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Medicine

A Cross Section Study of Autonomic Function Test in Geriatric Population

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Abstract **Original Research Article**

Background: Sympathetic and parasympathetic autonomic nervous system act in opposition to each other which enable us to perform our regular functions and homeostasis. Disorders of the ANS may manifest as OH (orthostatic hypotension), cardiac arrhythmia, lack of sweating bowel and bladder dysfunctions etc. The aged are particularly prone to get afflictions of the ANS. This is attributable to higher incidence of diabetes mellitus, degenerative diseases like Parkinson's, Multi system atrophy, nutritional disorders and addictions especially alcohol. The elderly's are prone to have cardiovascular diseases and sometimes the ANS may get afflicted by these diseases directly or due to side effect of medications being taken. However, in the absence of these conditions abnormalities of the ANS are present in the elderly, possibly due to the degeneration of the ANS as part of aging. The aim of this study is to see the effect of aging on the ANS.***Methods:***125 elderly male and 125 elderly female patients were selected for the study. It was ensured that the patients had no evidence of illnesses which can affect the ANS, patients such as hypertension, diabetes mellitus; ischemic heart disease and arrhythmia, without addictions and habituations were selected for the study. Autonomic dysfunction was assessed based on clinical symptoms and using different tests including HR variability with deep respiration, HR Response to Valsalva maneuver, HR response to standing, BP response to standing and ColdPressor and Hand grip test. These were compared with healthy volunteers aged between 25 to 65 years. ***Results:*** We found that the prevalence of autonomic dysfunction is significant in the elderly as a part of the aging process. ***Conclusion:*** The observation that autonomic disturbances can increase due to ageing has profound implications and this factor must be kept in mind when designing treatment.

Key words: Autonomic function, sympathetic, parasympathetic, blood pressure, cold pressor test and hand grip exercise.

INTRODUCTION

The Autonomic Nervous System is considered to be an important operating system for human body as it innervatesevery organ of human body and is virtually involved in all the diseases.

Together with slow acting, long lived effects of the endocrine system the ANS exerts its fast acting, short lived effects through the following functions-

- Perfusion of all the body with blood through heart rate and Blood Pressure control.
- Homeothermic function through sweating control and shivering.
- Processing of nutrients through control and coordination of different parts of gut and glands.
- Urinary motility
- Pupil movement, focusing and lacrimation

The ANS performs its functions without the involvement of the individual conscious faculties. Thus, it is "AUTONOMOUS". Anatomically it consists of a Central part, an Afferent and Sympathetic and Parasympathetic Efferent. The Central autonomic network consists of the insular cortex, hypothalamus, amygdala, the periaqueductal gray matter, nucleus tractus solitarius and ventrolateral medulla [1]. The autonomic reflexes regulate activities of smooth muscles, cardiac muscles and glands. Hypothalamus controlsand integrates the function of both the divisions of ANS.

There are significant age-related changes in autonomic nervous system function that are responsible for an impaired ability to adapt to environmental or intrinsic visceral stimuli in the elderly. It is very difficult to define and quantify ageing. Aging is customarily measured in chronological years, but the broad concept of aging is significantly more complex than years alone would indicate. Fundamental aspects of aging are determined by the mounting toll of biologic stresses over time (e.g., oxidative stress, inflammation) in juxtaposition to diminishing homeostatic capacities (contingent on telomere length, gene expression, and other biologic factors). As a result of these changes with ageing elderly become vulnerable to stresses [2, 3].

This variable has profound importance when considering interpretation of the various signs in the elderly and also so should be taken into consideration when prescribing drugs [4]. There are three domains of autonomic testing, namely sudomotor, cardio-vagal and adrenergic.

In our present study we have studied all the three domains of autonomic nervous system testing and compared the results with the subjects of normal age. The aim of the study is to find the effect of ageing on ANS and understand this is as an important confounding variable when dealing with the elderly patient.

Material and Methods

Study design and setting-A cross-sectional study was conducted in Department of Medicine at Index Medical College and Research Centre M.P. INDIA. The study protocol was approved by Ethics Committee of the Institute.The study was done over a period of 6 monthsstarted from June 2018.

Participants-125 healthy elderly individuals of both sexes aged above 65 years were compared with 125 healthy individuals aged 25 to 65 years of both sexes. An informed consent was taken from the volunteers joining the study.

