Original Research Article

Study of cardiac parasympathoautonomic regulation in men of different ages

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Abstract

Objective: Cardiovagal autonomic control is protective physiological mechanism that associates cardiorespiratory fitness. Its evaluation with non-invasive simple means has important role in clinical neurophysiology for application in medical preventive and promotive care. Cardiovagal regulatory function was evaluated among overtly healthy adult male workers of youth to elderly age, using simple non-invasive electrophysiological tests.

Methods: Based on specific selection criteria 52 males in 23-67 year age were administered deep breathing induced heart rate variability (HRV) and standing induced heart rate response tests of cardiovagal function. Electrocardiography was sole technical resource with manual observations and calculations.

Results: The statistically significant observations were mostly precluded due to limited size of the studied sample .However, increasing age even in studied range indicated progressive decline in cardiovagal control in both deep breathing HRV and standing 30:15 heart rate response tests

Conclusion: Declines of small magnitude in cardiovagal regulation at rest in supine posture may prove costly upon exercise situation when sympathetic outflow overtakes cardiovascular function. Exercise training and measures as Yoga that boost vagal tone acquire greater significance in aging adults who may have to occasionally take up physically strenuas tasks.

Keywords: cardiorespiratory fitness; cardiovagal control; electrocardiography; heart rate variability

1. Introduction

Intrinsic rhythmicity of pacemaker and hormonal priming are important, but beat to beat cardiac function is regulated by the balance between parasympathoautonomic slowing and sympathoautonomic accelerating influences. Respiration associated change in beating of heart is termed sinus arrhythmia. There are slower changes also due to baroreceptor reflex, rennin-angiotensin system activity, thyroid status, diurnal rhythm etc. In supine position parasympathetic stimuli have upper hand with very little sympathetic activation. Adaptibility of cardiovascular system is of paramount significance to health and survival. Many aspects as gender, age, nutritional and hormonal states bear role in cardiovascular adaptive physiology. Measurement of heart rate variability (HRV) has become widely used tool for assessing autonomic input to the heart under various physiological conditions [1-3]. Decline in vagal modulation of heart at rest at advancing age is documented [2,4]. The age influence is closely complexed with physical activity profile, however [3,5]. It was considered worthwhile to attempt an insight with simple means to cardiac dominant parasympathetic autonomic regulation in adult males working in the AIIMS, Bhopal as hospital employees, in general services and ad hock daily wage workers. Any definable patterns and associations were considered to serve as primary local evidence useful to preventive and promotive clinical and healthcare practices.

2. Subjects and method

The study was conducted between months of August to November, 2015 at Department of Physiology, AIIMS, Bhopal. The working community was chosen for reason of convenience in conduct of study. They were explained of the purpose and procedures of proposed study, and their written consent was obtained before inclusion to participate. The study was permitted by institute authority. It was envisaged to enrolled men between 20 year to 70 year of age, giving no history of any chronic disease or incapacitation, ongoing medication, tobacco chewing or smoking and more than occasional alcohol consumption. They should also have not suffered significant illness requiring hospitalization or bed rest in the preceding one month. They must not be hypertensive by systolic blood pressure (BP) 140 mm Hg or more and diastolic BP 90 or more. Age, height and weight of

the subjects were recorded and body mass indices (BMI) were calculated as weight in kg/height in meters^2.

2.1 Tests of cardiac parasympathoautonomic regulation:

The subjects were asked to report on test date at 9AM, after having only light breakfast two hour before without tea or coffee. They must not have taken any alcohol or strenuously exerted in preceding 48 hours. The examination room was quiet, well ventilated and not exposed to direct sunlight. The ambient temperatures were between 25 to 30 Degrees C. The subjects were instructed to lye relaxed on bed and ECG limb leads were connected to standard ECG machine. After ten minutes of the assembly, ECG was recorded for one minute at 25mm/sec speed. T he ECG strip was examined for any premature ventricular contractions, but none were detected. It was pertinent to discard the QRS complexes preceding and succeeding the extra systoles. If the ectopic occurred twice during one minute recording, the subject was to be excluded from study. The one minute recording was subdivided in to 10 second segments. First and last segments were ignored. RR intervals in each of the middle four 10 second segments were measured by scaled calliper and averaged. Mean value of such four averaged RR interval values was used to determine resting heart rate with normal breathing. Also in each segment shortest and longest RR were identified and the ultimate shortest and longest were noted. Heart rate variability (HRV) with normal breathing was calculated as beats per minute using the formula [6]:

HRV beats/min= [2500/shortest RR interval in mm]-
[2500/longest RR interval in mm]

2.2 Deep breathing HRV

The subjects were thought to breathe at a rate of 6 respiratory cycles/minute. The cycle of 5second deep inspiration and 5 second exhalation was controlled with metronome. Lead 2 ECG was then recorded continuously at 25mm/sec speed while subject deep breathed as instructed. The care for any premature ectopic was similarly taken .Heart rate variability was calculated as described. A test result was prespecified as normal if there was difference of 10 beats or more per minute between the slowest and fastest heart rates[7].

2.3 Heart rate response to standing up (30:15) test:

After the above test, subjects were given relaxation break for 15 minutes. The subjects were instructed to stand up as quick as possible after signal by the examiner.ECG recording was restarted and at around 30 seconds signal was given to strand and the instance was marked on ECG strip, which continuously recorded till one minute of straight standing without support. The longest RR interval detected between 26th to 35th heartbeat after standing was noted as RR30th and was divided by the shortest RR interval detected between 11th to 20th beat upon standing, to give 30:15 ratio[8].

