Reliability of Time Domain HRV Analysis

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Abstract- *Heart rate variability (HRV) is a measure of variation in heart rate. Researchers test the test- retest reliability of recorded HRV variables based on time domain analysis at distinct recording durations i.e. (a) 5 minutes (three sets) and (b) 10 minutes (two sets). Objectives: Reliability of HRV variables determined by time domain analysis for 5 (five) minutes and 10 (ten) minutes. The study was conducted on 30 randomly selected sportsmen. Ages ranged from 30 to 35 years with homogeneous socio-economic status. Collected data was computed with Mean, SD and product moment correlations. Finding: the reliability coefficient of time domain HRV analysis for five minutes were extremely high (i.e. above 0.8) reliability between NN50 (set 1) and NN50 (set 2); NN50 (set 1) and NN50 (set 3); NN50 (2) and NN50 (3); pNN50 (1) and pNN50 (2); pNN50 (1) and pNN50 (3) ; pNN50 (2) and pNN50 (3); SDNN (1) and SDNN (2) ; SDNN(1) and SDNN (3) ; SDNN (2) and SDNN (3); SDSD (1) and SDSD (2); SDSD (1) and SDSD (3); SDSD (2) and SDSD (3); RMSSD (1) and RMSSD (2); RMSSD (1) and RMSSD (3) was .939; RMSSD (2) and RMSSD (3) and accepted reliability were observed between SDANN (1) and SDANN (2); SDANN (1) and SDANN (3); SDANN (2) and SDANN (3). Similarly, the reliability coefficient of time domain HRV analysis for ten minutes were extremely high (i.e. above 0.8), the reliability between NN50 (set 1) and NN50 (set 2); pNN50 (1) and pNN50 (2); SDNN (1) and SDNN (2); SDSD (1) and SDSD (2); RMSSD (1) and RMSSD (2); and accepted reliability were observed between SDANN (1) and SDANN (2). The Study concluded that reliability coefficient of time domain HRV analysis for five minutes and ten minutes are compatible to each other and extremely high.*

Key Words: HRV, ECG, Time Domain Analysis, NN50, SDNN

Introduction

Heart rate variability (HRV) [1] is a measure of variation in heart rate. This term has become widely accepted though in practice, one usually measures the variation in the beat-to-beat interval rather than the variation in the instantaneous heart rate. Heart rate variability is a noninvasive measure of autonomic input to heart rate that has been successfully used to estimate modulation of autonomic tone. The last two decades have witnessed the recognition of a significant relationship between the autonomic nervous system and cardiovascular mortality, including sudden cardiac death [2–5].

Experimental evidence for an association between a propensity for lethal arrhythmias and signs of either increased sympathetic or reduced vagal activity has encouraged the development of quantitative markers of autonomic activity for eg. HRV.

During the 1970s, Ewing et al.[6] devised a number of simple bedside tests of short-term RR differences to detect autonomic neuropathy in diabetic patients. The association of higher risk of post-infarction mortality with reduced HRV was first shown by Wolf et al. in 1977 [7]. In 1981, Akselrod et al. introduced power spectral analysis of heart rate fluctuations to quantitatively evaluate beat-to-beat cardiovascular control [9]. These frequency–domain analyses contributed to the understanding of the autonomic background of RR interval fluctuations in the heart rate record [8, 10]. In the past studies [11-20] has shown that

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there is a positive relation of physical/exercise fitness and autonomic nervous system. Chronic exercise training has been shown to have a positive influence on cardiac autonomic function as assessed by measures of heart rate variability (HRV). Recent evidence indicates that several benefits associated with exercise training (e.g., improved insulin action, reduced blood pressure, improved blood lipid profile) may be realized transiently after a single bout of exercise. HRV has become the conventionally accepted term to describe variations of instaneous heart rate and RR intervals.

The most widely used methods used to measure heart rate variability can be grouped under standard of ethics. Each publication has a set of rules, sometimes written, sometimes unwritten, that governs what that publication considers to be a truthful and faithful representation of images to

A. Time-domain analysis
B. Frequency-domain analysis
C. Other methods also have been proposed, such as non-linear methods.

