Brief Communication

Heart rate variability as a predictor of hypotension after spinal anaesthesia in patients with diabetes mellitus

INTRODUCTION

Hypotension is one of the most common side effects after spinal anaesthesia (SA), particularly in patients with diabetes mellitus (DM). The risk of spinal hypotension is increased due to the pre-existing autonomic dysfunction (AD) and can lead to significant morbidity and mortality.[1] Though there are various preoperative clinical tests to assess AD, none can effectively predict post-spinal hypotension.[2] The aim of this study was to assess whether preoperative measurement of heart rate variability (HRV) can predict hypotension after SA in patients with DM.

METHODS

This study was approved by Institute Ethics Committee (JIP/IEC/2015/22/788) and was conducted in accordance with the Declarations of Helsinki from April 2016 to March 2018. After obtaining written informed consent, 120 Type 2 diabetic patients scheduled to undergo elective surgeries under SA were included in this study. Patients with hypertension, cardiac disease, coagulopathy, pregnancy and anticipated blood loss of more than 1000 ml were excluded from the study. The attending anaesthesiologist did a thorough preoperative assessment. A day prior to the surgery, cardiac autonomic function test was performed in the physiology department using MP150, Biopac Systems, Inc. Frequency domain parameters like high frequency (HF), low frequency (LF) and LF/HF ratio along with time domain parameters like mean RR, standard deviation of RR intervals (SDNN), square root of the mean of the sum of the squares of differences between adjacent RR interval (RMSSD) were recorded.

On the day of surgery, after recording baseline parameters and preloading with 15 ml/kg of crystalloid solution, SA was performed using 3 ml 0.5% bupivacaine. The highest level of sensory block achieved, haemodynamic parameters at various time intervals were noted. A fall in mean arterial pressure (MAP) by more than 20% from the baseline was treated with fluid boluses and mephenteramine 6 mg IV.

Expecting 40% diabetes patients to have hypotension after SA and the standardised mean difference in LF/HF of 1.72 with a power of 80% and alpha error of 5%, a sample size of 108 was calculated. To compensate for any dropouts, 120 patients were selected. Data collected were analysed using SPSS statistical software. Binary univariate logistic regression was used to compare patients with hypotension and without hypotension and its significance. Receiver operating characteristic (ROC) curve analysis was used to clarify the validation of baseline HRV parameters as a predictor for hypotension. $P < 0.05$ was considered as statistically significant.

RESULTS

Frequency domain parameters like LF and HF and time domain parameters like RR Interval, SDNN and RMSSD were decreased whereas LF/HF ratio was high in the study population as compared to normal standard values.[3] The median peak sensory block level achieved was T6 (range: T4–T10). Among the 120 patients, 83 patients developed hypotension with an overall incidence of 69%. Patients were divided into two groups based on the fall in mean arterial pressure i.e., without hypotension (<20% fall in MAP) and with hypotension (>20% fall in MAP). It was found that there was significant difference in LF, SDNN and RMSSD between groups and they appeared to be potential markers for significant cardiac autonomic dysfunction. There was also a statistically significant difference in the duration of diabetes between the two groups. [Table 1] Level of the block (<T6 vs. ≥ T6) as a covariate was not found to be statistically significant ($P = 0.12$). Among the variables, SDNN and RMSSD were independently associated with hypotension revealed by binary multivariate logistic regression (Forward-Wald) analysis. Figure 1 shows the ROC

Table 1: Binary univariate logistic regression comparing patients with hypotension and without hypotension

Parameters	MAP Variability		*P*
	No Hypotension (*n*=37)	Hypotension (*n*=83)	
Mean RR interval (ms)	740.03±113.62	712.67±113.11	0.225
SDNN (ms)	18.16±7.07	15.25±5.28	0.045
RMSSD (ms)	11.25±4.64	8.75±2.02	0.032
LF (ms^2)	108.73±27.09	95.19±21.03	0.042
HF (ms^2)	70.59±13.53	60.23±9.82	0.316
LF/HF ratio	3.54±1.81	3.90±1.78	0.675
Duration of Diabetes (yrs)	3.21±1.52	4.62±1.37	0.019
Fasting Sugar (mg/dl)	103.36±8.46	107.08±12.61	0.203

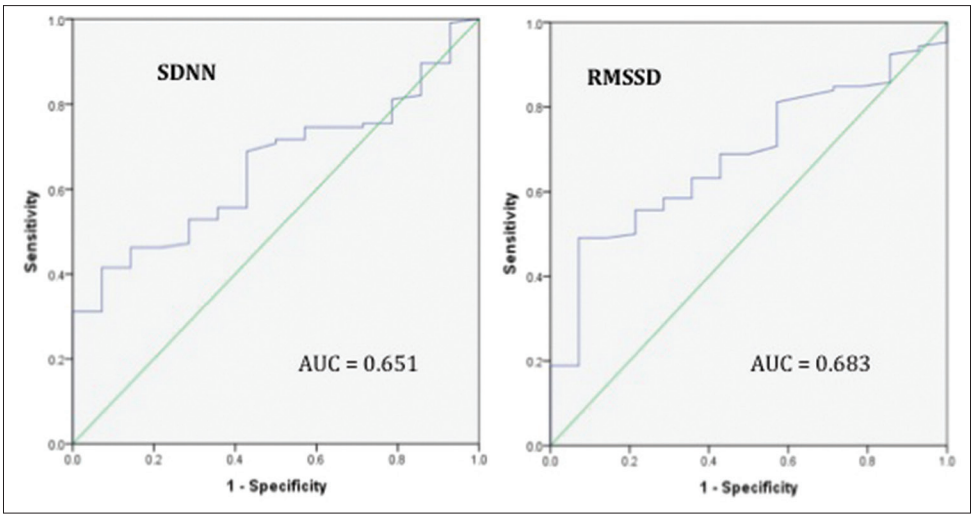

Figure 1: Receiver operating characteristic curve for SDNN and RMSSD. AUC – Area under the curve

curve analysis for SDNN and RMSSD. SDNN had an area under curve (AUC) of 0.651 (95% confidence interval: 0.531–0.771) and the best threshold of 14 had a sensitivity of 72% and specificity of 50%. Similarly, RMSSD had an AUC of 0.683 (95% confidence interval: 0.560–0.807) and threshold of 8 with a sensitivity of 63% and specificity of 64%.

