, P = 0.001) [Figure 2]. The optimal PVI threshold value in T1 was determined as 20.5 (sensitivity: 76.5%, specificity: 70.4%) [Table 4]. Multivariate logistic regression analysis showed that an increased PVI value in the sitting position before spinal anaesthesia is an independent risk factor of spinal anaesthesia-induced hypotension (odds ratio: 0.78, 95% CI: 0.62–0.98, P = 0.034) [Table 5].

Table 2: Demographic and obstetric characteristics of 46 parturients

Age (years)	29.2 (5.3)
Height (cm)	160.8 (6.2)
Weight (kg)	78.3 (12.8)
BMI (kg/m^2)	30.3 (4.4)
Gestational age (weeks)	38 (37-39)
Anaesthesia Time (min)	36.5 (10.3)
Surgery Time (min)	31 (10.1)
Apgar score 1 min	8 (7-9)
Apgar score 5 min	9 (8-10)

Parameters are expressed as mean (SD) or median (interquartile range), BMI: Body mass index

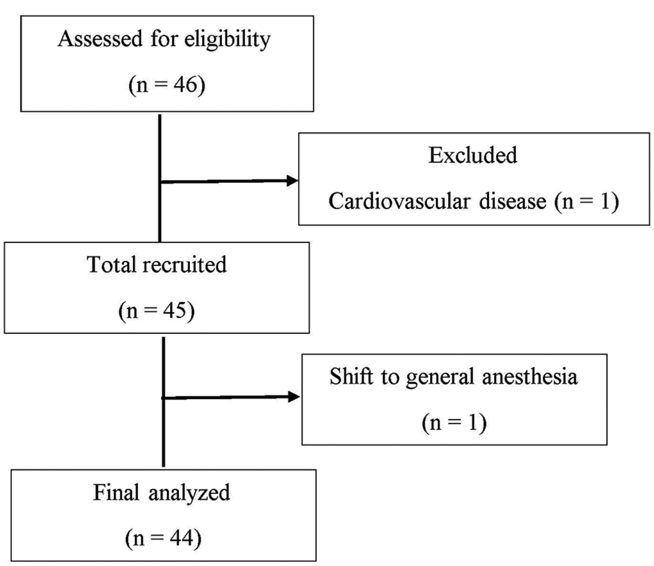

Figure 1: Consort flow diagram

Discussion

The main finding of the present study is that a higher pre-spinal PVI value is associated with spinal anaesthesia-induced hypotension. We found higher PVI values at baseline, pre- and post-spinal anaesthesia in the hypotension group. Based on the ROC curve analysis, the time point with the highest predictive value is when the patient is placed in a sitting position to administer spinal anaesthesia. In contrast to what is known, identifying this valuable information in the pre-spinal anaesthesia period can save time in patients at risk of hypotension by taking certain measures, including intravascular volume expansion or prophylactic vasopressor use.[18]

PVI is a well-known predictor of fluid responsiveness in mechanically ventilated patients.[19] The assessment of fluid responsiveness by PVI in spontaneously breathing patients is challenging owing to changes in frequency and tidal volumes with each breath of the patient.[20-22] However, a significant reduction in PVI has been demonstrated after passive leg raising, suggesting that this parameter is of value in the assessment of fluid responsiveness in spontaneously breathing patients. In addition, in the case of low blood volume and inadequate autonomic control because of pregnancy, the haemodynamics of these patients may be affected by positional changes.[23,24] Therefore, the PVI value that we measured when patients were placed in a sitting position for spinal anaesthesia may be significant.