These are based on the beat-to-beat or NN intervals, which are analyzed to give variables such as: Reliability of recording durations has been questioned in the past. According to European Task force it should be used whenever possible a) short-term recordings of 5 minutes made under physiologically stable conditions processed by frequency–domain methods, and/or (b) nominal 24-h recordings processed by time–domain methods.

One means of estimating the reliability or consistency of a test is to administer it on two different occasions to the same group (test, then retest) and then determine the correlation between the sets of scores. This correlation is called the coefficient of stability. The time interval between the two administrations of the test should be relatively short; that is, long enough that individuals are not likely to repeat error performance, but now so long that they may either forget or learn during the interval. In all the cases, the conditions for the test administration should be precisely the same both times the test is administered. It is particularly tempting for physical educators to administer physical performance tests on the same day in order to determine test- retest reliability. Baumgartner (1969) [22], however, has shown that same day test- retest coefficients consistently overestimate the reliability of a test. Consequently, test- retest administrations should be made on different days.

Researcher found a huge research gap in this regard. So, researcher was motivated to test the test- retest reliability recorded HRV variables based on time domain analysis distinct recording duration i.e. a) 5 minutes (three sets) and b) 10 minutes (two sets).

I. Objectives

Objectives of the study were a) Reliability of HRV variables determined by time domain analysis for 5 (five) minutes and b) Reliability of HRV variables determined by time domain analysis for ten (ten) minutes.

II. Hypothesis Of The Study

It was hypothesized that a) there will be average to high reliability coefficient between/among the recordings of HRV variables through time domain analysis for five minutes b) there will be average to high reliability coefficient between/among the recordings of HRV variables through time domain analysis for ten minutes.

III. Sample For The Study

The study was conducted on 30 males. Ages of the sample ranged from 30 to 35 years of same socio-economic status from judo, hockey, wrestling, basketball, athletics, cricket, swimming etc.

IV. Methodology

Subjects were asked to come with two hours fasting before the test. No medication was taken before 48 hours of the testing. Subjects were make to rest for 30 minutes before the commencement of the test and then heart rate variability (HRV) was performed, which quantifies autonomic drive to the myocardium. The ECG analog were filtered and quantified using the software namely 1) AUTONOMIC FUNCTION TEST HRV_Soft version 1.1, 2) HRV Software, Biomedical Signal Analysis Group, Department of Applied Physics, University of Kupio, Finland. Time domain analysis of the data was done. Both sympathetic and parasympathetic drives to myocardium were assessed by NN50, pNN50, SDNN, SDANN, RMSSD and SDSD. This was achieved by simultaneous measurement of ECG on a digital polygraph (Medicaid Company, Chandigarh, India)

V. Statistics

Collected data was computed with Mean, SD and product moment correlations. The level of significance was 0.01 level. The findings have been presented with table numbers 1, 2, 3 and 4.

I. Findings

Table: 1 Descriptive Statistics of Time Domain HRV Analysis for 5 minutes

Variables (Repeated Measures)	**Mean**	**SD**
NN50 Count (Set 1)	61.07	53.18
PNN50 Count (Set 1)	22.5	20.03
SDNN (Set 1)	51.20	23.53
SDSD (Set 1)	45.72	26.37
RMSSD (Set 1)	45.63	26.25
SDANN (Set 1)	19.53	12.52
NN50 Count (Set 2)	66.50	54.04
PNN50 Count (Set 2)	24.04	19.67
SDNN (Set 2)	55.09	26.05
SDSD (Set 2)	48.89	26.77
RMSSD (Set 2)	48.81	26.72
SDANN (Set 2)	20.81	13.42
NN50 Count (Set 3)	67.30	55.27
PNN50 Count (Set 3)	23.33	19.40
SDNN (Set 3)	57.61	33.37
SDSD (Set 3)	47.65	27.14
RMSSD (Set 3)	47.57	27.09
SDANN (Set 3)	25.10	17.86