INCLUSION AND EXCLUSION CRITERION

Subjects with history of hypertension, diabetes mellitus, arthritis and other chronic diseases like tuberculosis were excluded out. Subjects identified with symptoms of cardiac Autonomic neuropathy (CAN) that include: exercise intolerance, postural weakness, faintness, palpitation and symptoms suggestive of orthostatic hypotension e.g. dizziness, visual impairment, and syncope) were excluded. History of current medications used by the subjects was taken; steroids intake or any other drugs that can affect ANS were excluded.

SAMPLE SIZE CALCULATION

Numerical data was summarized as mean and standard deviation and categorical data as count and percentage.

Thetest to asses ans dysfunction were done in following three domains

- Cardiovagal
- Adrenergic
- Sudomotor

An Ewing's battery of non-invasive sympathetic and parasympathetic test performed to cover cardio vagal adrenergic responses.

Cardiovagal responses was assessed by
Resting Heart Rate
HR Response to Valsalva Manoeuvre (Valsalva Ratio)
HR Variability with Respiration (I/E Ratio)

Adrenergic responses was assessed by -
Blood pressure in supine position
BP response to Valsalva Manoeuvre
BP and HR response with Standing (30:15 ratio)
Sustained Hand Grip Test

Sudomotor response is assessed by –
Spoon Test
Cold Pressor Test

Procedure

Resting HR (RHR) AND Blood Pressure- The subject were asked to take rest in supine position for 10 min. Resting heart rate was determined for one minute. Rate in excess of 100 and below 60 beats /min was considered abnormal. Similarly Resting BP was taken.

Heart Rate Variability with Respiration (Deep Breathing Test) –Subjects were asked to inhale for 5 seconds and exhale for 5 seconds. This 10 second respiratory cyclewere repeated 6 times (i.e. 6 breaths per minute). The expiratory-inspiratory ratio (E: I ratio), which is the ratio of the longest RR interval during expiration and the shortest RR interval during inspiration from5 cycles, was determined. The normal E:I ratio in young person should be more than 1.2.

Heart Rate response to Valsalva Maneuever-Valsalva maneuver evaluates function of baroreceptors. It is a voluntary forced expiration of a subject against a resistance. An increase in transthoracic pressure mechanically leads to transient increase in blood pressure (phase I), which, by activation of baroreceptors, simultaneously results in a slight bradycardia. Then, due to limited venous return and low stroke volume, blood pressure decreases with concomitant compensatory tachycardia (phase II). When the expiration is stopped (phase III), a further transient fall in blood pressure is observed because of pulmonary vasculature expansion, while heart rate increases. In phase IV, probably due to baro-receptors' activation, an abrupt rise in blood pressure above the initial values with concomitant bradycardia occurs. Based on changes in hemodynamic parameters, various indices can be calculated.

The subjects were asked to blow into a special tube to maintain a column of mercury at 40 mmHg for 15 s. The clamp was placed on the nose during blowing.

The ECG was continuously recorded during the procedure and for the following 60s.The VALSALVA RATIO reflects parasympathetic activity, was calculated during straining as the ratio between longest mean RR intervals to the shortest mean RR interval. Its value below 1.21 is considered to be abnormal.

Heart Rate response to Standing-Haemodynamic responses to active standing are assessed during this test. Prior to the manoeuvre, the subject is rested in a supine position. Directly after assumption of the upright position a displacement of 400-600 ml of blood into the leg veins occur, which decreases venous return, cardiac stroke volume and arterial BP. Due to very rapid onset of compensatory mechanisms arterial blood pressure changes only slightly in healthy patients. The compensatory mechanism can be divided into an immediate response with an abrupt fall in systolic and diastolic blood pressure and a visible acceleration of heart rate (first 30 s), a phase of early stabilization, which occurs after approximately 1–2 min, and a response to prolonged orthostasis lasting for more than 5 min.

Ewing's OR 30:15 Ratio- Baseline HR was obtained in the supine position, and then patients were asked to quickly stand upright onto their feet. The HR variability is recorded for at least 1 min of active standing. There is increase in HR at approx 15 s that is followed by a second period of relative bradycardia at approx 30 s. The 30:15 ratio is the RR interval at approx 30 s, divided by the RR interval at approx 15 s. The 30/15 ratio should be at least 1.04, but it decreases with age.

