HEART RATE VARIABILITY IN HEALTHY POPULATION

Muhammad Alamgir Khan, M Mazhar Hussain, Shoaib Bin Aleem
Department of Physiology, Army Medical College, Rawalpindi, Pakistan

Background: Heart rate variability has been considered as an indicator of autonomic status. Little work has been done on heart rate variability in normal healthy volunteers. We aimed at evolving the reference values of heart rate variability in our healthy population. **Methods:** Twenty-four hour holter monitoring of 37 healthy individuals was done using Holter ECG recorder 'Life card CF' from 'Reynolds Medical'. Heart rate variability in both time and frequency domains was analysed with 'Reynolds Medical Pathfinder Digital/700'. **Results:** The heart rate variability in normal healthy volunteers of our population was found in time domain using standard deviation of R-R intervals (SDNN), standard deviation of average NN intervals (SDANN), and Square root of the mean squared differences of successive NN intervals (RMSSD). Variation in heart rate variability indices was observed between local and foreign volunteers and RMSSD was found significantly increased ($p<0.05$) in local population. **Conclusions:** The values of heart rate variability (RMSSD) in healthy Pakistani volunteers were found increased compared to the foreign data reflecting parasympathetic dominance in our population.

Keywords: Autonomic nervous system, heart rate variability, time domain analysis, holter monitoring

INTRODUCTION

Heart rate variability (HRV) refers to the complex beat-to-beat variation in heart rate produced by the interplay of sympathetic and parasympathetic neural activity at the sinus node of the heart.[1] Variations in sinus node impulse formation are depicted by heart rate variability derived from RR intervals. This rhythmic phenomenon, known as respiratory sinus arrhythmia (RSA), fluctuates with the phases of respiration, cardio-acceleration during inspiration, and cardio-deceleration during expiration.[2] Atrioventricular nodal conduction also adds to the RR variability but it seems to be negligible under clinical conditions. Use of this technique in defining physiological response of patients with diverse diseases, has been studied extensively. Especially spectral analysis techniques can distinguish among the intrinsic sources of HRV, as these rhythms occur at different frequencies.[3]

Ethnic differences in correlations between age and HRV indices in African Americans and Caucasians had also been documented where young African Americans manifested a pattern of response that was similar to older Caucasian Americans exhibiting signs of premature aging in their autonomic nervous system.[4] Racial differences with blacks having a lower sympathetic drive than age-matched whites was also documented.[5] Another study depicted the racial differences in autonomic tone as measured by indices of heart rate variability.[6] Heart rate variability had been explored exclusively in Asian populations in Japanese children but had not been compared with other races.[7]

Racial differences had been observed in different studies among different populations based on the variations in their autonomy. There is only limited data in young children[8] and none had compared adult Asians and Caucasians.

We planned a study to evaluate the heart rate variability in normal healthy population of our country (Pakistan) to look for the effects of variations in autonomic nervous system and compared the heart rate variability values of our population with foreign population. The time domain parameters of heart rate variability were studied.

MATERIAL AND METHODS

The study was carried out in Physiology Department, Army Medical College, Rawalpindi in collaboration with Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD), Rawalpindi.

Thirty-seven (23 male and 14 female) electrocardiographically healthy individuals were included in the study. Subjects were between 21 and 70 years of age with a mean age of 35±14 years. A detailed medical history was obtained from each participant. Subjects with diabetes mellitus, cardiovascular, neurological or psychiatric diseases were excluded. Smoking behaviour, age, height and weight were registered.

The study was carried out after getting formal approval from Medical Ethics Committee at Army Medical College Rawalpindi. Formal consent was obtained from all the individuals on a written form before conducting the study. It was a non-interventional descriptive study by convenience non-probability sampling of the individuals.

Twelve lead standard electrocardiography (ECG) was performed on all subjects. Roughly 10 cardiac cycles were recorded to evaluate the rhythm

of the heart. Any problem like old myocardial infarction, ischemic heart disease, bundle branch blocks, arrhythmias etc. led to exclusion of the individuals from the study.

We used holter ECG recorder 'life card CF' from 'Reynolds Medical' to record ambulatory ECG for 24 hours. The holter ECG data was utilised for analysis of heart rate variability. The commercially available HRV analysis software 'Reynolds Medical Pathfinder Digital/700' was used for analysis of th heart rate variability. This software is fully compatible with 'life card CF' holter recorders that we used to record ambulatory ECG. The whole data was edited manually with care using visual checks and manual corrections of individual RR intervals and QRS complex classifications. All erroneous complexes were edited from the data.

