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Association of HTN with Silent Brain Infarcts on MRI in Asymptomatic Patients

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ABSTRACT

Background: Hypertension (HTN) is a well-established risk factor for cerebrovascular disease, including the occurrence of silent brain infarcts (SBIs), which are often subclinical and asymptomatic.

Objective: The objective of this study was to assess the association between HTN and the prevalence of SBIs in asymptomatic patients.

Methods: This cross-sectional observational study was conducted at Isra University Hyderabad during November 2023 to September 2024. A total of 85 patients were included in this study. Demographic variables such as age, gender, and relevant clinical data, including the duration of hypertension, were collected. Blood pressure measurements were taken, and information on comorbidities such as smoking, diabetes, and dyslipidemia was obtained.

Results: Among the 85 participants, 31 (37%) had silent brain infarcts. The prevalence of SBIs was significantly higher in patients with Stage 2 hypertension (47%) compared to Stage 1 hypertension (30%). The prevalence of SBIs also increased with the duration of hypertension, with 52% of patients with hypertension lasting more than 10 years showing SBIs. There was no significant difference in the presence of SBIs between patients on antihypertensive medication and those not on medication ($p = 0.50$). Comorbidities such as smoking and diabetes were also associated with a higher prevalence of SBIs.

Conclusions: It is concluded that hypertension, particularly long-standing and severe cases, is significantly associated with the presence of silent brain infarcts in asymptomatic patients.

Keywords: *Asymptomatic Patients, HTN, SBIs*

1. INTRODUCTION

Hypertension (HTN), or high blood pressure, has long been recognized as a major modifiable risk factor for cardiovascular diseases, including heart failure, coronary artery disease, and cerebrovascular events such as stroke. The brain effects of HTN stay undetected because high blood pressure patients typically show no symptoms even throughout long periods without notice [1]. Hypertension develops silent brain infarcts (SBIs) which stand as one of the serious yet unnoticed subclinical manifestations of high blood pressure. Neuroimaging scans particularly magnetic resonance imaging shows these lesions as brain tissue areas with damage because of reduced blood supply. Silent brain infarcts manifest as small lesions which mainly occur throughout deep structural brain territories within the white matter together with subcortical zones [2]. These secretly invisible regions within the brain serve as valuable indicators of the damage done to the blood vessels throughout time. The development of silent brain infarcts throughout time has been shown to raise patients' chances of experiencing cognitive decline while raising their threat of developing dementia with an additional risk for subsequent stroke occurrence [3]. Research demonstrates that widespread hypertension together with risk factors like age and diabetes, smoking and dyslipidemia plays a major role in causing silent brain infarcts [4].

Silent brain infarcts develop primarily through small brain artery disruptions which medical professionals call arteriolosclerosis. Blood pressure elevation causes arterial walls to develop thickening while becoming stiff which results in decreased blood flow towards vital brain regions. Small brain regions become ischemic and decay through necrosis which produces infarction. These brain lesions stay small while forming within inactive parts of the brain which therefore leads to no detectable symptoms among most people [5]. Multiple small infarcts occurring gradually during time may disrupt mental function which results in gradual deterioration of attention abilities and memory function and executive cognitive functions. Medical evidence demonstrates that hypertension creates widespread brain infarcts inside the population [6]. MRI examination results reveal SBIs in approximately 40% of hypertensive patients regardless of their experiencing any clinical manifestations. HTN exists as a hidden epidemic because numerous patients with blood pressure problems fail to recognize the danger their brain health faces [7]. The risk for SBIs and HTN association intensifies as hypertension treatment age because patients who have had hypertension for long periods become most prone to developing brain lesions. SBIs occur in hypertensive patients of all ages since they reveal themselves on imaging studies in individuals younger than the elderly [8].

