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The role of ageing and diabetic complications on autonomic modulation in geriatric population

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ABSTRACT

The geriatric population belongs to the age group 70 years and encounter debilitating changes in almost all the system of the body. This study was aimed to record and asses the Heart Rate Variability (HRV) in elderly population involved, to predict and prevent further deterioration by assessing the cardiac function with respect to the cardiac regulatory mechanisms.To assess the autonomic changes , in this study different parameters of HRV were recorded in the people of age above 70yrs and compared with normal individuals belongs to the age less than 70years during normal(N),deep breathing(DB) and cold pressor test(CPT) conditions. Showed that the SDANN, Time domain HRV was decreased as age advances in all the conditions except the CPT condition. This study showed that as age advances the autonomic activity decreases, the degree of decrease is more in sympathetic part than parasympathetic.

Key words: HRV, age, diabetes, LF, HF, LF/HF ratio, SDANN

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INTRODUCTION

The Heart rate variability (HRV) is one of the non invasive methodology, found to be an important tool in the hands of scientists to asses both cardiac and Autonomic Nervous System (ANS) activity. HRV means beat-to-beat fluctuation in the rhythm of the heart which is an indirect measure of cardiac health [1]. HRV represents one of the most promising markers [2] for autonomic activity. Heart rate variability in Deep Breathing (HRV –DB) was approximately double than during quiet breathing [3]. Hence due to larger variation in intervals, HRV –DB probably more precise measure and recently HRV-DB has been shown to be an independent prognostic marker after myocardial infarction [4].This method can be carried out without much difficulty in general population. During deep breathing, the parasympathetic activity is stimulated by respiratory effort so; HRV-DB is used to determine the parasympathetic activity. The cold pressor test is used to stimulate the sympathetic activity of the body and thus HRV in cold pressor test helps to determine sympathetic activity.

Age and heart rate are main determinants of HRV. Regardless of life style HRV is reduced with increased heart rate and age. Aging has a profound impact on many of the interacting neural and endocrine mechanisms that regulate heart rate. Parasympathetic and sympathetic influences become attenuated, rennin and angiotensin levels fall and circadian hormonal and temperature rhythms loose amplitude [5], [6] showed that HRV of healthy subjects declines with age.

Decreased heart rate variation was seen with aging but the balance between parasympathetic and beta adrenergic input at rest and in response to postural changes does not appear to be influenced by age during spontaneous breathing. Metronome breathing altered spectral content within subjects and produced age related differences in response to postural maneuvers not seen during spontaneous breathing [7]. A reduction in HRV has been reported in several cardio logical and non cardio logical diseases [8]. As a complication of diabetes, autonomic neuropathy is characterized by early and wide spread neural degeneration of small nerve fibers of both sympathetic and parasympathetic tracts [18]. Diabetic autonomic neuropathy (DAN) etc [14]. This prompted us to investigate the effect of ageing and diabetic complications on autonomic modulation in geriatric population. Hence this study was proposed to record and asses the HRV in elderly population to predict the degree of deterioration of autonomic activity.

MATEREALS AND METHODS

This study was conducted in the department of Physiology, Kasturba Medical College, Manipal University, Mangalore on the inmates of LITTLE SISTER OLD AGE HOME at Nanthoor circle, Mangalore, Karnataka. We recruited about 80 old aged individuals of the age group of 50 to 85 years, belongs to both the sexes, after their informed and written consent. The study was approved by institutional ethical committee. A detailed clinical history of all the subjects was taken. Relevant past history, family history, any drug history, personal history like smoking, alcoholism, occupation etc, were also taken. General physical examination, vital signs, complete systemic examination was done. Only medically fit persons were included in the study. Subjects suffering from any systemic disorders and those who are not consented are excluded from the study.

Heart rate Variability was recorded using Digital data Acquisition system, HRV soft 1.1 VERSION, AIIMS, NEW DELHI. A high quality ECG recording was taken under standardized condition to minimize artifacts. The ECG signal was first analogally recorded & then digitally converted and analyzed in the time domain and frequency domain.