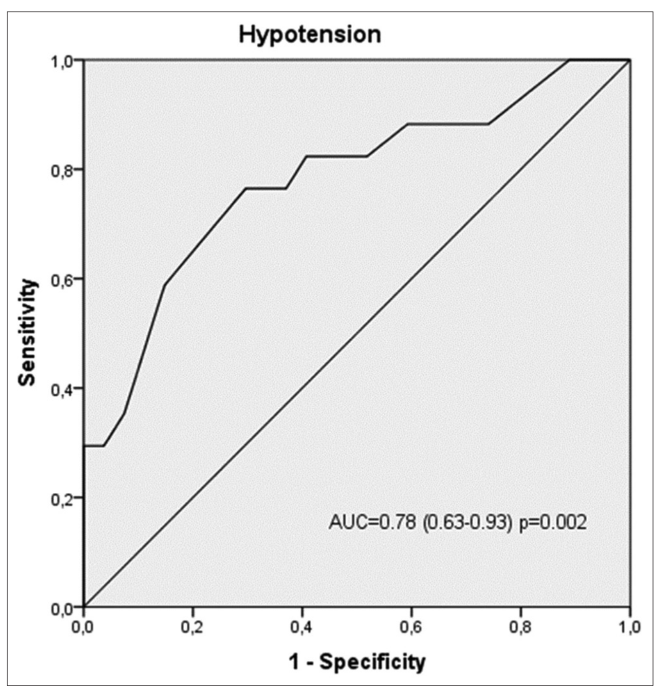

Figure 2: Receiver operating characteristic curve for pleth variability index in the sitting position to predict spinal anaesthesia-induced hypotension

Table 3: Haemodynamic data in parturients with and without spinal anaesthesia-induced hypotension

	Hypotension (*n*=27)	Non-hypotension (*n*=17)	*P*
Sensory block level	Th5 [Th4-Th6]	Th5 [Th4-Th6]	0.621
Systolic Blood Pressure (mmHg)			
T0	130.9 (16.5)	130 (16.9)	0.878
T1	143 (16.7)	142.5 (16.7)	0.928
T2	121.9 (20.3)	128.3 (16.9)	0.282
T3	97.8 (19.7)	124.2 (12.4)	0.001*
T4	82.9 (13.4)	120.2 (14.1)	0.345
Mean Blood Pressure (mm Hg)			
T0	98.7 (15.9)	96 (12.3)	0.559
T1	112.4 (14.2)	108.8 (13.8)	0.403
T2	88.4 (16.9)	98.9 (17.9)	0.056
T3	65.7 (20)	91.4 (12.4)	0.001*
T4	81.9 (17.9)	87 (11.2)	0.295
Diastolic Blood Pressure (mm Hg)			
T0	82.9 (13.4)	81.5 (10.2)	0.711
T1	92.4 (12.6)	88.5 (14.4)	0.344
T2	71.2 (15.9)	84.7 (16.2)	0.01*
T3	51.6 (20.2)	74.6 (10.7)	0.001*
T4	63.6 (16.5)	69.3 (10.2)	0.206
Heart Rate (bpm)			
T0	87.2 (11.8)	89.7 (14.3)	0.532
T1	96.7 (10.7)	101.1 (16.9)	0.289
T2	86.5 (13.1)	89.7 (20)	0.521
T3	88.2 (21.6)	94 (17.6)	0.359
T4	90 (15.4)	91 (15.7)	0.848
Pleth Variability Index (%)			
T0	21 (7.2)	16.6 (5.3)	0.023*
T1	22.2 (5.1)	17.1 (4.4)	0.001*
T2	24.5 (7.8)	20 (6)	0.040*
T3	19.8 (6)	17.1 (5.6)	0.144
T4	20.9 (5)	18.6 (5.7)	0.184
Perfusion Index			
T0	3.4 (1.6)	4.1 (2.7)	0.285
T1	2.9 (1.6)	3.3 (2.2)	0.546
T2	2.8 (1.3)	3.3 (2.2)	0.445
T3	3.4 (2.2)	4 (2.7)	0.447
T4	4.9 (3)	5.9 (3.5)	0.348

