

A Comparative Study of Gender Differences in Age Associated Changes in Autonomic Nervous System

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ABSTRACT

There is much clinical evidence to suggest that cardiovascular functions vary both in males and females and the activity of autonomic nervous system varies with age and gender. The cardiovascular responses of blood pressure, cardiac output, heart rate and other variables to change in posture differ between the sexes. This study evaluated the gender differences in age-associated changes in cardiac sympathetic activity. This was a prospective study with the Primary Data which was collected from Pravara Rural Hospital Loni, Maharashtra, India. Total 80 completely healthy male and female subjects were selected for the study and divided into three groups according to their age. All the subjects were evaluated using CANWIN cardiac autonomic neuropathy analyzer; a windows based cardiac autonomic neuropathy analysis system with interpretation. Descriptive statistics was done using “unpaired t” test and one way ANOVA results were used to compare between the three study groups. Comparison of outcome parameters was calculated with significance test. This study suggests that gender differences exist in age-related changes in cardiac sympathetic activity. There is marked influence of age on sympathetic nervous system activation due to impaired sensitivity of baroreceptors in women than in men of the same age group.

INTRODUCTION

Overall, the age related changes in autonomic functions of human body are less investigated [1]. The autonomic nervous system plays a major role in the regulation of the cardiovascular system under both physiological and pathological conditions [2]. Normal human ageing is associated with changes in the autonomic control of several biological functions. The two subsystems sympathetic and parasympathetic of autonomic nervous system mature with time, but degree of the changes due to ageing is different because of their divergent neural pathways.

Therefore, symaptho-vagal balance also fluctuates with ageing [3]. The autonomic nervous system through its sympathetic and parasympathetic divisions regulates and modulates most of the cardiovascular functions. It is also well recognized that cardiovascular functions vary both in males and females. The cardiovascular responses of blood pressure, cardiac output, heart rate and other variables to change in posture differ between the sexes. The differences are related to greater decrease of thoracic blood volume with standing in women than the men. The overall complexity of heart rate dynamics is higher in women than men [4]. A study on confounding variables of cardiovascular autonomic function had revealed that age is one of the important confounders for cardiac autonomic function [5]. There are a few reports on gender-related differences in cardiac autonomic tone. In a population of normal subjects, using short-term and long-term recordings, there was found predominance of parasympathetic over sympathetic tone in women and vice versa in men. It was also demonstrated that the gender-related difference in parasympathetic regulation diminishes after the age of 50, while sympathetic dominance in men disappears significantly later [6]. It is generally accepted that sympathetic activity increases progressively with aging [7]. Although, cardiovascular risk increases with age in both sexes, this increase is sharper in women as compared to the men of same age group. More women than men have congestive heart failure and overall, more women than men die from cardiovascular disease in the US

[8,9]. The mechanisms underlying this differential age effect are not well understood. Changes in serum total cholesterol level, body mass index and diabetes prevalence explain only 50% of the age-related increase in cardiovascular morbidity and mortality among women^[10].

Work done over the past few years gives us an indication of effect of gender on the autonomic nervous system activity, so this study was planned to be carried out which involved three Sympathetic function tests to be done on males and females of different age groups with the objective of testing the hypothesis that aging has a greater impact on sympathetic activity in women than in men. The changes were noticed in some parameter of sympathetic function tests amongst males and females of same age group.

MATERIAL AND METHODS

The present study of ANS functions in males & females of different age groups was conducted in the Department of physiology Rural Medical College Loni, Maharashtra, India. The anthropometric measurements were carried out in all the groups. History taking and medical examination was carried out. The nature of the test was explained to the subjects.

Inclusion criteria

Totally, 80 (40 males and 40 females) healthy volunteer subjects (not having any major illness or chronic addiction) were selected for the study from among those visiting the OPD of Pravara Rural Hospital, Loni, Maharashtra, India. According to the age they were divided into three groups, as follows: Group I – Age 31 – 40 yrs as elders, comprising of 10 males (Group I A) and 10 females (Group I B). Group II – Age 41 – 60 yrs as young old comprising of 15 males (Group II A) and 15 females (Group II B). Group III – Age 61 yrs and onwards as old old comprising of 15 males (Group III A) and 15 females (Group III B)^[4].

