

Original article:

Effect of haemoglobin concentration on cardiovascular system by heart rate variability modulations

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Abstract:

Introduction: Decreased Heart rate variability (HRV) is associated with increased cardiac risk in several conditions. Previous studies show decreased heart rate variability among subject with low haemoglobin concentration. However the underlying pathology of anaemia may be the direct cause of low HRV which may preclude from drawing the conclusion that anaemia per se cause decreased HRV.

Aims: - To study the relationship between HRV and haemoglobin concentration on cardiac autonomic modulation in HRV.

Settings and Design: The study includes 50 apparently healthy paramedical students of age 18 to 25. They were divided into two groups I (Hb>12gm %) and II (Hb<12gm %). It was a case control study.

Methods and Material: Haemoglobin estimation: Colorimetric method was used for estimation of Haemoglobin. HRV Analysis: RMS Polyrite D polygraph version 3.0.11 was used for HRV recording and analysis.

Statistical analysis used: Results were expressed as means \pm S.D. using an SPSS package version 10.0.

Results: The mean haemoglobin concentration of group I (mean \pm SD= 14.03 \pm 1.69) was significantly higher compared with mean haemoglobin of group II M \pm SD=10.28 \pm 1.12). There is no statistically significant relation found between haemoglobin concentration and HRV in mild to moderate anaemia. (For all HRV parameters P value > .05).

Key-words: Anaemia, Autonomic nervous system, Heart rate variability, Haemoglobin

Introduction

Anemia has major consequences on human health as well as on social and economic development; it is the world's second leading cause of disability and is responsible for about 1million deaths a year, of which three quarters occur in Africa and South East Asia. India is among the countries with high prevalence of anemia. It is widely prevalent in all age groups.^[1]

Heart rate variability (HRV) is the cardiac beat to beat variation mainly occurring due to variations in cardiac activities, which vary under autonomic

control. Decreased HRV has been recognized as a strong indicator of risk related to adverse events in healthy individuals as well as in diseased ones, reflecting the vital role of the autonomic nervous system in maintaining health.^[2-7]

HRV is analyzed under two domains: the time domain and the frequency domain. In the time domain method, mean heart rate (MHR), mean heart beat interval (MNN), the square root of variance of RR intervals (SDNN), and square root of the mean squared differences of successive RR intervals (RMSSD) are calculated. SDNN reflects all

cyclic components of the variability in recorded series of RR intervals. RMSSD is an estimate of high-frequency variations in short-term RR recordings and, therefore, reflects parasympathetic regulation of the heart.^[5]

Frequency domain parameters include total power (TP), very low frequency (VLF), low frequency (LF), high frequency (HF), normalized low frequency (LF Norm), normalized high frequency (HF Norm), and LF/HF ratio. HF reflects the parasympathetic outflow, TP reflects overall autonomic activity; however, the physiological explanation of the VLF component is less defined.^[8] The LF power is modulated by both sympathetic and parasympathetic outflows as well as by other factors, including baroreceptor activity.^[8, 9]

Anemia is an independent risk factor for adverse cardiovascular outcome in patients with kidney diseases and possibly in general population. Decreased Heart Rate Variability (HRV) is associated with increased mortality and morbidity in various types of heart disease including Myocardial Infarction, Cardiomyopathy, Congestive Heart Failure and Chronic Mitral Regurgitation.^[5,6]

Low hemoglobin concentration and Heart Rate Variability (HRV) relation has been searched in several types of anemia, thalassemia, vitamin B12 deficiency, Iron deficiency, Megaloblastic anemia and Sick cell trait. However the underlying pathology of anemia may be the direct cause of Heart Rate Variability (HRV) in majority of studies.^[7,8,9,10]

This study has been planned to establish if any direct relationship between Hemoglobin

concentration and Heart Rate Variability (HRV) exist.

Material and methods

The study involved 50 apparently healthy volunteers divided in to two groups I and II on the basis of their hemoglobin concentration. The volunteers were recruited from SAIMS Indore. The ages of both groups ranged between 18 to 25 years. (Table1)

Subjects with past medical history suggestive of smoking, diabetes mellitus, hypertension, heart diseases, or any illness that may affect heart rate were excluded from the study.

Colorimetric method was used for estimation of hemoglobin concentrations. RMS Polyrite D version 3.0.11 polygraph was used for studying HRV. Volunteers were advised to lie down (in supine position) and breathe comfortably while feeding the software with their data. Ensuring clean ECG signals and absence of movement artifacts, the ECG recording was initiated. Heart rhythm scanner automatically finishes the trial session once its time expires (5 min).