The recording was done in the morning between 8.30 to 9.30am in a cool room temperature of 20 to 28 degree Celsius after breakfast. They were requested to come in a relaxed condition & quiet mood . The room was darkened & without acoustic disturbance. They were instructed to be relaxed and to breathe quietly at their own rate.

After a resting period, the subjects ECG was recorded in the supine position during normal breathing for 5 min . After this a break of 2min was given. Then the next ECG recording was taken during deep breathing for 1 min, the procedure was as follows. The subject was asked to inspire for the first 5 seconds from the count of 1 to 5 and expire the next 5 seconds from the count of 5 to 1. This recording was taken for 6 such cycles i.e. for one minute.

Cold pressor test: The subjects were asked to keep one hand till wrist in an ice cold box for 1 min, during which the ECG was recorded.

Statistical analysis

The statistical analysis was done by using ANOVA, student's unpaired 't' test, Mann Whitney U test, and Tukey's Test. P value was taken as significant at 5 percent confidence level i.e. $p < 0.05$.

RESULTS

Effect of AGE on HRV

The Study group consists of 80 volunteers in the age group of 50 to 85 years. They were divided in to two groups, each with 40 subjects of both sexes who were less than 70 yrs of age (Group I) and 40 subjects of both sexes who were more than 71 yrs of age (Group II). The different parameters of HRV under different conditions in these two groups were recorded, tabulated and analyzed (table:-1). In time domain method, the SDANN i.e., standard deviation of adjacent normal to normal beat was taken in different conditions between these two groups were compared. The mean value of SDANN in group I was 14.18±5.12 and group II was 10.42±6.54 in Normal breathing condition which showed significantly higher value ($P<0.05$) in Group II. In DB and CPT condition, the mean SDANN value of HRV in the group I was 21.44±10.13 and 16.83±6.02 and in the group II was 18.79±8.77 and 10.14±7.02 respectively .In both these conditions also the SDANN was significantly higher (p<0.05) in group I when compared to group II. HRV in frequency domain analysis showed that in normal condition, the LF component of group I was 28.96±7.60 and group II was 23.52±8.76. Here also the group I shown significantly greater value (p<0.05) in the LF than group II. The same result was obtained with the LF in the DB and CPT conditions where the LF of group I was 76.75±13.65and 49.98±17.45 and group II was 66.26±12.72 and 50.67±12.62 respectively. The LF component of HRV also showed the same result (P<0.05) in normal and DB conditions. Whereas during CPT, the HF component of group I was 40.44±19 and group II was 42.83±14.83, were not significantly different from each other. The LF/HF ratios compared between the two groups were also not significantly different in these groups in normal, DB, CPT conditions.

Table 1:- Effect of Age on HRV in Time domain and Frequency domain methods during Normal breathing, Deep breathing and Cold pressor test. n=40 in each group.

Group	HRV	Age group		P-Value
		< 70Yrs	≥ 71Yrs	
		Mean ± S.D	Mean ± S.D	
Normal	SDANN	14.18±5.12	10.42±7.60	0.013
	LF	28.97±6.54	23.53±8.77	0.04
	HF	42.79±16.05	32.83±18.71	0.027
	LF/HF Ratio	0.79±0.55	0.89±0.42	0.197 NS
Deep breathing	SDANN	21.44±10.14	18.79±8.88	0.045
	LF	76.76±13.65	66.26±12.72	0.021
	HF	30.34±10.85	22.85±9.69	0.033
	LF/HF Ratio	2.90±1.23	3.51±1.80	0.288
Cold Pressure	SDANN	16.84±6.02	10.14±7.02	0.001HS
	LF	49.98±17.45	50.67±12.62	0.049
	HF	44.04±19.42	42.84±14.84	0.69 NS
	LF/HF Ratio	1.32±0.61	1.28±0.44	0.18 NS

Note: HS=Highly Significant, NS=Not Significant.