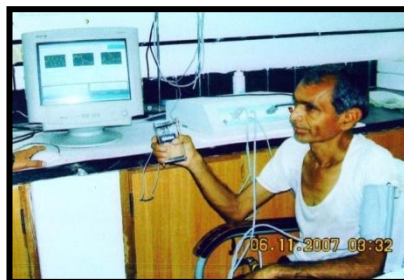
Exclusion criteria

Subjects less than 30 years of age, suffering from any major illness and with chronic addiction were excluded from the study. Data comprising of clinical history regarding name, age, sex, occupation were obtained and recorded from all the subjects. Special emphasis was given in history for finding out any symptoms suggestive of autonomic neuropathy. The two tests out of three, included in this study were carried out using CANWIN.

CANWIN

Canwin is the state of the art PC (Fig 1); windows based cardiac autonomic neuropathy analysis system manufactured by GENESIS MEDICAL SYSTEMS PVT. LTD. HYDERABAD, with interpretation. It has an extensive data base to keep track of subjects' history and for archive test retrieval and comparisons being fully autonomic. The need of manual recordings, readings and calculation is eliminated. Inbuilt time domain waveform analysis and B.P. measurements make the task of conducting the sympathetic function tests very easy.

Figure 1



Cardiovascular Sympathetic Function Tests

- 1) **Resting Pulse rate** – pulse rate was recorded on each subject by palpatory method for the period of one minute.
- 2) **Blood Pressure response to sudden standing, i.e. Postural or Orthostatic hypotension**

Procedure: The test was conducted with the subject in lying down supine position. Blood pressure was measured in supine position and then immediately after standing and one minute after standing. Blood Pressure was measured for the first time in supine position when the green light glows on the screen of canwin machine and then when red light glows, the subject was asked to stand up quickly and the Blood Pressure is recorded immediately after standing for the second time. Then the Blood Pressure is recorded again after one minute after standing. The test ends automatically and the result was displayed immediately.

3) Sustained Hand-grip test

Procedure: The Blood Pressure was recorded in sitting position. Then the subject was asked to hold the spring dynamometer in the dominant hand and instructed to compress the dynamometer with full efforts for the period of 5 minutes. The blood pressure was recorded thrice during these 5 minutes automatically and the alteration in the blood pressure just before the release of hand grip test is taken as the index of response to hand – grip test.

RESULTS

The statistical analysis for sympathetic tests was carried out separately for males and females in all the three groups by applying “unpaired t test”. One way ANOVA was done to compare the cardiovascular sympathetic functions between the 3 study groups. After analyzing all the three groups the cardiovascular sympathetic functions were studied sex wise as well as age wise applying the statistical significance test (‘p’ value).

It was observed in Group I that, Pulse rate, orthostatic hypotension test and Hand grip test were not increased significantly, i.e. $P > 0.05$ (Table 1). In Group II, Pulse rate and Hand grip tests were increased significantly, i.e. $P < 0.05$ and Orthostatic hypotension test was not increased significantly i.e. $P > 0.05$ (Table 2). In Group III, Hand grip test was increased significantly, i.e. $P < 0.05$ and Pulse rate and Orthostatic hypotension test were not increased significantly, i.e. $P > 0.05$ (Table 3).

Comparison of sympathetic functions between the 3 study groups showed that all the three sympathetic function tests increased significantly as the age advances i.e. $P > 0.05$ (Table 4).

Table 1: Mean values of sympathetic tests in group I:

Sympathetic tests	Gr I A (n=10) Mean ± SD	Gr I B (n=10) Mean ± SD	't' value	'p' value	Result
Pulse Rate	73.8 ± 5.36	71.6 ± 5.76	0.88	$p > 0.05$	Not significant
Orthostatic Hypotension Test	7.2 ± 6.43	5.50 ± 5.37	0.64	$p > 0.05$	Not significant
Hand Grip Test	9.8 ± 6.87	14.50 ± 12.80	1.02	$p > 0.05$	Not significant

Table 2: Mean values of sympathetic tests in group II

Sympathetic tests	Gr II A (n=15) Mean ± SD	Gr II B (n=15) (n=15) (n=15) Mean ± SD	't' value	'p' value	Result
Pulse Rate	72.53 ± 7.42	77.5 ± 5.71	2.03	$p < 0.05$	Significant
Orthostatic Hypotension Test	7.4 ± 4.73	7.64 ± 6.54	0.11	$p > 0.05$	Not significant
Hand Grip Test	11.4 ± 6.29	5.86 ± 5.56	2.52	$p < 0.05$	Significant

