



Original Research Article



Comparison of heart rate variability in children of parents with diabetes mellitus with that of children of parents without diabetes mellitus

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Abstract

Cardiovascular autonomic neuropathy is a serious complication of diabetes, impacting the autonomic nerves that regulate the heart and blood vessels. Many studies have documented autonomic dysfunction in patients with diabetes mellitus but there are very few studies on cardiac autonomic activity in children of diabetic parents. This case-control study was designed to compare heart rate variability (HRV) in children of parents with diabetes mellitus with that of children of parents without diabetes mellitus. This study consisted of 50 normal children of parents without diabetes mellitus (control group) and 50 normal children having at least one parent with type 2 diabetes mellitus (study group) in the age group of 15 to 25 years belonging to both genders. Recording of ECG and its analysis was done with the help of polygraph (RMS Positive Dynamics). Both time and frequency domain indices of heart rate variability (HRV) were analyzed and statistical analysis was done using unpaired t test. The results showed that frequency domain indices of HRV i.e. low frequency (LF) and LF/HF ratio were significantly lower and high frequency (HF) was significantly higher in control group as compared to study group. On the other hand, the difference between time domain indices of HRV were not significant between the study group and control group. Thus, we conclude that children of diabetic parents have increased sympathetic and decreased parasympathetic activity as compared to children of non-diabetic parents.

Introduction

Background

Diabetes mellitus is a chronic metabolic disorder, characterized by persistent hyperglycemia, which results from either inadequate insulin production, insulin resistance, or both [1]. Autonomic dysfunction and neuropathy have become the most powerful predictors of risk for mortality in diabetes mellitus [2]. Many studies have documented autonomic dysfunction in patients

with diabetes mellitus [3,4,5]. But there are very few studies on cardiac sympathetic activity in children of parents with diabetes mellitus [6].

Heart rate variability (HRV) is a non-invasive tool for the assessment of cardiac autonomic control [7]. In a normal heart with an intact autonomic nervous system (ANS) there will be continuous physiological variations of sinus cycles reflecting a balanced sympathovagal state and a normal HRV [8]. Heart rate variability is generally assessed based on time-domain or frequency-domain

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analysis. Low frequency (LF) reflects the interaction of both sympathetic and parasympathetic nervous system whereas high frequency (HF) reflects solely the activity of the parasympathetic nervous system and LF/HF ratio is accepted as an indicator of sympathovagal balance [9]. Time domain indices of HRV analysis are derived from either direct RR interval measurements or the differences between successive RR intervals [9]. Parameters of time-domain analysis include: (i) mean RR – time interval between two successive heart beats, (ii) RMSSD - the square root of the mean squared differences of the successive NN intervals, (iii) NN50 - number of intervals greater than 50 ms, (iv) pNN50 - proportion of differences in consecutive NN interval, all reflecting parasympathetic activity [7].

Objectives

The objective of the present study was to compare HRV in children of parents with diabetes mellitus (study group) with that of children of parents without diabetes mellitus (control group).

Methods

Study design

This was a case-control study.

Study setting

The present study was conducted in the Department of Physiology, K J Somaiya Medical College, Mumbai, Maharashtra, India. Institutional ethical committee approval was taken before commencement of the research.

Participants

Participants were enrolled by convenience sampling. Subjects in the age group of 18 to 25 years including both males and females were enquired about the parental history of diabetes mellitus. Written informed consent was taken before the recruitment into the study. Present study recruited 50 normal children of parents without diabetes mellitus (control group) and 50 normal children with at least one parent with type 2 diabetes mellitus (study group). Subjects with history of smoking, cardiovascular, respiratory, diabetes mellitus, thyroid disorders or any other endocrine disorder or on long term medications for any other chronic disease were excluded from the study.

Variables

Frequency domain indices of HRV i.e. low frequency (LF), high frequency (HF) and LF/HF ratio were analyzed. Time domain indices of HRV i.e. mean RR (in ms), Root Mean Square of Successive Differences (RMSSD), Number of

Successive Interval Differences > 50 ms (NN50) and Percentage of Successive Interval Differences > 50 ms (pNN50) were analyzed [9].