T0: Baseline, T1: In the sitting position before spinal anaesthesia, T2: In the supine position after spinal anaesthesia, T3: Start of the surgery, T4: Delivery, Data are presented as mean (SD) or median [interquartile range]. *Statistically significant

Table 4: Receiver operating characteristic analysis for PVI to predict spinal anaesthesia-induced hypotension

PVI	AUC	95% CI	Threshold	Sensitivity (%)	Specificity (%)
T0	0.687	0.525-0.850	18.5	64.7	70.4
T1	0.780	0.633-0.927	20.5	76.5	70.4
T2	0.654	0.484-0.823	20.5	64.7	51.9

T0: Baseline, T1: In the sitting position before spinal anaesthesia, T2: In the supine position after spinal anaesthesia, PVI: Pleth Variability Index, CI: Confidence interval

The role of PVI values in predicting spinal anaesthesia-induced hypotension in the caesarean section has been previously investigated and conflicting results have been observed. Kuwata *et al.*[9] found that the PVI value after spinal anaesthesia is a good predictor of spinal anaesthesia-induced hypotension in patients undergoing caesarean section (AUC = 0.793, threshold: 18%, sensitivity: 78.1%, specificity: 83.3%). Moreover, they found that the baseline PVI correlated with the degree of hypotension. Similarly, Sun *et al.*[15] reported

Table 5: Results of individual variable logistic regression analysis to predict the incidence of spinal anaesthesia-induced hypotension during elective caesarean section

Factor	Odds ratio	95% CI	*P*
Baseline PVI (%)	1.01	0.86-1.20	0.845
Sitting position PVI (%)	0.78	0.62-0.98	0.034*
Baseline HR (bpm)	0.98	0.93-1.04	0.473
Baseline SBP (mm Hg)	0.96	0.85-1.08	0.478
Baseline MBP (mm Hg)	1.11	0.90-1.38	0.326
Baseline DBP (mm Hg)	0.93	0.79-1.10	0.409
Age (years)	0.95	0.81-1.11	0.515
BMI (kg/m^2)	1.06	0.88-1.27	0.570

CI: Confidence interval, PVI: Pleth Variability Index, HR: Heart Rate, SBP: Systolic Blood Pressure, MAP: Mean Blood Pressure, DBP: Diastolic Blood Pressure, BMI: Body mass index

that the baseline PVI correlated with the incidence of spinal anaesthesia-induced hypotension ($P = 0.017$). However, the ROC curve analysis of Sun's study revealed that the baseline PVI is a poor predictor of spinal anaesthesia-induced hypotension (AUC = 0.66, threshold: 23.5%, sensitivity: 47.5%, specificity: 87.5%). Moreover, Arslan *et al*.[25] found that the post-spinal PVI value was different between the hypotension and non-hypotension groups. However, according to the ROC curve analysis of Arslan's study, the predictive value of post-spinal PVI was poor (AUC = 0.663, threshold: 18.5%, sensitivity: 63%, specificity: 58.5%). In contrast to our study, Yokose *et al*.[10] found no difference in baseline PVI values. The results of the present study are different from these studies. Methodological differences such as performing spinal anaesthesia in a sitting position or the definition of hypotension may be related to these results.

Sympathetic blockade after spinal anaesthesia contributes to the development of hypotension in pregnant women.[2] Ginosar *et al*.[26] demonstrated that an increase in PI is an early and sensitive indicator of sympathectomy. However, contradictory results have been obtained in studies on this subject so far.[5,9-11,15,25] Peripheral perfusion can be impaired in pregnant women in the supine position and without left uterine displacement caused by aortocaval compression. Therefore, this may affect the PI values.[5,11,27] In contrast to other studies in favour of PI, we recorded basal values after the patients were placed in the 15° left tilt position. These methodological differences may lead to different conclusions.