The beat to beat temporal variation during normal sinus rhythm was expressed as heart rate variability (HRV). Variations in impulse formation are depicted by heart rate variability derived from RR or NN (node to node) intervals on ECG. HRV was analysed in time domain according to the recommendations of Task Force of the European Society of Cardiology (ESC) and the North American Society of Pacing and Electrophysiology (NASPE).[9] We considered time domain parameters; SDNN (standard deviation of RR intervals), SDANN (standard deviation of average NN intervals) and RMSSD (Square root of the mean squared differences of successive NN intervals. The basis of heart rate variability lies on the fact that fluctuations in heart rate reflect variations of sympatho-vagal activity.

Data was analysed by using computer software SPSS-11. Variables were expressed as Mean±SD. Z-test was used for comparing variables between local and foreign healthy volunteers. Value of $p<0.05$ was considered significant.

RESULTS

A total of 40 apparently and electrocardiographically normal healthy volunteers underwent Holter monitoring. However, 3 healthy volunteers were excluded from the study due to technical failure, excess artifacts or insufficient hours of monitoring. HRV was analysed in the remaining 37 healthy volunteers.

Figure-1 graphically represents values of time domain indices of normal healthy volunteers. SDNN in normal healthy volunteers was 139.48±28.36 millisecond. SDANN in normal healthy volunteers was 125.86±21.35 millisecond. RMSSD was recorded as 27.05±7.07 millisecond.

The heart rate variability values determined in the healthy volunteers were compared with values in healthy volunteers in foreign population. Variation in RMSSD was found statistically significant ($p<0.05$). Table-1 shows the comparison of time domain parameters between healthy volunteers of our population and foreign population.

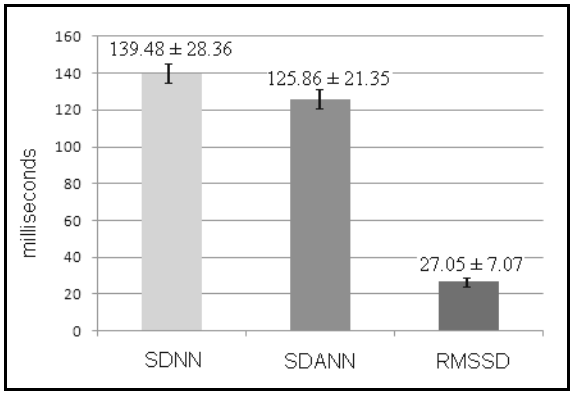

Figure-1: Time Domain Parameters in normal healthy volunteers

SDNN: Standard deviation of R-R intervals, SDANN: Standard deviation of average NN intervals, RMSSD: Square root of the mean squared differences of successive NN intervals

Table-1: Comparison of time and frequency domain parameters of healthy volunteers of our population with foreign population[10]

HRV Parameters	Healthy volunteers of foreign population[10]	Healthy volunteers of Pakistani population	*p*
SDNN (ms)	141±39	133±35	>0.05
SDANN (ms)	127±35	118±34	>0.05
RMSSD (ms)	27±12	40±17	<0.05

SDNN: Standard deviation of R-R intervals, SDANN: Standard deviation of average NN intervals, RMSSD: Square root of the mean squared differences of successive NN intervals

DISCUSSION

The heart rate variability is a representation of integrated response of the cardiovascular system to several different influences. Our study aimed at documenting the reference values of time domain parameters of healthy volunteers of our population.

Our study showed that time domain parameters affected by sympathetic and parasympathetic activity; SDNN and SDANN were decreased in our population as compared to the reference values given in foreign literature.[11] On the contrary the values of RMSSD, (parameter predominantly affected by parasympathetic activity) were greater than the normal values in healthy individuals of foreign population. Quintana and colleagues mentioned the values of heart rate variability in their normal population but the sample size was very small (n=24).[12] Likewise Ramaekers *et al* also studied heart rate variability in normal healthy volunteers on the day and night basis so it also did not document 24 hours heart rate variability values.[13]

Khan *et al*[14] also conducted a local study in the recent past in which reference values of SDNN, SDANN and RMSSD were mentioned and their values are similar to our results. The difference between our study and the previous local study is that we included a greater number of individuals and both time and frequency domain parameters were analyzed. We also compared our data with the foreign population to see the changes in autonomy which was not done in that local study. Our results depicted decrease in SDNN and SDANN and an increase in RMSSD. Increased RMSSD suggested increased parasympathetic activity in our population which indicates decreased risk of arrhythmogenesis.[15] These variation might be due to the fact that only middle aged healthy population was considered in the foreign study whereas we included both the young and adult healthy volunteers in our study.