BP Response with Standing(Orthostatic Hypotension)-Fluctuations of blood pressure are assessed based on somewhat later responses to standing (first 4 min), and they are expressed as the difference between the baseline supine and the minimal blood pressure after standing up. A decline in systolic blood pressure by more than 20 mmHg and by more than 10 mmHg for diastolic blood pressure is considered abnormal

Hands Grip Test- A rise in diastolic blood pressure and heart rate is determined during isometric pressing of a handgrip dynamometer at approximately one third of the maximum contraction strength for 3–5 min. The normal response is rise in DBP by >10-15 mmhg and rise in HR by about 30% of the baseline.

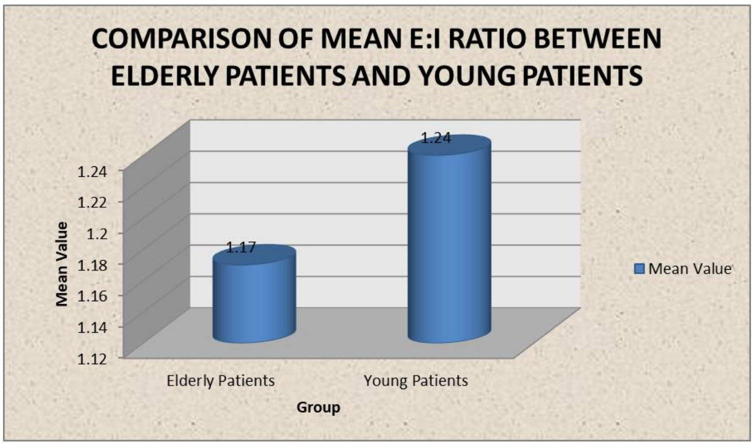
Cold pressor test- Immersion of hands or feet for about 60–90 s in cold water (4°C) should, due to activation of afferent pain and temperature fibres from the skin as well as emotional arousal, lead to sympathetic activation and increase in blood pressure and heart rate. A rise in diastolic blood pressure is calculated and it should normally exceed 15 mmHg.

Spoon Test- It is a non-quantitative bedside screening test to asses sudomotor dysfunction. Based on the concept that sliding of the convex side of a spoon on the forehead shows resistancein anhidrosis.

RESULTS

Table-1: Comparison of mean E: I Ratio between elderly patients and young patients

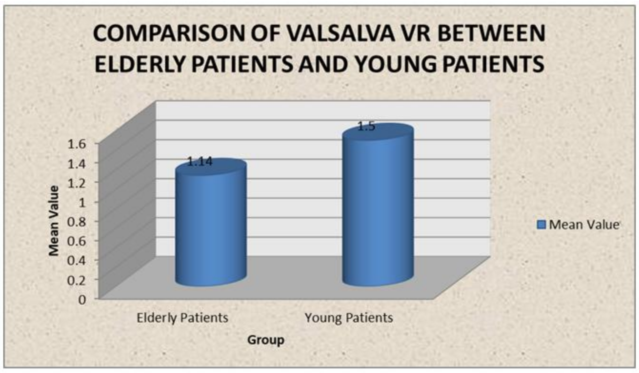
Group	No.	Mean ± SD	't' value	P value
Elderly Patients	250	1.17 ± 0.06	-8.833, df=498	0.008*
Young Patients	250	1.24 ± 0.11		



Graph-1: Comparison of mean E: I ratio between elderly patients and young patients

Table-2: Comparison of Valsalva VR between elderly patients and young patients

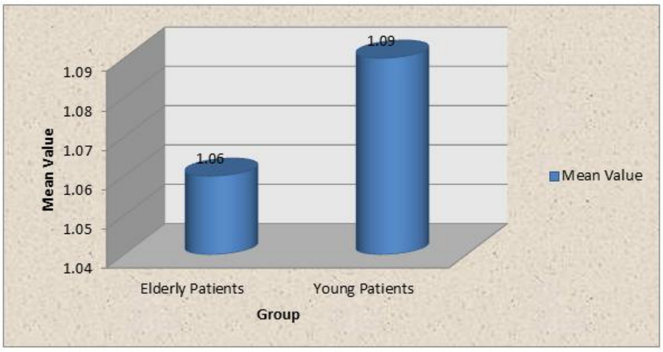
Group	No.	Mean ± SD	't' value	P value
Elderly Patients	250	1.38 ± 0.18	-10.462, df=498	0.000*
Young Patients	250	1.50 ± 0.06		