After recording the session, the ECG data was reviewed for abnormal ECG readings. Abnormal ECG readings were deleted and the software was allowed to calculate HRV parameters from the rest of the raw data.

Results were expressed as means \pm S.D. using an SPSS package version 10.0, the data from both group were compared with student's t-test for continuous variables and Chi-square test for dichotomous variable, and Mann-Whitney's U-test for variables without normal distribution. A two-tailed p value < 0.05 was considered significant.

Results

Physical characteristics of studied subjects are summarized in Table 1.

The mean hemoglobin concentration of Group I (mean (M) ± standard deviation (SD) = 14.03± 1.69) was significantly higher compared with the mean hemoglobin concentration of Group II(M ± SD = 10.28 ± 1.12) (P = 0.000).

In this study, there is decrease in HRV indices with decrease in hemoglobin concentration however there is no statistically significant relation found between hemoglobin concentration and heart rate variability, i.e. there is no change in cardiac autonomic modulation in mild to moderate anemia.(Table2)

Table 1: Characteristics of studied subjects

	Group I (N = 15)	Group II (N = 13)	P value
	Mean ± SD	Mean ± SD	
Age (years)	19.16 ± 1.55	19.47 ± 1.93	0.5350 (NS)
Body mass index (kg/m ²)	18.69 ± 1.88	18.78 ± 4.11	0.9163 (NS)
Systolic blood pressure (mmHg)	111.03 ± 12.2	110.3 ± 12	0.8372 (NS)
Diastolic blood pressure (mmHg)	70.32 ± 8.87	67.3 ± 9.4	0.2589 (NS)
<u>Hemoglobin concentration (g/dl)</u>	14.03 ± 1.69	10.28 ± 1.12	<0.001 (Highly significant)

Table 2 : Heart rate variability parameters in group-I and II.

	Group -I	Group -II	Significance (p value)
VLF	155.31± 143.59	155.9 ± 112.4	0.9879 (NS)
LF	133.48± 130.23	124.3± 101.2	0.7943 (NS)
HF	123.45± 166.62	89.8± 79.2	0.4147 (NS)
LF/HF	1.55± 0.93	1.7± 0.8	0.5625 (NS)
TP	413.32± 358.42	371.1± 246.3	0.6529 (NS)

Discussion

The main finding of this study is that there is a statistically insignificant change in HRV with change in hemoglobin concentration.

Previous studies have reported decreased HRV among subjects with anemia. [10-12] However, the underlying pathology of anemia may be the direct cause of low HRV. This fact may preclude from drawing the conclusion that anemia *per se* causes diminished HRV. For example, the results of Aytimir *et al* showed that all HRV parameters correlated positively with the level of vitamin B₁₂ and negatively with the duration of B₁₂ deficiency. [13]

Heart rate variability (HRV) analysis provides information about the influences of the autonomic nervous system and sympathovagal balance. Heart rate variability is a method that determines the effects of the autonomic nervous system on the heart and spontaneous changes in heart rate. A

decrease in heart rate variability reflects an autonomic dysfunction. Heart rate variability decreases after MI, as well as in diabetic neuropathy and heart failure. Currently, HRV is considered as a predictor of sudden cardiac arrest and arrhythmias [5, 6, 14, 16].

Anemia is the most common nutritional deficiency in developed and developing regions of the world. The physiologic response to anemia is a compensatory increase in cardiac output through increases in blood volume, preload, heart rate, and stroke volume, along with a decrease in afterload due to increased sympathetic activity, evidenced as palpitation and tachycardia, is frequent in patients with anemia.

Severe iron deficiency may ultimately cause cardiomyopathy and concomitant low HRV. [14, 15] Moreover, chronic renal failure is usually associated with diminished HRV for reasons other than anemia. [18, 19]

Anemia may be associated with low HRV because of a concomitant disease that is known to affect autonomic modulation such as diabetes mellitus,^[6] hypertension,^[7] and ischemic heart diseases.^[2,3,11] Almost all previous studies compared HRV parameters of normal subjects with those of patients with specific type of anemia without assessing the relation between hemoglobin concentrations and HRV indices. In this study we tried to find the same, however no statistically change in HRV with change in hemoglobin concentration was found in our study. The analysis of heart rate variability (HRV) is being

used as a reliable and reproducible technique for assessing autonomic activity in patients with cardiovascular disease. However, its use in patients with isolated anemia has not been investigated thoroughly.

Limitations:

The sample size of study is small to generalize our results. Severe anemia cases were not included in study.

Conclusion:

This study shows that there is statistically insignificant change in HRV in mild to moderate cases of Anemia.

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