Table 3: Mean values of sympathetic tests in group III

Sympathetic tests	Gr III A (n=15) Mean ± SD	Gr III B (n=15) Mean ± SD	't' value	'p' value	Result
Pulse Rate	73.4 ± 7.81	78.18 ± 8.34	1.65	$p > 0.05$	Not significant
Orthostatic Hypotension Test	9.33 ± 7.73	9.37 ± 7.70	0.014	$p > 0.05$	Not significant
Hand Grip Test	11.66 ± 11.12	4.56 ± 3.33	2.37	$p < 0.05$	Significant

Table 4: Comparison of Mean value of sympathetic tests in group I, group II and group III with ANOVA results

Sympathetic tests	GroupI (n=20)	GroupII (n=30)	GroupIII (n=30)	ANOVA (F value)	'p' value	Result
Pulse Rate	72.7 ± 5.43	80.01±7.57	83.79±11.12	26.661	p<0.05	Significant
Orthostatic HypotensionTest	6.35 ± 5.99	6.58±6.01	6.62±7.15	26.652	p<0.05	Significant
Hand Grip Test	13.65±11.84	13.69±11.85	14.68±11.87	46.707	p<0.05	Significant

DISCUSSION

Work done over the past few years gives us an indication of effect of gender on the autonomic nervous system activity. The data on this aspect was lacking in this part of the country, so the present study was conducted to measure the autonomic nervous system activity in males and females. The study was planned to be carried out which involved three sympathetic function tests to be done on males and females of different age groups. These results indicate that the Sympathetic dysfunctions go on increasing in severity as the age advances. Even though, the sympathetic dysfunctions associated with aging occur both in males and females, the females show early development and more severe autonomic dysfunctions as compared to the males of the same age group.

The main finding in this study is that aging has a more striking effect on increasing sympathetic activity in women than in men. These changes can be explained on the basis of the Sympathetic - adrenergic and baroreflex functions with aging. The sympathetic nervous system and the baroreflex are the important tools by which Central Nervous System uses the Autonomic Nervous System to maintain homeostasis [11]. Sympathetic nervous system activation, impaired cardiac and peripheral adrenergic functions and decreased baroreflex circulatory control are fundamental features of number of cardiovascular disorders including coronary artery disease, congestive heart failure, essential hypertension and type - II diabetes mellitus [11]. Thus, there was evidence of an age related increase of cardiovascular sympathetic nervous system activity [12]. These findings are consistent with the hypothesis that there is sympathetic nervous system and parasympathetic nervous system compensation of cardiovascular functions in response to an age related decrease in baroreceptor sensitivity [12].

The function of the arterial baroreflex could be theoretically disrupted by aging at a number of levels. Most obviously, this could occur in the afferent component of the reflex arc, with changes affecting the baroreceptors in the arterial wall, with medial thickening and rigidity, and with the formation of atheromatous plaques in the intima [13]. In contrast to findings of previous study [14], of muscle sympathetic nervous activity (MSNA) in both younger and older subjects was significantly lower in women compared with men of the same age which might have been due to the small sample size and inclusion of older women using hormone replacement therapy [14]. However, our findings are consistent with findings of [15], who found that MSNA was lower in women than in men among subjects younger than 50 years and similar for both genders in subjects older than 50 years of age [15]. The age related menopause-independent increase in sympathetic activity in women may be relevant to the absence of any cardiovascular benefit from hormone replacement therapy in postmenopausal women [16]. Also the findings of our study are consistent with the epidemiological data indicating a higher prevalence of hypertension in women by age 60 [10, 17]. The significant positive correlation between MSNA and blood pressure particularly in older females provides further support for a possible role of sympathetic activation in the close link between aging and hypertension, particularly in women [18].

CONCLUSION

To conclude, the sympathetic activity increases progressively as the age advances in humans due to reduced sensitivity of baroreceptors. Also aging is accompanied by a greater increase in sympathetic activity in women than in men of the same age group. This increase sympathetic activity in women is independent of body mass index and menopausal status. Sympathetic neural mechanisms may thus contribute importantly to the more marked influence of age on blood pressure and cardiovascular disease in women. Since autonomic neuropathy is the cause or effect of many age related clinical disorders leading to deteriorated quality of life, therefore, evaluation of ANS functions is one of the important investigations in the geriatric medicine.

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