DISCUSSION

This study demonstrated that heart rate variability parameters were significantly reduced in patients with diabetes mellitus and around 69% of patients developed hypotension following SA. Variables like SDNN and RMSSD were found to be independently associated with hypotension and can be a useful aid to predict hypotension after SA.

Diabetes patients with cardiac autonomic neuropathy exhibit both central and peripheral vascular dysfunction[4] and any further decrease in the systemic vascular resistance due to sympathetic block by SA could lead to severe hypotension. This hypotension is dependent on factors such as pre-operative autonomic balance, hydration, and spinal block level.[5] Several studies found HRV as an early and sensitive predictor for detection of autonomic dysfunction.[6]

In our study, heart rate variability parameters were decreased in all diabetic patients. There was an overall sympatho-vagal imbalance in the study group with a relatively higher sympathetic activity and lower parasympathetic activity as shown by a higher LF/HF ratio. All other parameters of both time and frequency domain were reduced as compared to normal patients.[3] This overall decrease in baseline HRV parameters makes them prone to various cardiovascular events in the perioperative period. This is in accordance with Lee *et al*. who studied the effect of SA on HRV parameters and found that patients with controlled diabetes had significantly decreased low frequency as compared to high frequency.[7]

Hans *et al*. demonstrated that patients with higher sympathetic tone were particularly susceptible to spinal hypotension and can be predicted by a high LF/HF ratio.[8] In contrary, our study showed strong evidence of differences in SDNN and RMSSD in patients who developed hypotension, which indicates a decreased parasympathetic tone in these patients. This could be because of the difference in the study population as diabetic patients were expected to have some pre-existing autonomic dysfunction, particularly parasympathetic attenuation. However, our study also showed that both SDNN and RMSSD had poor accuracy as a screening tool, with low sensitivity and specificity.

One of the limitations of our study was that we didn't measure HbA1c, which is considered as an indicator of long-term control of diabetes. Due to this, the effect of long-term control of diabetes on autonomic dysfunction could not be ascertained from this study.

CONCLUSION

Our findings suggest that patients with diabetes mellitus had lower heart rate variability and parameters like SDNN and RMSSD can be a useful aid, though it doesn't have sufficient accuracy to be used as a screening tool to predict hypotension after SA.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Stalin Vinayagam, Sukirti Baba Panta, Ashok Shankar Badhe, Vivek Kumar Sharma[1]

Department of Anaesthesiology and Critical Care, [1]Department of Physiology, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India

Address for correspondence:
Dr. Sukirti Baba Panta,
Department of Anaesthesiology and Critical Care, 2nd Floor, Institute Block, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry - 605 006, India.
E-mail: sbp2059@gmail.com

REFERENCES

1. Critchley LA. Hypotension, subarachnoid block and the elderly patient. Anaesthesia 1996;51:1139-43.
2. Raimondi F, Colombo R, Spazzolini A, Corona A, Castelli A, Rech R, *et al*. Preoperative autonomic nervous system analysis may stratify the risk of hypotension after spinal anaesthesia. Minerva Anestesiologica 2015;81:713-22.
3. Nunan D, Sandercock GR, Brodie DA. A quantitative systematic review of normal values for short-term heart rate variability in healthy adults. Pacing Clin Electrophysiol 2010;33:1407-17.
4. Maser RE, Lenhard MJ. Cardiovascular autonomic neuropathy due to diabetes mellitus: Clinical manifestations, consequences, and treatment. J Clin Endocrinol Metab 2005;90:5896-903.
5. Hanss R, Bein B, Weseloh H, Bauer M, Cavus E, Steinfath M, *et al*. Heart rate variability predicts severe hypotension after spinal anaesthesia. Anesthesiology 2006;104:537-45.
6. Burgos LG, Ebert TJ, Asiddao C, Turner LA, Pattison CZ, Wang-Cheng R, *et al*. Increased intraoperative cardiovascular morbidity in diabetics with autonomic neuropathy. Anesthesiology 1989;70:591-7.
7. Lee SH, Lee DH, Ha DH, Oh YJ. Dynamics of heart rate variability in patients with type 2 diabetes mellitus during spinal anaesthesia: Prospective observational study. BMC Anesthesiology 2015;15:141.
8. Hanss R, Bein B, Ledowski T, Lehmkuhl M, Ohnesorge H, Scherkl W, *et al*. Heart rate variability predicts severe hypotension after spinal anaesthesia for elective cesarean delivery. Anesthesiology 2005;102:1086-93.

Access this article online	
Quick response code	Website: www.ijaweb.org
	DOI: 10.4103/ija.IJA_13_19

How to cite this article: Vinayagam S, Panta SB, Badhe AS, Sharma VK. Heart rate variability as a predictor of hypotension after spinal anaesthesia in patients with diabetes mellitus. Indian J Anaesth 2019;63:671-3.