Heart Rate Variability as A Predictor of Hypotension Following Spinal Anesthesia for Elective Caesarian Section in Preeclamptic Parturients: A Descriptive Observational Study

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Abstract

AIM: In this study we aimed to find out the heart rate variability measuring using electrical cardiometry is not reliable as a predictor for hypotension following spinal anesthesia in preeclamptic parturients undergoing elective cesarean section.

METHODS: Electrical Cardiometry system was used to measure Heart rate variability (HRV) at five different time points before fluid loading (T0, baseline), after fluid loading (T1), 5 min after spinal anaesthesia (T2), 15 min after spinal anaesthesia (T3) and 30 min after spinal anaesthesia (T4). Traditional HRV measurement was determined using time-domain analysis. This Observational descriptive cohort study was conducted in Kasr Al-Ainy Hospital, Faculty of Medicine, Cairo University from February 2018 till June 2019, after approval of the Ethical Committee and written patients consent.

RESULTS: The main finding of the current study is that heart rate variability measuring using electrical cardiometry is not reliable as a predictor for hypotension following spinal anaesthesia in preeclamptic parturients undergoing elective cesarean section.

CONCLUSION: Heart rate variability cannot be used as a predictor for hypotension following spinal anaesthesia in preeclamptic patients undergoing elective caesarean section using electrical cardiometry.

Introduction

Electrical Cardiometry system was used to measure Heart rate variability (HRV) at five different time points before fluid loading (T0, baseline), after fluid loading (T1), 5 min after spinal anaesthesia (T2), 15 min after spinal anaesthesia (T3) and 30 min after spinal anaesthesia (T4). Optimal autonomic evaluation conditions include a quiet environment, a temperature-controlled room, adequate skin preparation, resting in the supine position for almost 15min, fasting and refraining from smoking and consuming alcohol, caffeine or other excitatory drugs.

Traditional HRV measurement was determined using time-domain analysis specifically SDNN [SD of the normal-to-normal RRI] using electrical cardiometry ICON Cardiotronic Osypka Medical, Inc.

The placement of four skin sensors on the neck and left side of the thorax to allow for the continuous measurement. 2 electrodes on the neck (mastoid process and base of the neck), 2 electrodes on the left side of the thorax (at level xiphisternum junction and below it by 10 cm)

Fluid loading was performed with 5 ml/kg of a crystalloid solution over 10 min with Slow IV infusion of 50 mg Ranitidine, and 10 mg Metoclopramide and basal blood pressure measurement were taken before preload.
The spinal blockade was performed according to institutional standards of practice without premedication before the spinal blockade. The spinal blockade was performed after fluid loading. Injection of 12-13 mg of 0.5% hyperbaric bupivacaine was carried out through a 25 G Whitacre needle at level L3-L4. The patients were placed in a supine position immediately after the regional blockade, with a left lateral uterine tilt. The level of sensory blockade was tested with pinpricks at five-minute intervals, and the level of the motor blockade will be assessed by using a modified Bromage scale. We categorised the severity of hypotension into three groups such as mild (a decrease of mean arterial pressure 20% below the baseline), moderate (a decrease of mean arterial pressure 20-30% below the baseline) and severe (a decrease of mean arterial greater than 30% below the baseline). In cases of moderate and severe hypotension, 8 mg ephedrine IV bolus was administered and if hypotension persists increments of 5 mg ephedrine was used and 100 ml of crystalloid.

In this study we aimed to find out the heart rate variability measuring using electrical cardiometry is not reliable as a predictor for hypotension following spinal anesthesia in preeclamptic parturients undergoing elective cesarean section.

Methods

This Observational descriptive cohort study was conducted in Kasr Al-Ainy Hospital, Faculty of Medicine, Cairo University from February 2018 till June 2019, after approval of the Ethical Committee and written patients consent.

Inclusion criteria: Age: 18-40 years, ASA II Pregnant females with pre-eclampsia, pre-eclampsia was defined as hypertension (BP > 140/90) and proteinuria (urinary protein excretion of greater than 150 mg per day) undergoing elective cesarean section under spinal anaesthesia

Exclusion criteria: Refusal of the patient, Age below 18 years, ASA III-V patients, Patients with severe cardiac and/or pulmonary disease, Patients with severe renal impairment and severe hepatic impairment, Severe pre-eclampsia taking Beta Blockers, Diabetes mellitus, drugs that affect HRV, e.g. opioids, benzodiazepines and contraindication to spinal anaesthesia

Data collection: HRV; BP (SBP, DBP); SVR systemic vascular resistance; SV stroke volume.

Primary outcome: The sensitivity and the specificity of HRV as a predictor of hypotension following spinal anaesthesia

Secondary outcomes: Complications due to hypotension, e.g. dizziness, nausea, vomiting, dyspnea, chest pain, arrhythmia, loss of consciousness, blurring of vision.

History was taken from all patients. Baseline vital signs were recorded, including noninvasive measurement systolic arterial pressure, mean arterial blood pressure & diastolic arterial pressure and heart rate and oxygen saturation.

