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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/m^2, 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.

Table 1: Demographic data

	Mean	Standard Deviation	Minimum	Maximum
Age yrs	28.32	5.30	20.00	39.00
BMI kg/m^2	31.19	2.94	27.00	39.00
gestational age wks	38.23	.67	37.00	39.00
parity	1.97	1.28	.00	4.00
Ephedrine mg	11.56	11.69	.00	30.00
Saline ml	162.96	169.04	.00	400.00

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 T_2, T_3 compared to HRV at T_0 where mean HRV at T_0 was 31.29 ± 23.42 ms and at T_2 mean was 39.86 ± 22.51 ms (P < 0.003). At T_3 mean was 41.74 ± 29.21 ms (P < 0.003) but at T_4 mean was 35.19 ± 26.17 ms (P < 0.168) Figure 1.

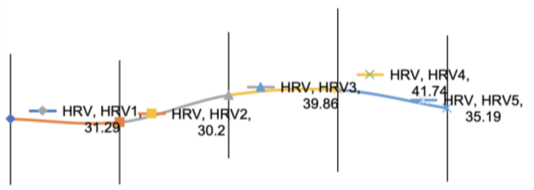

Figure 1: HRV measured over time

ROC curve for prediction of moderate hypotension using baseline HRV Shows no significant P value (0.317) Table 2.

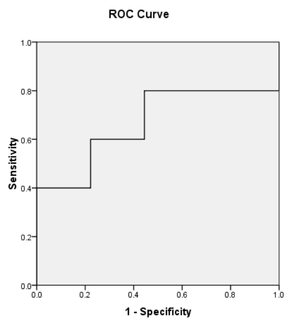

Figure 2: ROC curve for prediction of moderate hypotension using baseline HRV

ROC curve for prediction of severe hypotension using baseline HRV Shows no significant, P-value (0.766) Figure 2.

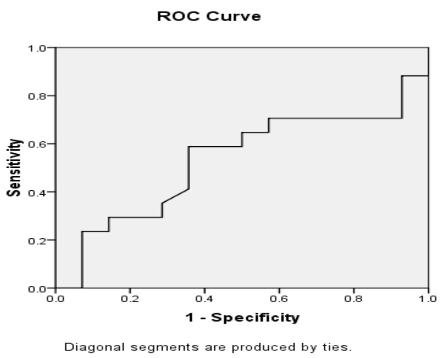

Figure 3: ROC curve for prediction of severe hypotension using baseline HRV

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

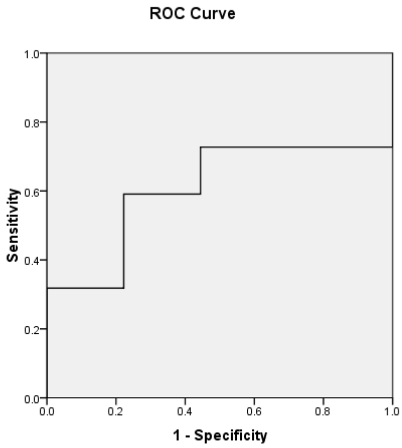

Figure 4: ROC curve for prediction of moderate or severe hypotension using baseline HRV

Systolic blood pressure (SPB) measured over time significant change in SPB over time were observed during the study (P < 0.001), SPB showed a significant decrease at T_2, T_3 , T_4 compared to SPB at T_0 where mean SPB at T_0 was 159.42 ± 15.51 mmHg and at T_2mean was 116.29 ± 25.46 mmHg (P < 0.001). At T_3 mean was 118.81 ± 19.79 mmHg (P < 0.001) at T_4 mean was 119.45 ± 22.69 mmHg (P < 0.001), Table 2.

