Journal of the American Society of Hypertension 8(8) (2014) 561–570

Research Article

The impact of hypertension on cerebral perfusion and cortical thickness in older adults

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Manuscript received February 25, 2014 and accepted April 7, 2014

Abstract

Hypertension may increase risk for dementia possibly because of its association with decreased cortical thickness. Disturbed cerebral autoregulation is one plausible mechanism by which hypertension impacts the cerebral structure, but the associations among hypertension, brain perfusion, and cortical thickness are poorly understood. The current sample consisted of 58 older adults with varying levels of vascular disease. Diagnostic history of hypertension and antihypertensive medication status was ascertained through self-report, and when available, confirmed by medical record review. All participants underwent arterial spin labeling and T1-weighted magnetic resonance imaging to quantify total and regional cortical perfusion and thickness. Analysis of covariance adjusting for medical variables showed that participants with hypertension exhibited reduced temporal and occipital brain perfusion and total and regional cortical thickness relative to those without hypertension. The effects of hypertension on total brain perfusion remained unchanged even after adjustment for age, although no such pattern emerged for cortical thickness. Decreased total brain perfusion predicted reduced thickness of the total brain and of the frontal, temporal, and parietal lobe cortices. Antihypertensive treatment was not associated with total cerebral perfusion or cortical thickness. This study provides initial evidence for the adverse effects of a diagnostic history of hypertension on brain hypoperfusion and reduced cortical thickness. Longitudinal studies are needed to investigate the role of hypertension and its interaction with other contributing factors (eg, age) in the manifestation of cerebral hypoperfusion and reduced cortical thickness. J Am Soc Hypertens 2014;8(8):561–570.

Keyword: Arterial spin labeling; Blood pressure; brain structure; cerebral blood flow.

Support for this work was provided by National Institutes of Health Grant R01HL084178.

Conflicts of interest: None.

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1933-1711/$ - see front matter
http://dx.doi.org/10.1016/j.jash.2014.04.002

Introduction

Approximately one of three U.S. adults has hypertension and nearly 50% of these individuals do not have it controlled.[1] This is concerning, as hypertension elevates mortality risk and leads to chronic medical conditions such as cardiovascular disease (CVD).[1] Hypertension is also associated with poor neurocognitive outcomes, including increased risk for Alzheimer's disease and vascular dementia.[2,3] These adverse outcomes may in part be attributed to the negative impact of hypertension on the brain. Hypertension is linked with stroke, greater white matter hyperintensity volume, and total and regional (eg, hippocampus) brain atrophy.[4–6] Although poorly understood, hypertension may also be associated with decreased cortical thickness—a sensitive risk factor for cognitive decline and Alzheimer's disease conversion.[7–11]

Hypertension is associated with reduced cerebral blood flow (CBF), which in turn, may serve as one possible etiology for adverse brain changes in hypertensive older adults. Specifically, hypertension may contribute to reduced CBF to cortical and subcortical structures.[12,13] Reduced brain perfusion has been correlated with decreased integrity of the cerebral structure, including decreased thickness of the cortex. Poorer cerebral circulation is linked with reduced cortical thickness in older adults, with specific effects found on frontal and temporal lobe cortices.[14] Individuals susceptible to lower brain perfusion levels (eg, Apolipoprotein E epsilon 4 carriers) also exhibit reduced thickness of regions vulnerable to aging (eg, medial prefrontal cortex) and Alzheimer's disease (eg, occipitotemporal and basal temporal cortices).[8,15–17]

The adverse effects of hypertension on the brain may be attenuated through medication therapy. Blood pressure lowering in older adults has been suggested to reduce the risk of stroke and the development of dementia.[18,19] Antihypertensive treatment is associated with better cerebral perfusion levels[20] and may also reduce risk of brain atrophy and lesions.[21] Nonetheless, the effects of antihypertensive drugs on the brain appear to be complicated. As an example, past work also shows antihypertensive treatment has limited effects on the brain structure and does not reduce dementia risk.[22,23] Furthermore, there is also extant evidence suggesting that antihypertensive medications may have no impact on cerebral perfusion levels.[24]

As reviewed previously, past studies have examined the effect of hypertension on CBF and brain morphometry, yet, no study has simultaneously investigated the associations among hypertension, brain perfusion, and cortical thickness. The purpose of the present study was to examine the associations among hypertension, CBF, and cortical thickness in a representative sample of older adults using T1-weighted magnetic resonance imaging (MRI) and arterial spin labeling (ASL), a perfusion MRI technique. We also examined whether antihypertensive treatment was associated with better cerebral perfusion and increased cortical thickness.

Methods

Participants

A total of 58 older adults were recruited from a larger National Institutes of Health study examining the effects of CVD on the brain. The present sample consisted of 58 participants with complete MRI, medical, and demographic data (Table 1). Participants were recruited from outpatient cardiology offices and advertisements in local papers and screened for study eligibility. The inclusion criteria

Table 1
Demographic and medical characteristics of older adults with and without hypertension

Characteristic	Hypertension	No Hypertension	Total Sample	t/χ^2
Demographic characteristic				
N	23	35	58	
Age, mean (SD)	69.61 (9.13)	64.29 (9.21)	66.40 (9.47)	2.16*
Gender (% women)	47.8	65.7	58.6	1.83
Years of education, mean (SD)	15.91 (2.63)	16.15 (2.55)	16.05 (2.56)	−0.34
Race (% Caucasian)	91.3	97.2	94.8	4.37
Medical characteristic				
Cardiac index, mean (SD)	2.80 (0.61)	2.75 (0.54)	2.77 (0.56)	0.31
Coronary artery disease (%)	30.4	11.4	19.0	3.26
Atrial fibrillation (%)	8.7	8.6	8.6	0.00
Diabetes (%)	17.4	2.9	8.6	3.72
Elevated total cholesterol (%)	73.9	34.3	50.0	8.72†
Antihyperlipidemics (%)	82.6	34.3	53.4	13.03†
Antihypertensive agents (%)	95.7	22.9	51.7	29.45†

SD, standard deviation.
Test statistics compare between group differences for those with and without hypertension.
* $P < .05$.
† $P < .01$.