A study with bigger sample size may be done to determine validity and reliability of 24 hours holter in healthy volunteers. Furthermore, we could not quantify the exact physical activity or the exercise capacity of the participants because even mild levels of physical activity markedly affect heart rate and heart rate variability.

CONCLUSION

This study was an effort to evolve normal reference values in both time and frequency domains. We found out that the parasympathetic activity is increased in our population as compared to foreign populations. The results contribute to importance of population studies of heart rate variability because alteration in heart rate variability in various habitats is regarded as a sufficiently objective marker of adaptive reactions.

REFERENCES

1. Schwab JO, Eichner G, Schmitt H, Weber S, Coch M, Waldecker B. The relative contribution of the sinus and AV node to heart rate variability. Heart 2003;89:337–8.
2. Choi JB, Hong S, Nelesen R, Bardwell WA, Natarajan L, Schubert C, et al. Age and ethnicity differences in short-term heart-rate variability. Psychosomatic Medicine 2006;68:421–6.
3. Zion AS, Bond V, Adams RG, Williams D, Fullilove RE, Sloan RP, *et al*. Low arterial compliance in young African-American males. Am J Physiol Heart Circ Physiol 2003;285:H457–62.
4. Liao D, Barnes RW, Chambless LF, Simpson RJ Jr, Sorlie P, Heiss G. Age, race, and sex differences in autonomic cardiac function measured by spectral analysis of heart rate variability-the ARIC study: Atherosclerosis Risk in Communities. Am J Cardiol 1995;76:906–12.
5. Guzzetti S, Mayet J, Shahi M, Mezzetti S, Foale RA, Server PS, *et al*. Absence of sympathetic overactivity in Afro-Caribbean hypertensive subjects studied by heart rate variability. J Hum Hypertens 2000;14:337–42.
6. Urbina EM, Bao W, Pickoff AS, Berenson GS. Ethnic (black-white) contrast in 24 hour heart rate variability in male adolescents with high and low blood pressure: The Bogalusa Heart Study. Ann Non invasive Electrocardiol 2000;5:207–13.
7. Kazuma N, Otsuka K, Wakamatsu K, Shirase E, Matsuoka I. Heart rate variability in normotensive healthy children with aging. Clin Exp Hypertens 2002;24(1–2):83–9.
8. Reed KE, Warburton DER, Whitney CL, McKay HA. Differences in heart rate variability between Asian and Caucasian children living in the same Canadian community. Appl Physiol Nutr Metab 2006;31:1–6.
9. Task Force of the European Society of Cardiology and North American Society of Pacing and electrophysiology: Heart rate variability: Standards of measurement, physiological interpretation and clinical use. Euro H J 1996;17:354–81.
10. Silvetti MS, Drago F, Ragonese P. Heart rate variability in healthy children and adolescents is partially related to age and gender. Int J Cardiol 2001;81:169–74.
11. Stazjel J. Heart rate variability: a noninvasive electrocardiographic method to measure the autonomic nervous system. Swiss Med Wkly 2004;134:514–22.
12. Quintana M, Storckf N, Lindbladf LE, Lindvall K, Ericson M. Heart rate variability as a means of assessing prognosis after acute myocardial infarction. Eur Heart J 1997;18:789–97.
13. Ramaekers D, Ector H, Aubert AE, Rubens A, Van de Werf F. Heart rate variability and heart rate in healthy volunteers. Is the female autonomic nervous system cardioprotective? Eu Heart J 1998;19:1334–41.
14. Khan MA. Ventricular late potentials and heart rate variability in patients with mitral valve prolapse [dissertation]. Rawalpindi: College of Physicians and Surgeons; 2006.
15. Christiansen EH, Frost L, Molgaard H, Nielsen TT, Pederson AK. Association between parasympathetic activity and late potentials at low noise level. Ann non invasive electrocardiol 2006;2:254–63.

Address for Correspondence:

Muhammad Alamgir Khan, Assistant Professor of Physiology, Army Medical College, Rawalpindi. **Tel:** +92-51-561-31457-325, **Cell:** +92-336-5146277

Email: docalamgir@gmail.com