Section: Physiology

Original Research Article

THE IMPACT OF HYPERTENSION ON COGNITIVE FUNCTION: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Cognitive impairment is a growing public health concern globally, with increasing rates of dementia. Hypertension has been identified as a significant risk factor for cognitive decline, but the relationship between blood pressure and cognitive function remains unclear. This study investigates the association between cognitive function and blood pressure in hypertensive and normotensive individuals.

Materials and Methods: This cross-sectional study was conducted as a part of an ICMR-approved STS project in a tertiary care health centre. The study included 180 participants aged 18 years and above. Blood pressure was measured using a calibrated non-mercury LED sphygmomanometer, and cognitive function was assessed using the 30 points Montreal Cognitive Assessment (MoCA) test. Participants were divided into two groups based on blood pressure: normotensive (controls, n= 129) and hypertensive (cases, n=51). Data were analysed using unpaired t-tests and Pearson correlation analysis to assess the relationship between blood pressure parameters (systolic and diastolic) and MoCA scores.

Results: The study found a significant difference in systolic blood pressure (SBP), diastolic blood pressure (DBP), and MoCA scores between normotensive and hypertensive subjects ($p<0.001$). A significant negative correlation was observed between both SBP and DBP with MoCA scores ($p<0.001$). Hypertensive individuals (MoCA score- mean ± SD= 19.84 ± 3.84) exhibited lower cognitive function compared to normotensive individuals (MoCA score- mean ± SD= 25.89 ± 2.75).

Conclusion: The study highlights a significant association between elevated blood pressure and cognitive impairment. Elevated systolic and diastolic blood pressure are associated with cognitive impairment. Early intervention and blood pressure control may help prevent or manage cognitive decline, thereby improving quality of life.

Keywords: Hypertension, Cognitive function, Montreal Cognitive Assessment (MoCA) test.

INTRODUCTION

Cognitive impairment is one of the emerging public health issues Worldwide. As per the World Health Organization (WHO) statement 2017, 46.8 million elderly people suffer from cognitive impairment (dementia) globally. By 2030, this number is expected to rise two-fold in every 2 decades, and reaches 74.7 million. Many cognitive abilities start to deteriorate at a relatively young age, and the noticeable decline becomes more prevalent in old age. Cognitive functions decline at various rates and it vary greatly between individuals depending on various factors like genetics, lifestyle, and health conditions.[1] In India, the prevalence of cognitive impairment in the elderly was reported to vary from 3.5% to 11.5%.[2] Cognitive functions are mental processes such as perception, attention, memory, decision making, and language comprehension that allow us to carry out any task. Cognitive function

plays a very pivotal role in day to day routine and important for quality life.[3] The cognitive impairment is leading to dementia in many people. Cardiovascular disorders, such as high blood pressure, cardiomyopathies, arteriosclerosis, cerebral infarcts and strokes are associated with increased risk of cognitive impairment.[4]

The global burden of hypertension by 2010 was estimated at approximately 1.4 billion, and is projected to exceed 1.6 billion by 2025.[5] In South Asia, high blood pressure is ranked as the third most crucial risk factor for attributable burden of disease. Hypertension exerts a significant impact on cardiovascular health status and healthcare systems in India.[6] Blood pressure is expected to increase with the changes in life style.[7] The heart, kidney, brain, and arterial blood vessels are the prime targets of hypertensive damage and the changes in cerebrovascular system is the most frequent cause of cognitive impairment. Vascular ageing indicators, such as artery stiffness and small vessel dysfunction have been associated with cognitive impairment.[8,9]

High blood pressure influences the cognitive performance in different domains such as global cognitive functioning, attention, processing speed, executive functions, memory and visuospatial abilities. Association of High blood pressure and cognitive performance seems to be independent of demographic factors, other medical co-morbidities, and psychiatric illness.[10] This research aims to investigate the relationship between cognitive function and blood pressure, emphasizing the importance of screening individuals with hypertension for cognitive deficits. Early identification of these deficits can enable timely intervention and help prevent the progression to full-blown dementia.

MATERIALS AND METHODS

This cross-sectional study was conducted as a part of an ICMR-approved STS project in a tertiary care health centre. and it was conducted after the prior approval of Institutional Ethics Committee. Well informed written consent was obtained from all the subjects. In this study, we recorded the Blood Pressure and Montreal Cognitive Assessment (MoCA) score of 180 subjects and compared the association between the variability of cognitive function and blood pressure. Subjects above 18 years age, of both the sex with minimum high school education (10th class) were included in the study and subjects diagnosed with any psychological disorders or on treatment of any drugs that affects the cognitive ability, subjects having any other co-morbid conditions, alcoholics, chronic smokers, subjects having visual, auditory impairments or unable to speak and denied of their voluntary participation were excluded from the study.