Graph-2: Comparison of Valsalva VR between elderly patients and young patients

Table-3: Comparison of standing heart rate between elderly patients and young patients 30:15 Ratios

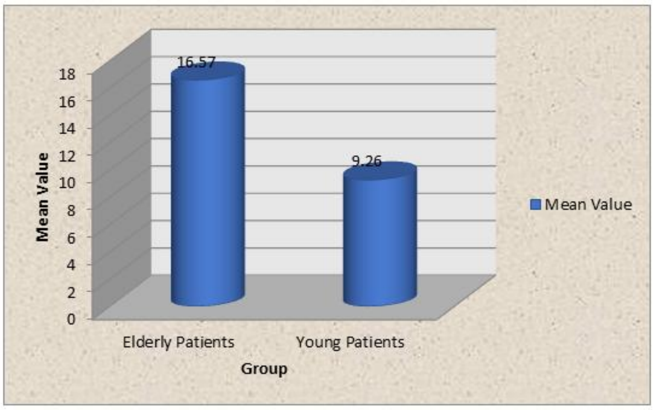
Group	No.	Mean ± SD	't' value	P value
Elderly Patients	250	1.06 ± 0.05	-10.004, df=498	0.000*
Young Patients	250	1.09 ± 0.04		



Graph-3: Showing variation in heart rate on standing in elderly and young patients

Table-4: Comparison of change in mean systolic blood pressure from resting to standing position between elderly patients and young patients

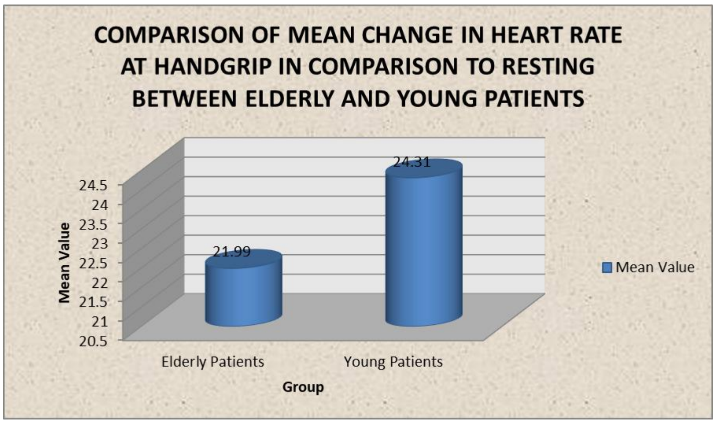
Group	No.	Mean ± SD	't' value	P value
Elderly Patients	250	16.57 ± 6.41	15.937, df=498	0.000*
Young Patients	250	9.26 ± 3.39		



Graph-4: Change in Systolic BP Resting to Standing between Elderly and Young Patients

Table-5: Comparison of mean heart rate during hand grip test between elderly patients and young patients

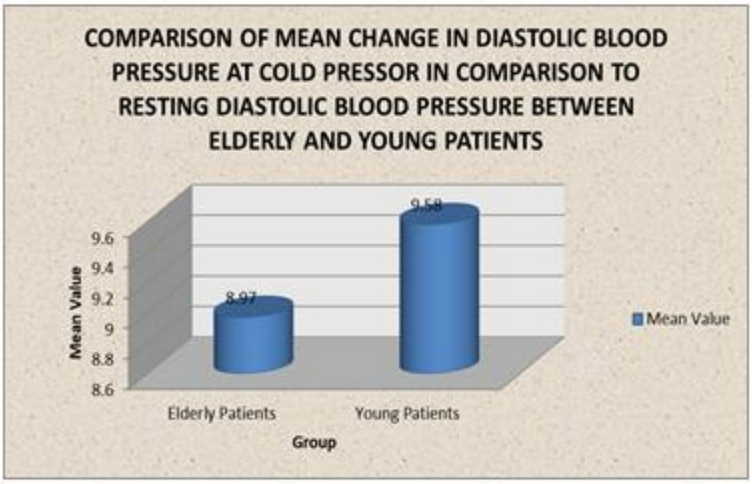
Group	No.	Mean ± SD	't' value	P value
Elderly Patients	250	97.75 ± 11.75	-3.482, df=497	0.001*
Young Patients	250	101.49 ± 12.29		