Sample size

41 female suffering from preeclampsia were included in a study scheduled for elective cs under spinal anaesthesia. Sample size calculations were performed with the following data: two-sided α of 5% and power of 80%, and area under the receiver operating characteristic (ROC) curve (AUC) value = 0.7. This generated an estimate of 41 patients Kweon T [4].

Statistical methods

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Science) version 22. Data were summarised using mean and standard deviation in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. For comparison of serial measurements within each patient, repeated-measures ANOVA with posthoc was used in normally distributed quantitative variables while non-parametric Friedman test and Wilcoxon signed-rank test were used for non-normally distributed quantitative variables (Chan, 2004). ROC curve was constructed with the area under curve analysis performed to detect the best cutoff value of HRV for detection of hypotension. P-values less than 0.05 were considered as statistically significant.

Results

Forty-one preeclamptic parturients were scheduled for the elective caesarian section under spinal anaesthesia.

Demographic data

Our study showed that mean age was 28.32 ± 5.30 kg, mean body mass index 31.19 ± 2.94 kg/m², mean gestational age 38.23 ± .67 wks, parity mean 1.97 ± 1.28, mean ephedrine dose 11.56 ± 11.69 mg, mean saline volume to treat hypotension 162.96 ± 169.04 ml, Table 1.
Heart rate variability (HRV) measured over time significant change in HRV over time were observed during the study (P < 0.001) HRV shows a significant increase in HRV at T2, T3 compared to HRV at T0 where mean HRV at T0 was 31.29 ± 23.42 ms and at T2 mean was 39.86 ± 22.51 ms (P < 0.003). At T3 mean was 41.74 ± 29.21 ms (P < 0.003) but at T4 mean was 35.19 ± 26.17 ms (P < 0.168) Figure 1.

Systolic blood pressure (SBP) measured over time significant change in SBP over time were observed during the study (P < 0.001) SBP showed a significant decrease at T2, T3, T4 compared to SBP at T0 where mean SBP at T0 was 159.42 ± 15.51 mmHg and at T2 mean was 119.45 ± 22.69 mmHg (P < 0.001). At T3 mean was 118.81 ± 19.79 mmHg (P < 0.001) at T4 mean was 119.45 ± 22.69 mmHg (P < 0.001), Table 2.

ROC curve for prediction of severe hypotension using baseline HRV shows no significant P value (0.361) Figure 3.

Diastolic blood pressure (DBP) measured over time significant change in DBP over time were observed during the study (P < 0.001) DBP shows a significant decrease in DBP at T2, T3, T4 compared to DBP at T0 where mean DBP at T0 was 92.81 ± 12.76 mmHg and at T2 mean was 61.74 ± 19.83 mmHg (P < 0.001). At T3 mean was 64.35 ± 13.23 mmHg (P < 0.001) at T4 mean was 58.29 ± 17.06 (P < 0.001), Table 3.
Mean blood pressure (MPB) measured over time significant change in MPB over time were observed during the study (P < 0.001)MPB shows a significant decrease in MPB at T2, T3, T4 compared to MPB at T0 where mean MPB at T0 was 115.01 ± 12.66 mmHg and at T2 mean was 79.92 ± 20.67 mmHg (P < 0.001). At T1 mean was 82.51 ± 14.44 mmHg (P < 0.001) at T4 mean was 78.68 ± 17.07 (P < 0.001) Table 4.

### Table 4: MPB measured over time

| Time  | Mean  | Standard Deviation | Minimum | Maximum | P-value in comparison with T1 |
|-------|-------|--------------------|---------|---------|-------------------------------|
| T0    | 115.01| 12.66              | 92.67   | 144.67  |                               |
| T1    | 112.19| 11.88              | 86.67   | 133.33  | < 0.001                       |
| T2    | 79.92 | 20.67              | 41.67   | 110.00  | < 0.001                       |
| T3    | 82.51 | 14.44              | 56.67   | 106.67  | < 0.001                       |
| T4    | 78.68 | 17.07              | 45.33   | 106.67  | < 0.001                       |

Overall P value < 0.001

Systemic vascular resistance (SVR) measured over time significant change in SVR over time was observed during the study (P < 0.01) SVR at T0 was 1028.13 ± 273.18 dynes sec cm⁻¹ and at T1 mean 975.94 ± 224.26 dynes sec cm⁻⁵ (P < 0.043) was at T2 mean was 1082.16 ± 318.31 dynes sec cm⁻⁵ (P < 0.643), At T3 mean was 1065.32 ± 296.01 dynes sec cm⁻⁵ (P < 0.318), At T4 mean was 936.74 ± 308.17 dynes sec cm⁻⁵ (P < 0.256) Table 5.