Table 2: Effect of Diabetes on HRV in Time domain and Frequency domain methods during Normal breathing, Deep breathing and Cold pressor test. n=40 in each group.

Group	HRV	Non Diabetic	Diabetic	P-Value
		Mean ± S.D	Mean ± S.D	
Normal	SDANN	13.91±5.59	7.04±4.14	0.003HS
	LF	27.10±10.25	24.44±8.87	0.38NS
	HF	39.60±16.13	35.94±24.79	0.38 NS
	LF/HF Ratio	0.83±0.53	0.86±0.36	0.48 NS
Deep breathing	SDANN	20.69±9.95	14.17±4.45	0.16 NS
	LF	73.36±14.51	69.92±12.58	0.51 NS
	HF	27.54±10.77	27.12±12.68	0.84 NS
	LF/HF Ratio	3.14±1.49	3.15±1.58	0.91 NS
Cold Pressure	SDANN	13.63±6.85	16.56±8.73	0.35 NS
	LF	48.83±16.37	43.47±14.42	0.49 NS
	HF	43.75±18.13	42.63±15.47	0.95 NS
	LF/HF Ratio	1.28±0.58	1.07±0.30	0.43 NS

Note: HS=Highly Significant, NS=Not Significant.

EFFECT OF DIABETES ON HRV

Further, when the subjects were regrouped on the basis of diabetes as diabetic and non diabetic groups and the different parameters of HRV under different conditions in these two groups were recorded, tabulated and analyzed (table-2).The results showed that, the SDANN in normal condition was significantly higher in non diabetic ($P<0.01$), whereas all other parameters in all conditions didn't show any significant variations.

DISCUSSION

In the present study normal aging is associated with a constant decline of cardiovagal modulation due to significant decrease of parasympathetic activity, which resulted in a decrease in the HRV as the age advanced in healthy subjects [10]. The mean age of group-I was 63 years and group-II was 75 years. In these subjects the HRV parameters like SDANN, LF, HF, and LF/HF ratio were taken in normal breathing condition to assess the effect of age perse on the autonomic nervous system, during deep breathing and cold pressor test conditions to evaluate impairment of age particularly on parasympathetic and sympathetic outflow respectively.

The SDANN of HRV decreases in the advanced age group in all the experimental condition. This is in agreement with well known fact that normal ageing also have shown that as the age advances, HRV declines [9-11]. To find out degree of declining activity in either of the autonomic nervous system, the LF component which mirror the sympathetic activity and the HF component reflecting the parasympathetic activity were analyzed. In this study though the value of LF & HF declines in the aged group in normal and deep breathing conditions, the cold pressor experiment which stimulate the sympathetic activity, the Lf & HF value is same in both the groups.

Michael Reardon et. al,[12] compared HRV in subjects who are below and above 70 yrs. He found out that there was a significant difference in HRV index in those above 70 yrs compared with those below 70 yrs and concluded that aging reduces the global measure of HRV and may reflect reduced responsiveness of autonomic activity to external stimuli with age .Thus the result of this study indicated that as the age advances the autonomic activity decreases, but the degree of decrease is less in the sympathetic system.

Further in this study, the SDANN of diabetic people decreased significantly in the older group but LF & HF component did not show any difference. Time domain methods are sensitive and are strongly correlated with other established HRV measurements in assessing diabetic neuropathy. Frequency domain measure analysis of HRV shows abnormalities associated with DAN, reduced power in all spectral bands [15-17], failure to increase LF on standing, which is a reflection of impaired sympathetic response or depressed baroreceptor sensitivity[15, 17,] and abnormally reduced total power with unchanged LF/HF ratio[15]. In advanced neuropathic states, the resting supine power spectrum often reveals extreme low amplitude of all spectral components, making it difficult to separate signals [15-17]

CONCLUSION

From this study, we concluded that the HRV decreases as age advances. This is achieved mainly by decreasing parasympathetic activity than sympathetic activity. The decline of HRV was potentiated by diabetes.

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