Measurements

The subjects were asked to refrain from ingesting any beverages containing caffeine and alcohol for at least 12 hours prior to the study. They were asked to report between 10 A.M.-12 P.M. in the laboratory after an adequate night's sleep followed by light breakfast. After reporting the subjects were given 15 minutes of rest. ECG recording was done only after respiratory rate became regular and smooth at both times.

The recordings of ECG of all subjects were done by the same person in order to avoid any inter-observer error. Data was collected on a Polygraph (RMS Positive Dynamics, Chandigarh, India). We followed the recommendations set by the Task Force Guidelines established by European Society of Cardiology and the North American Society of Pacing and Electrophysiology [9]. Following visual examination of the ECG, only stable and artifact free recordings with normal sinus rhythm were included in the analysis. HRV analysis of ECG of the subjects was done by blinding of the data analyst until the entire analysis was completed.

Statistical analysis

The data was expressed in terms of mean and standard deviation and statistical difference was determined using unpaired t test. Statistical significance was tested at 5% and expressed in terms of 'p' value with $p < 0.05$ as statistically significant.

Results

The subjects included in the study group and control group were similar in terms of age and Body mass index (BMI).

Main results

Table 1: Comparison of frequency domain indices of HRV between study group and control group

Parameter	Study group	Control group	p value
LF (n.u.)	54.842±15.321	65.729±7.186	<0.0001
HF (n.u.)	45.158±15.320	34.271±7.187	<0.0001
LF/HF ratio	1.511±0.945	2.083±0.823	0.0037

Table 1 shows that High frequency (HF) power, Low frequency (LF) power in normalized units and LF/HF ratio were increased in children of diabetic parents as compared to control group and the difference was found to be statistically significant.

Table 2 shows that time domain indices of HRV viz mean RR, RMSSD, NN50 and pNN50 were almost

similar between both the groups and also the difference was statistically not significant.

Table 2: Comparison of time domain indices of HRV between study group and control group

Parameter	Study group	Study group	p value
Mean RR	0.749±0.123	0.773±0.086	0.295
RMSSD	47.201±21.72	43.95±15.53	0.43
NN50	39.258±22.037	37.358±15.177	0.645
pNN50(%)	23.9 ± 20.688	22.367±16.634	0.706

Discussion

The present study shows that, differences of frequency domain indices of HRV i.e. LF and LF/HF ratio were significantly reduced and HF was significantly increased in control group as compared to study group. But time domain parameters of HRV viz. mean RR, RMSSD, NN50 and pNN50 between study group and control group were statistically insignificant. Our results are indicative of decreased parasympathetic activity and increased sympathetic activity in study group as compared to control group. Our study is in concurrence with study done by De Angelis et al who showed that NIDDM (Non-insulin-dependent diabetes mellitus) family history is characterized in the basal condition by an imbalance of the autonomic system, which, compared with controls, is expressed by a higher weight of sympathetic and a lower weight of parasympathetic components [6].

This is also in accordance with study done by Pokhrel et al who found out that markers of sympathetic regulation were significantly higher and those of parasympathetic function were significantly reduced in subject group having parental history of type 2 diabetes mellitus. LF/HF ratio was significantly increased suggesting sympathovagal imbalance in offspring of diabetic parents even in their euglycemic state [10]. Whereas according to Foss et al and Bagudai et al, parental history of diabetes does not have any significant impact on the cardiovascular autonomic activity before the disease manifestation per se in the individuals themselves [11,12].

Thus, it can be inferred that there may be presence of subclinical impairments of HRV in children of parents with diabetes mellitus. The possible mechanism could be presence of concomitant impairment in endothelial and ANS functioning, which manifests, indirectly, with increase in vascular sympathetic outflow and a depressed baroreflex, vagal, control of heart rate [13]. Such a cohort of young individuals with altered sympathovagal balance can benefit from physical activity, breathing exercises and yoga [14,15].

Limitations

Given that this study was conducted on a limited sample size, further research on a larger group of individuals would be required to validate the findings.

Conclusion

Decreased LF and LF/HF ratio and increased HF in study group shows sympathovagal imbalance suggesting subclinical autonomic derangement in children of parents with type 2 diabetes mellitus. Early diagnosis of such condition can help healthcare workers to suggest necessary precautions and lifestyle interventions to subjects in order to prevent or delay further development of overt autonomic dysfunction.

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Authors' contributions

Both authors contributed equally to this work.

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None declared

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