3. Observations and result

As per selection, no gender difference, hypertension, any morbidity or habits could influence the observed changes. Only constitutional variables should be considered as influencing, e.g. integrity of cardiac autonomic innervations and function, hormonal profiles and genotypes/phenotypes. The subjects were mostly in range of normal weights and hence age was the better basis to categorise them as under 40,41to 50 and above 50 year ages.

Table 1: Profile of subjects and parameters of cardiac parasympathoautonomic regulation

Parameters	Age groups (years)		
	23-40	**41-50**	**51-67**
Number	23	17	12
BMI kg/M^2	22.8±4.2	24.8±5.3	24.1±4.8
Blood Pressure mmHg Systolic	125.4±15.6	132.2±14.9	138.7±12.2
Diastolic	76.5±12.8	80.2±13.2	83.7±10.1
Heart Rate Normal Breathing	70±6	71.4±7.6	74.2±9.1
HRV Normal breathing(NB) beats/min	12.8±4.1	9.06±4.7	8.4+-5.5
HRV Deep Breathing (DB)beats/min	23.8±7.2	17.2±5.06	14.8±7.1
Difference of HRV DB-NB beats/min	11±4.8	8.1±5.3	6.4±5.1
Subjects with HRVDB under 10	4 (16.4 %)	5 (29.4 %)	5 (41.7 %)
Subjects with HRV DB more than 10	19 (83.6 %)	12 (70.6 %)	7 (58.3 %)
30:15 Ratio(Standing HR Response)	1.16±0.03	1.11±0.03	1.06±0.04

The study subjects in youngest age group were relatively lighter while middle and older age categories had average high normal body mass indices. None were hypertensive yet oldest group had higher normal average values of both systolic and diastolic pressure. Similar was heart rate profiles. Heart rate variability at normal breathing was clearly lower than that upon deep breathing schedule. The difference between two parameters was highest in younger age group and most reduced in the oldest. There was highest percentage of subjects exhibiting abnormally low HRV in deep breathing test in the oldest (41.7%) and lowest among the youngest (16.4%) age group. The 30:15 heart rate response ratios were highest in the younger and lowest in the oldest group in age wise linear pattern.

4. Discussion

In recent years, non-invasive techniques based on the electrocardiogram have been used as markers of autonomic modulation of heart. These include HRV [9]; baroreflex sensitivity [10]; QT interval [11]. A new method called heart rate turbulence HRT, based on fluctuation of sinus rhythm cycle length after a single premature ventricular beat has also been employed [12]. Among all these HRV has emerged as a simple, non-invasive method to evaluate sympathovagal balance at the SA node level. In a normal heart with an integer autonomic regulation, continuous physiological variations of sinus cycles, reflecting a balanced sympathovagal state and normal HRV would be seen. In damaged states changes in activity in the afferent and efferent fibres of autonomic nervous system and in local neural regulation would contribute to sympathovagal imbalance, reflected as diminished HRV.

Autonomic function tests are non-invasive and safe. They can be categorized in to tests of autonomic activity; cardiovagal tests; adrenergic tests and sudomotor tests. Selection of specific test should match suspected clinical/functional impairment. Heart rate response to deep breathing involves both afferent and efferent pathways through vagus [13], most suits as test for cardiovagal function .Heart rate response to standing, is an integrated reflex response involving alteration in heart rate and blood pressure. Measurement of 30:15 ratios gives a simple numerical value that reflects the presence or absence of relative bradycardia. The initial heart rate response to standing consists of tachycardia at 3 then 12 seconds, followed by bradycardia at 20 seconds. The initial cardio accelerator is an exercise reflex, while the subsequent tachycardia and bradycardia are baroreflex mediated. The 30:15 ratio [RR interval at beat 30/RR interval at beat 15], serves as index of cardiovagal function [14,15]. When the ratio is 1 or less, vagal damage is probably present.

Autonomic function testing is very pertinent clinical obligation for clinical neurophysiology laboratories. Autonomic cardiovascular indices correlate with function, e.g. exercise performance [16], and also increased mortality risk is posed by autonomic dysfunction [17]. The close correlation between body adiposity and HRV is seen. Less adiposity in the youth associates a high level of parasympathetic activity [18,19]. The preliminary trends observed for BMI among studied age groups and the cardiovagal indices, are in agreement with this knowledge. Stress is the state of mismatch between perceived demands and perceived capacities to meet those demands. Directly or indirectly stress is linked to work related illness [20]. Precisely this reflects in diurnal variation of HRV(21).HRV shows wide variation in normal populations, as autonomic outflows are labile not constant. Age, emotion, time of day, posture all influence HRV [22-25].

Age and resting heart rate are major distant factors that negatively correlate to heart rate and HRV(26).Pattern of increasing age and decreased HRV as well as 30:15 heart rate ratios, seen in this study is consistent with such knowledge. Aging in the autonomic nervous system, particularly aging of parasympathetic system may explain the phenomenon [27]. Age, must be factored in any studies of HRV therefore [28].

5. Conclusion

The deterioration in HRV among aging more or less sedentary people seen at rest cannot be ignored. The cardiovagal deficit would aggravate upon exertion which induces domination of the sympathetic autonomic arm on cardiovascular control. Sympathetic over activity bears major cardiovascular risks of cardiac arrhythmia, ischemia and failure, against which vagus provides protection [1,29]. Cardiovagal control increases with increased build-up of exercise capacity. Hence, regular exercise programmes may be more important in older people that are still active in their job. This should improve their fitness and decrease vulnerability to conditions consequent to autonomic failure.

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