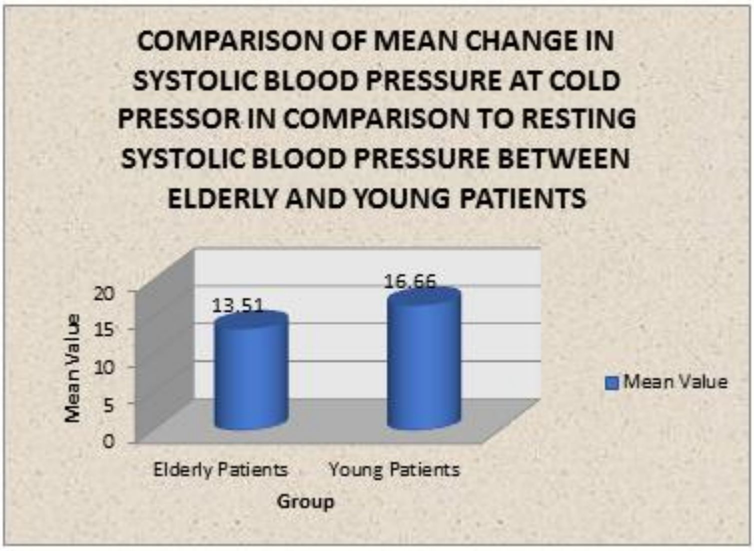


Graph-5: Comparison of Mean change in HR during Hand Grip Test in comparison to Resting HR between Elderly and Youngs

Table-6: Comparison of cold pressor test systolic and diastolic blood pressure between Elderly patients and young patients

Blood Pressure	Group	No.	Mean ± SD	't' value	P value
Systolic Blood Pressure	Elderly Patients	250	142.62 ± 9.75	-2.164, df=498	0.031*
	Young Patients	250	144.57 ± 10.36		
Diastolic Blood Pressure	Elderly Patients	250	91.35 ± 8.06	5.874, df=498	0.000*
	Young Patients	250	87.54 ± 6.35		





Graph-6: Comparison of mean change in DBP during Cold Pressor in comparison to Resting DBP

DISCUSSION

The autonomic nervous system has a craniosacral parasympathetic and a thoracolumbar sympathetic pathway and supplies every organ in the body. As no single cardiovascular autonomic test is sufficiently reliable it is recommended to use a combination of different test i.e.a battery of test that will measure both parasympathetic and sympathetic function ex- deep breathing test, Valsalva maneuver, pressor test[5].

The ANS has a big role to play in the homeostasis of the body. The ANS is primarily concerned with the regulation of day to day body functioning and in flight or fight response. As humans age, there is a myriad of problems which the body faces [6].

Aging is associated with autonomic dysfunction, and many clinical syndromes associated with older adults are due to inadequate autonomic responses to physiological stressors. As normal aging itself reduces the function of the ANS this fact compounds the challenge for the elderly. Considering the fact that many medications either act on the ANS or have side effects pertaining to the ANS, it should be kept in mind while designing treatment. The fact that a significant number of aged is likely to have a varying degree of ANS dysfunction should be kept by clinicians when planning treatment. Also the house design should be elder-friendly. Well-lit rooms, slip-resistant floors, and safe stairs. Handrails on both sides of the staircase and in the toilet can prevent a fall. Education to the elderly and their caregivers is a must to be in airy cool shaded places in summers as the sudomotor function is not optimal in the aged. For the same reason, the elderly areprone to heatstroke. This factor should be considered when prescribing drugs that can cause hypohydrosis e.g.- anticholinergic agents. Polypharmacy as far as possible should be avoided [7, 8].

In this study, we have found that age related ANS dysfunction is significant statistically. Awareness and education are needed at all levels whether it is the aged themselves, their caretakers, healthcare professionals or the society. Over time the demographic profile has changed and thanks to better health care and longevity we have now more elderly among us. Awareness of age-related problems is the need of the day for the society as a whole and ANS related issues need the attention of healthcare professionals [9, 10].

CONCLUSION

Hence we conclude that increasing age has an important role in declining autonomic functions. So in multiple of chronic diseases and in managing geriatric problems, the autonomic status of the subject and rate of its decline should be considered.

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