### Table 5: SVR measured over time

| Time  | Mean  | Standard Deviation | Median | Minimum | Maximum | P-value in comparison with T1 |
|-------|-------|--------------------|--------|---------|---------|-------------------------------|
| T1    | 1028.13| 273.18             | 992.00 | 610.00  | 1646.00 |                               |
| T2    | 975.94 | 224.26             | 900.00 | 584.00  | 1366.00 | 0.043                         |
| T3    | 1082.16| 318.31             | 1101.00| 630.00  | 2077.00 | 0.643                         |
| T4    | 1065.32| 296.01             | 1005.00| 603.00  | 1639.00 | 0.318                         |
| T5    | 936.74 | 308.17             | 893.00 | 420.00  | 1636.00 | 0.256                         |

P value 0.101

Stroke volume (SV) measured over time significant increase in SV over time (P < 0.006) SV at T0 (P < 0.006) was 100.71 ± 24.58 ml and at T1 (P < 0.006) mean was 108.29 ± 23.95 ml, At T2 (P = 1) mean was 105.26 ± 28.95 ml, At T2- (P = 1) mean was 105.19 ± 23.56 ml but at T4 (P < 0.047) mean was 110.48 ± 25.35 ml Table 6.

### Table 6: SV measured over time

| Time  | Mean  | Standard Deviation | Minimum | Maximum | P-value in comparison with T1 |
|-------|-------|--------------------|---------|---------|-------------------------------|
| T0    | 100.71| 24.58              | 68.00   | 170.00  |                               |
| T1    | 108.29| 23.95              | 72.00   | 167.00  | 0.006                         |
| T2    | 105.26| 28.95              | 69.00   | 163.00  | 1                              |
| T3    | 105.19| 23.56              | 69.00   | 160.00  | 1                              |
| T4    | 110.48| 25.35              | 78.00   | 174.00  | 0.047                         |

P value 0.006

**Discussion**

The main finding of the current study is that heart rate variability measuring using electrical cardiometry is not reliable as a predictor for hypotension following spinal anaesthesia in preeclamptic parturients undergoing elective cesarean section. The autonomic nervous system (ANS) plays an important role in the human response to various internal and external stimuli, which can modify homeostasis [1]. Heart rate variability (HRV) has been validated as a predictor of hypotension from several researchers. The study done by Chamchad et al. concluded that in pregnant women, HRV-derived variables could predict hypotension after spinal anaesthesia [2].

The results of our study go in line with the results of the study done by Toptaş M et al., [3] sixty patients were randomly allocated to 2 groups. Group I (n = 30) received 15 mg (3 mL) of hyperbaric bupivacaine and Group II (n = 30) received 15 mg (3 mL) of isobaric bupivacaine for spinal anaesthesia. Hemodynamic parameters were recorded before and after spinal anaesthesia over 30 min. Analyses of HRV were performed on the day of surgery, after volume loading, and 20 min after spinal injection. Low frequency (LF) values, high frequency (HF) values, and LF/HF ratios were recorded. The incidence of hypotension and alterations of HRV parameters in both groups were investigated. They observed that the analysis of HRV was inadequate for the prediction of hypotension due to spinal anaesthesia.

The results of our study are like the results of the study done by Kweon T et al., [4] 41 patients undergoing spinal anaesthesia were included. Heart rate variability was measured at five different time points. Baseline total power and low to the high-frequency ratio (LF/HF) in predicting hypotension after spinal anaesthesia were analysed by calculating the area under the receiver operating characteristic curves (AUC). They concluded that Heart rate variability is not a reliable predictor of hypotension after spinal block in hypertensive patients whose sympathetic activity is already depressed [4].

The results of our study are against the results of the study done by Ghabach MB et al., [5], Remart’inez J et al., [6] and Ursulet, L et al., [7]. The purpose of this study was to assess the effect of antenatal weight gain on baseline heart rate variability and incidence of hypotension in singleton parturients with a normal pre-pregnancy body mass index, presenting at term for elective caesarean section under spinal anaesthesia. Sixty-six parturients, of ASA physical status 1-2, were allocated to one of three groups according to their weight gain during pregnancy. They conclude that weight gain < 11 kg during pregnancy is associated with increased baseline heart rate variability and a higher incidence of hypotension at the time of elective caesarean section.
section under spinal anaesthesia.

The results of our study are different from the results of the study done by Hanss R et al., [8], [9] Chamchad D et al., [10], Kimura T et al., [11], Y. Fujiwara S et al., [12] and Fawzy G et al., [13] al. Retrospectively analysed HRV of patients scheduled to undergo elective cesarean delivery during SAB showed significant differences depending on the severity of hypotension after SAB. Preliminary findings were prospectively confirmed. High LF/HF before SAB predicted severe hypotension. Preoperative HRV analysis may detect patients at risk of hypotension after SAB. Sixty women (ASA I or II) with an uneventful pregnancy, at term, scheduled to undergo elective cesarean delivery during SAB, were studied. Three HRV analyses were performed, all of them before SAB: (1) on the day before surgery (DOS); (2) on the day of surgery (DOS), baseline before prehydration (DOS-BL); and (3) on the DOS after prehydration.

In conclusion, heart rate variability cannot be used as a predictor for hypotension following spinal anaesthesia in preeclamptic patients undergoing elective cesarean section using electrical cardiology.

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