The study subjects were divided into two groups based on the values of blood pressure as per JNC 7 guidelines. Group I consist of 129 normotensive subjects and group II consists of 51 hypertensive subjects. Subjects BMI was calculated from height and weight using Quetelet index. Subjects blood pressure was recorded using well calibrated non-mercury LED sphygmomanometer in sitting posture after 5 minutes of rest. Two readings were recorded with the gap of 5 minutes. The average of the two readings were considered.

Cognitive function assessment was done using 30-point Montreal Cognitive Assessment (MoCA) Test. MoCA test was administered in their understanding language (English/Hindi). MoCA assess the subjects' cognitive performance in different cognitive domains such as working memory, short-term memory recall, visuospatial abilities, different aspects of executive functions, phonemic fluency, verbal abstraction, attention, orientation, and language. MoCA score of greater than 26 was considered as normal.

Data was collected and were analyzed with SPSS software. Comparative analysis was done between normotensives and hypertensives using un-paired t-test and association between BP parameters and cognitive function (MoCA score) was assessed using Pearson correlation analysis. The results were expressed in mean and standard deviation.

RESULTS

Blood pressure and MoCA score were studied in 129 normotensive control and 51 hypertensive case subjects. Table 1 shows comparison of Age, BMI, blood pressure parameters and MoCA score between two study groups. Observations showed statistically non-significant difference between age ($p= 0.189$) & BMI ($p= 0.086$) and statistically significant difference between systolic blood pressure (SBP) ($P<0.001$), diastolic blood pressure (DBP) ($P<0.001$) and MoCA score ($P<0.001$) with higher values in hypertensive subjects compared to controls.

Table 2 shows Pearson correlation for systolic blood pressure (SBP), diastolic blood pressure (DBP) and MoCA score depict a significant negative correlation between blood pressure parameters (SBP & DBP) and MoCA score ($p< 0.001$). Graph 1 shows regression analysis of SBP and MoCa score. Graph 2 shows regression analysis of DBP and MoCa score. Both the graphs show a significant linear negative correlation between blood pressure parameters and MoCA score.

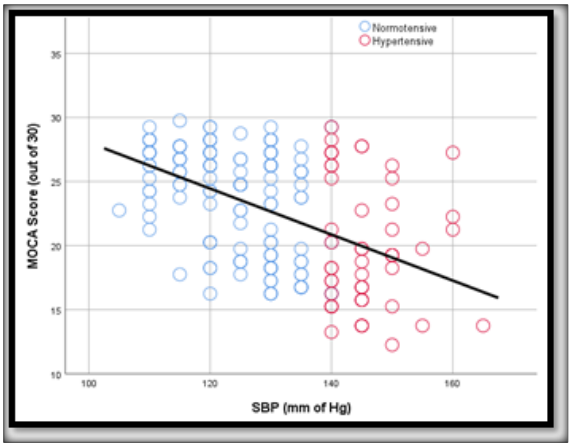

Figure 1: Regression analysis of MoCA score and Systolic Blood Pressure (SBP)

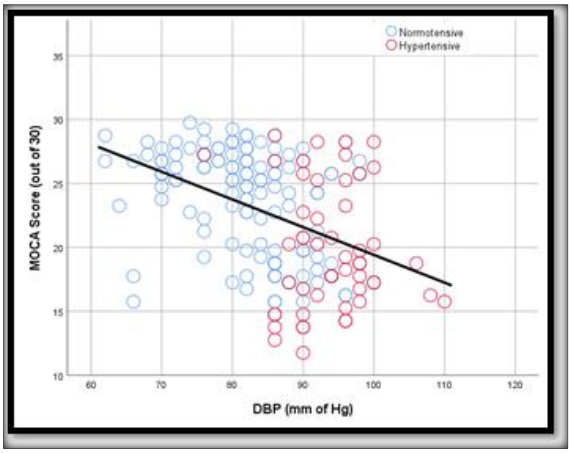

Figure 2: Regression analysis of MoCA score and Diastolic Blood Pressure (DBP)

Table 1: Comparison of Age, BMI, BP parameters & MoCA score between controls & cases