There are some limitations in the present study. First, we did not measure dynamic parameters (such as stroke volume or cardiac output) that would provide information regarding the patient's volume status. Moreover, real-time blood pressure measurement could be performed using an arterial line. However, the arterial and central venous cannulations required to make these measurements would be extremely invasive and inappropriate for elective caesarean section.

Second, a cold operating room may provoke peripheral venous vasoconstriction in patients. This may lead to inaccurate measurements in parameters measured by pulse oximetry. To avoid this, standard room temperature and heating pads are used in our hospital.

Third, medication cannot be used to relieve anxiety and stress in pregnant women who have elected to undergo caesarean section because of their adverse effects on the new-born. This may cause sympathetic activation and peripheral vasoconstriction, affecting the PI values. To avoid this, the data of the patients were obtained 5 min after lying on the operating table and calming speeches were made during the process.

Conclusion

We demonstrated that PVI value before spinal anaesthesia in the sitting position can be used to predict spinal anaesthesia-induced hypotension in healthy parturients undergoing caesarean section. Using pre-aesthetic PVI, necessary measures can be taken without delay. As a non-invasive and simple tool, PVI can be useful in routine anaesthesia management.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

References

1. Lee JE, George RB, Habib AS. Spinal-induced hypotension: Incidence, mechanisms, prophylaxis, and management: Summarizing 20 years of research. Best Pract Res Clin Anaesthesiol 2017;31:57-68.
2. Hanss R, Bein B, Ledowski T, Lehmkuhl M, Ohnesorge H, Scherkl W, *et al*. Heart rate variability predicts severe hypotension after spinal anesthesia for elective cesarean delivery. Anesthesiology 2005;102:1086-93.
3. Adsumelli RS, Steinberg ES, Schabel JE, Saunders TA, Poppers PJ. Sequential compression device with thigh-high sleeves supports mean arterial pressure during Caesarean section under spinal anaesthesia. Br J Anaesth 2003;91:695-8.
4. Klohr S, Roth R, Hofmann T, Rossaint R, Heesen M. Definitions of hypotension after spinal anaesthesia for caesarean section: Literature search and application to parturients. Acta Anaesthesiol Scand 2010;54:909-21.
5. Duggappa DR, Lokesh M, Dixit A, Paul R, Raghavendra Rao RS, Prabha P. Perfusion index as a predictor of hypotension following

spinal anaesthesia in lower segment caesarean section. Indian J Anaesth 2017;61:649-54.