Note: Set 1, 2 and 3 are three sets of 5 minutes continuous recording

Table: 2 Descriptive Statistics of Time Domain HRV Analysis for 10 minutes

Variables (Repeated Measures)	**Mean**	**Sd Deviation**
NN50 Count (Set 1)	105.47	80.29
PNN50 Count (Set 1)	23.46	19.97
SDNN (Set 1)	53.76	23.28
SDSD (Set 1)	47.74	26.80
RMSSD (Set 1)	47.69	26.76
SDANN (Set 1)	18.18	8.73
NN50 Count (Set 2)	104.23	74.64
PNN50 Count (Set 2)	23.46	19.19
SDNN (Set 2)	244.8	104.23
SDSD (Set 2)	45.69	26.46
RMSSD (Set 2)	47.94	25.94
SDANN (Set 2)	21.35	13.12

Note: Set 1 and 2 are two sets of 10 minutes continuous recording

Table: 3 Reliability Coefficient of Time Domain HRV Analysis for 5 minutes

S.No.	**Variables (Repeated measures)**	**Coefficient of Reliability**
1	NN50 (1) vs NN50(2)	.968**
2	NN50 (1) vs NN50 3)	.942**
3	NN50 (2) vs NN50(3)	.962**
4	pNN50 (1) vs pNN50(2)	.959**
5	pNN50 (1) vs pNN50(3)	.957**
6	pNN50 (2) vs pNN50(3)	.974**
7	SDNN (1) vs SDNN (2)	.897**
8	SDNN (1) vs SDNN (3)	.868**
9	SDNN (2) vs SDNN (3)	.928**
10	SDSD (1) vs SDSD (2)	.955**
11	SDSD (1) vs SDSD (3)	.939**
12	SDSD (2) vs SDSD (3)	.965**
13	RMSSD (1) vs RMSSD (2)	.955**
14	RMSSD (1) vs RMSSD (3)	.939**
15	RMSSD (2) vs RMSSD (3)	.965**
16	SDANN (1) vs SDANN (2)	.577**
17	SDANN (1) vs SDANN (3)	.518**
18	SDANN (2) vs SDANN (3)	.513**

*Correlation is significant at 0.01 level

Note: (1), (2) and (3) are three sets of 5 minutes continuous recording.

Table: 4 Reliability Coefficient of Time Domain HRV Analysis for 10 minutes

S.No.	Variables (Repeated measures)	Coefficient of Reliability
1	NN50 (1) vs NN50(2)	976**
2	pNN50(1) vspNN50(2)	.988**
3	SDNN (1) vs SDNN(2)	.917**
4	SDSD (1) vs SDSD (2)	.987**
5	RMMSD(1)vsRMMSD(2)	.980**
6	SDANN (1) vs SDANN(2)	.443

*Correlation is significant at 0.01 level

Note: (1) and (2) are two sets of 10 minutes continuous recording

The finding revels that the reliability coefficient of time domain HRV analysis for five minutes, there were extremely high (i.e. above 0.8) reliability between NN50 (1) and NN50 (2) (.968); NN50 (1) and NN50 (3) (.942); NN50 (2) and NN50 (3) (.962); pNN50 (1) and pNN50 (2) (.959); pNN50 (1) and pNN50 (3) (.957); pNN50 (2) and pNN50 (3) (.974); SDNN (1) and SDNN (2) (.897); SDNN(1) and SDNN (3) (868); SDNN (2) and SDNN (3) (.928); SDSD (1) and SDSD (2) (.955); SDSD (1) and SDSD (3) (.939); SDSD (2) and SDSD (3) (.965); RMSSD (1) and RMSSD (2) (.955); RMSSD (1) and RMSSD (3) (.939); RMSSD (2) and RMSSD (3) (.965) and accepted reliability were observed between SDANN (1) and SDANN (2) (.577); SDANN (1) and SDANN (3) (.518); SDANN (2) and SDANN (3) (.513). Similarly, the reliability coefficient of time domain HRV analysis for ten minutes, there were extremely high (i.e. above 0.8) reliability between NN50 (1) and NN50 (2) (.976); pNN50 (1) and pNN50 (2) (.988); SDNN (1) and SDNN (2) (.917); SDSD (1) and SDSD (2) (.987); RMSSD (1) and RMSSD (2) (.980); and accepted reliability were observed between SDANN (1) and SDANN (2) (.443).

Conclusion

Reliability coefficient of time domain HRV analysis for five minutes and ten minutes are compatible to each other.

Recommendation

The SDANN variable of HRV time domain analysis is less reliable irrespective of duration recordings, hence avoidable for short duration recordings.

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