Table 2: SPB measured over time

	Mean mmHg	Standard Deviation mmHg	Minimum mmHg	Maximum mmHg	P-value in comparison with T1
SBP1(T_0)	159.42	15.51	140.00	200.00	---
SBP2T_1	158.26	14.44	140.00	190.00	1
SBP3 T_3	116.29	25.46	74.00	150.00	< 0.001
SBP4 T_3	118.81	19.79	86.00	160.00	< 0.001
SBP5 T_4	119.45	22.69	80.00	155.00	< 0.001
Overall P value		< 0.001			

Diastolic blood pressure (DPB) measured over time significant change in DPB over time were observed during the study (P < 0.001)DPB shows a significant decrease in DPB at T_2, T_3, T_4 compared to DPB at T_0 where mean DPB at T_0 was 92.81 ± 12.76 mmHg and at T_2 mean was 61.74 ± 19.83 mmHg (P < 0.001). At T_3 mean was 64.35 ± 13.23 mmHg (P < 0.001) at T_4 mean was 58.29 ± 17.06 (P < 0.001), Table 3.

Table 3: DPB measured over time

	Mean mmHg	Standard Deviation mmHg	Minimum mmHg	Maximum mmHg	P-value in comparison with T1
DBP1 T_0	92.81	12.76	64.00	120.00	---
DBP2 T_1	89.16	13.83	60.00	110.00	0.138
DBP3 T_2	61.74	19.81	25.00	90.00	< 0.001
DBP4 T_3	64.35	13.23	38.00	84.00	< 0.001
DBP5 T_4	58.29	17.06	27.00	85.00	< 0.001
Overall P value		< 0.001			

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 T_2, T_3, T_4 compared to MPB at T_0 where mean MPB at T_0 was 115.01 ± 12.66 mmHg and at T_2mean was 79.92 ± 20.67 mmHg ($P < 0.001$). At T_3 mean was 82.51 ± 14.44 mmHg ($P < 0.001$) at T_4 mean was 78.68 ± 17.07 ($P < 0.001$) Table 4.

Table 4: MPB measured over time

	Mean mmHg	Standard Deviation mmHg	Minimum mmHg	Maximum mmHg	P-value in comparison with T1
MAP1T_0	115.01	12.66	92.67	144.67	---
MAP2T_1	112.19	11.88	86.67	133.33	0.304
MAP3T_2	79.92	20.67	41.67	110.00	< 0.001
MAP4T_3	82.51	14.44	56.67	106.67	< 0.001
MAP5T_4	78.68	17.07	45.33	106.67	< 0.001
Overall P value			< 0.001		

Systemic vascular resistance (SVR) measured over time no significant change in SVR over time was observed during the study ($P < 0.101$) SVR at T_0 was 1028.13 ± 273.18 dynes sec cm^{-5}and at t_1 mean 975.94 ± 224.26 dynes sec cm^{-5} ($p < 0.043$) was at T_2mean was 1082.16 ± 318.31 dynes sec cm^{-5} ($P < 0.643$), At T_3 mean was 1065.32 ± 296.01 dynes sec cm^{-5} *(P < 0. 318), at T_4 mean was 936.74±308.17 dynes sec cm^{-5} ($P < 0.256$) Table 5.

Table 5: SVR measured over time

	Mean	Standard Deviation	Median	Minimum	Maximum	P-value in comparison with T1
SVR1	1028.13	273.18	992.00	610.00	1646.00	---
SVR2	975.94	224.26	900.00	584.00	1366.00	0.043
SVR3	1082.16	318.31	1101.00	630.00	2077.00	0.643
SVR4	1065.32	296.01	1005.00	603.00	1639.00	0.318
SVR5	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 T_0 ($P < 0.006$) was 100.71. ± 24.58 mland at T_1 ($P < 0.006$) mean was 108.29 ± 23.95 ml, At T_2 ($P = 1$) mean was 105.26 ± 28.95 ml, At T_2-($P = 1$) mean was 105.19 ± 23.56 mlbut at T_4 ($P < 0.047$) mean was 110.48 ± 25.35 ml Table 6.

Table 6: SV measured over time

	Mean ml	Standard Deviation ml	Minimum ml	Maximum ml	P-value in comparison with T1
SV1 T_0	100.71	24.58	68.00	170.00	---
SV2 T_1	108.29	23.95	72.00	167.00	0.006
SV3 T_2	105.26	28.95	69.00	163.00	1
SV4 T_3	105.19	23.56	69.00	160.00	1
SV5 T_4	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 incidences 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´ınez 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 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 DBS; (2) on the day of surgery (DOS), baseline before pre hydration (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 cardiometry.

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