6. Ngan Kee WD, Khaw KS. Vasopressors in obstetrics: What should we be using? Curr Opin Anaesthesiol 2006;19:238-43.
7. Sng BL, Wang H, Assam PN, Sia AT. Assessment of an updated double-vasopressor automated system using Nexfin for the maintenance of haemodynamic stability to improve peri-operative outcome during spinal anaesthesia for caesarean section. Anaesthesia 2015;70:691-8.
8. Ilies C, Kiskalt H, Siedenhans D, Meybohm P, Steinfath M, Bein B, *et al*. Detection of hypotension during Caesarean section with continuous non-invasive arterial pressure device or intermittent oscillometric arterial pressure measurement. Br J Anaesth 2012;109:413-9.
9. Kuwata S, Suehiro K, Juri T, Tsujimoto S, Mukai A, Tanaka K, *et al*. Pleth variability index can predict spinal anaesthesia-induced hypotension in patients undergoing caesarean delivery. Acta Anaesthesiol Scand 2018;62:75-84.
10. Yokose M, Mihara T, Sugawara Y, Goto T. The predictive ability of non-invasive haemodynamic parameters for hypotension during caesarean section: A prospective observational study. Anaesthesia 2015;70:555-62.
11. Toyama S, Kakumoto M, Morioka M, Matsuoka K, Omatsu H, Tagaito Y, *et al*. Perfusion index derived from a pulse oximeter can predict the incidence of hypotension during spinal anaesthesia for Caesarean delivery. Br J Anaesth 2013;111:235-41.
12. Goldman JM, Petterson MT, Kopotic RJ, Barker SJ. Masimo signal extraction pulse oximetry. J Clin Monit Comput 2000;16:475-83.
13. Hales JR, Stephens FR, Fawcett AA, Daniel K, Sheahan J, Westerman RA, *et al*. Observations on a new non-invasive monitor of skin blood flow. Clin Exp Pharmacol Physiol 1989;16:403-15.
14. Lima AP, Beelen P, Bakker J. Use of a peripheral perfusion index derived from the pulse oximetry signal as a noninvasive indicator of perfusion. Crit Care Med 2002;30:1210-3.
15. Sun S, Huang SQ. Role of pleth variability index for predicting hypotension after spinal anesthesia for cesarean section. Int J Obstet Anesth 2014;23:324-9.
16. Cannesson M, Desebbe O, Rosamel P, Delannoy B, Robin J, Bastien O, *et al*. Pleth variability index to monitor the respiratory variations in the pulse oximeter plethysmographic waveform amplitude and predict fluid responsiveness in the operating theatre. Br J Anaesth 2008;101:200-6.
17. Cannesson M, Delannoy B, Morand A, Rosamel P, Attof Y, Bastien O, *et al*. Does the Pleth variability index indicate the respiratory-induced variation in the plethysmogram and arterial pressure waveforms? Anesth Analg 2008;106:1189-94.
18. Kinsella SM, Carvalho B, Dyer RA, Fernando R, McDonnell N, Mercier FJ, *et al*. International consensus statement on the management of hypotension with vasopressors during caesarean section under spinal anaesthesia. Anaesthesia 2018;73:71-92.
19. Liu T, Xu C, Wang M, Niu Z, Qi D. Reliability of pleth variability index in predicting preload responsiveness of mechanically ventilated patients under various conditions: A systematic review and meta-analysis. BMC Anesthesiol 2019;19:67.
20. Broch O, Bein B, Gruenewald M, Hocker J, Schottler J, Meybohm P, *et al*. Accuracy of the pleth variability index to predict fluid responsiveness depends on the perfusion index. Acta Anaesthesiol Scand 2011;55:686-93.
21. Hoiseth LO, Hoff IE, Hagen OA, Landsverk SA, Kirkeboen KA. Dynamic variables and fluid responsiveness in patients for aortic stenosis surgery. Acta Anaesthesiol Scand 2014;58:826-34.
22. Loupec T, Nanadoumgar H, Frasca D, Petitpas F, Laksiri L, Baudouin D, *et al*. Pleth variability index predicts fluid responsiveness in critically ill patients. Crit Care Med 2011;39:294-9.
23. Keller G, Cassar E, Desebbe O, Lehot JJ, Cannesson M. Ability of pleth variability index to detect hemodynamic changes induced by passive leg raising in spontaneously breathing volunteers. Crit Care 2008;12:R37.
24. Zieleskiewicz L, Noel A, Duclos G, Haddam M, Delmas A, Bechis C, *et al*. Can point-of-care ultrasound predict spinal hypotension during caesarean section? A prospective observational study. Anaesthesia 2018;73:15-22.
25. Arslan M, Oksuz G, Bilal B, Yavuz C, Kandilcik M, Doganer A, *et al*. Can perfusion index or pleth variability index predict spinal anesthesia-induced hypotension during caesarean section. JARSS 2019;27:251-7.
26. Ginosar Y, Weiniger CF, Meroz Y, Kurz V, Bdolah-Abram T, Babchenko A, *et al*. Pulse oximeter perfusion index as an early indicator of sympathectomy after epidural anesthesia. Acta Anaesthesiol Scand 2009;53:1018-26.
27. Xu Z, Xu T, Zhao P, Ma R, Zhang M, Zheng J. Differential roles of the right and left toe perfusion ındex in predicting the ıncidence of postspinal hypotension during cesarean delivery. Anesth Analg 2017;125:1560-6.