Parameters	Subjects	N (180)	Mean ± St. Dev.	Sig.
Age (Years)	Controls	129	46.47 ± 12.67	0.189
	Cases	51	49.8 ± 20.52	
BMI (Kg/m*2)	Controls	129	23.29 ± 20.52	0.086
	Cases	51	24.14 ± 2.87	
SBP (mm of Hg)	Controls	129	123.74 ± 8.5	0.000
	Cases	51	145.78 ± 6.00	
DBP (mm of Hg)	Controls	129	81.7 ± 8.32	0.000
	Cases	51	93.43 ± 6.3	
MOCA Score (out of 30)	Controls	129	25.89 ± 2.75	0.000
	Cases	51	19.84 ± 3.84	

Table 2: Correlation analysis of blood pressure parameters with MoCA score

Parameters		SBP (mm of Hg)	DBP (mm of Hg)	MoCA Score (30)
SBP (mm of Hg)	Pearson Correlation	1	.678**	-.491**
	Sig. (2-tail.)	--	.000	.000
	N	180	180	180
DBP (mm of Hg)	Pearson Correlation	.678**	1	-.441**
	Sig. (2-tail.)	.000	--	.000
	N	180	180	180
MoCA Score (30)	Pearson Correlation	-.491**	-.441**	1
	Sig. (2-tail.)	.000	.000	--
	N	180	180	180

** Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

The relationship between hypertension and cognitive function has been a topic of controversy for decades with conflicting results. Numerous studies investigated this association have produced inconsistent results, and a definitive relationship has not yet been established. While there is a significant likelihood that changes in blood pressure (both high and low) can impact cognitive function, on the other side studies have also reported either mild or no significant relationship between the two.[11]

In this study, blood pressure and cognitive function were assessed between hypertensive and normotensive people and the results showed a significant decline in the cognitive function in hypertensive people. The results of this study were aligned with the findings of a longitudinal study conducted on middle aged individuals (<55 years) showed a cognitive decline in hypertensive population, and better cognitive function in normotensive individuals.[12] Another longitudinal study also reported the impaired cognitive function in uncontrolled hypertensive people over 45 years old.[13]

Association between cognitive function and systolic and diastolic blood pressure were also assessed separately in this study, the results showed a negative correlation between the blood pressure parameters with the cognitive function. Similar results of negative association between systolic blood pressure and cognitive function was reported in a 20- year cohort study conducted on 13476 participants, the study concluded that midlife hypertension with systolic BP was associated with more cognitive decline than the late life hypertension.[14] An 8-year follow-up study reported a poor cognitive function with both increased Systolic and diastolic BP at young age (45-55 years).[15] Another study also reported that elevated systolic BP at any level of diastolic BP is associated with worse cognitive performance, and showed a

better cognitive function associated with higher DBP when SBP in normal limits. This was explained by that higher DBP protects against cerebral hypoperfusion thus better cognitive performance.[16] The relationship between blood pressure (BP) and cognitive disorders depends on both age and the type of BP. These studies found a stronger association of higher blood pressure (both SBP & DBP) with cognitive decline in midlife than in later years. While in late life high SBP and low DBP were associated with higher risk of dementia.

The precise explanation for this association is not yet fully understood. However, it is believed that high blood pressure can impact cerebral perfusion by inducing adaptive vascular changes and accelerating arteriosclerotic alterations in the brain, resulting in narrowed vessels and increased resistance. These changes disrupt the normal physiological processes of cerebral blood flow in hypertension by inducing structural and functional changes in cerebral arteries, such as lumen narrowing and increased wall-to-lumen ratio. These alterations impair blood flow, especially during ischemic events or low arterial pressure. Factors like the renin-angiotensin-aldosterone system and reactive oxygen species drive arterial remodelling, while endothelial dysfunction compromises vasodilation and myogenic reactivity. Hypertension also damages the blood-brain barrier through inflammation, oxidative stress, and vasoactive molecules, exposing neurons to cytotoxicity and increasing the risk of cognitive decline.[17] Additionally, hypertension is linked to reduced vagal tone and adrenergic predominance, which may contribute to both the progression of hypertension and related cognitive dysfunction.[10] All these factors collectively play a role in the intricate relationship between high blood pressure and cognitive impairment.

CONCLUSION

The findings of this study highlight the association of blood pressure and cognitive function. Elevated systolic and diastolic blood pressure are associated with cognitive impairment. Early intervention in hypertensive individuals may help prevent further cognitive deterioration. Controlling high blood pressure may help prevent or manage cognitive impairment, which can significantly impact quality of life. To fully understand the relationship between blood pressure and cognition, both systolic and diastolic blood pressure should be considered in relation to one another.

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