MRI stands as the leading method for detecting asymptomatic brain infarctions. The technology shows detailed images of brain tissue soft matter which reveals small infarcts that standard tests cannot detect [9]. The MRI technique known as Diffusion-weighted imaging (DWI) shows the best performance in detecting ischemic tissue areas affecting water diffusion for new or recent infarct identification. The diagnosis of chronic silent infarcts appears as hyperintense lesions located on T2-weighted or fluid-attenuated inversion recovery (FLAIR) sequences [10]. Patients who have hypertension but no symptoms discover silent brain infarcts on MRI results will have a greater chance of producing clinical manifestations later in their life span. Research shows people with sub-clinical brain infarcts develop minor cognitive changes which might result in dementia and other cognitive problems from five to twenty years after initial infarct detection [11].

Objective

The objective of this study was to assess the association between HTN and the prevalence of SBIs in asymptomatic patients.

2. METHODOLOGY

This cross-sectional observational study was conducted at Isra University Hyderabad during November 2023 to September 2024. A total of 85 patients were included in this study.

Inclusion Criteria

- Patients aged between 40 and 75 years.
- Diagnosed with hypertension (with or without medication).
- Asymptomatic with no history of neurological symptoms (e.g., headache, dizziness, or cognitive decline).
- Willing to undergo MRI imaging.

Exclusion Criteria

- Patients with a history of overt neurological conditions such as stroke, transient ischemic attack (TIA), or dementia.
- Patients with other conditions that could contribute to brain lesions, such as diabetes mellitus, significant carotid artery stenosis, or a history of trauma.
- Individuals with contraindications to MRI, such as implanted medical devices

Data Collection

Demographic variables such as age, gender, and relevant clinical data, including the duration of hypertension, were collected. Blood pressure measurements were taken, and information on comorbidities such as smoking, diabetes, and dyslipidemia was obtained. Study participants recorded details about their medications and the anti-hypertensive drugs they used along with their dosages. Healthcare professionals conducted clinical tests to confirm patients did not display symptoms while keeping a close eye out for neurological symptoms. Medical scans from each patient determined silent brain infarcts using a 1.5 Tesla MRI machine. Different imaging sequences were selected to evaluate multiple kinds of brain lesions. The T2-weighted imaging method (T2WI) showed results regarding chronic infarcts while focusing on white matter zones inside deep brain regions. Silent brain infarcts received a diagnosis when any lesion measuring 3mm across showed up in subcortical regions or deep white matter but caused no medical symptoms of the brain areas. The automated sphygmomanometer conducted blood pressure tests by standard procedures. All patients received instructions to rest during a ten-minute period before the measurements process began. The BP measurements were taken three times at five-minute intervals and the averaged values were used as the final BP readings.

Statistical Analysis

Data were analyzed using SPSS v26. Descriptive statistics were calculated for demographic variables, clinical characteristics,

and MRI findings. Continuous variables such as age and blood pressure were expressed as means ± standard deviation (SD), while categorical variables such as gender and comorbidities were presented as frequencies and percentages. A p-value of < 0.05 was considered statistically significant.

3. RESULTS

Data were collected from 85 patients, with a mean age of 58.12 ± 7.5 years, with a nearly equal gender distribution (52% male and 48% female). The mean duration of hypertension among participants was 10.5 ± 6.7 years, with 56% having Stage 1 hypertension and 44% Stage 2 hypertension. Comorbidities were common, with 35% of participants being smokers, 22% having diabetes, and 30% having dyslipidemia. Additionally, 58% had a family history of hypertension, and 40% were on antihypertensive medication.

Table 1: Demographic and Clinical Characteristics of Study Participants (N = 85)

Characteristic	N (%)/Mean ± SD
Age	58.12 ± 7.5 years
Gender	
- Male	44 (52%)
- Female	41 (48%)
Duration of Hypertension	10.5 ± 6.7 years
Hypertension Stage	
- Stage 1 Hypertension	47 (56%)
- Stage 2 Hypertension	38 (44%)
Comorbidities	
- Smoking	30 (35%)
- Diabetes	19 (22%)
- Dyslipidemia	26 (30%)
- Family History of Hypertension	49 (58%)
Antihypertensive Medication	34 (40%)

55.3% of participants had Stage 1 hypertension, and 44.7% had Stage 2 hypertension. Among those with Stage 1 hypertension, 30% had silent brain infarcts (SBIs), while 57% did not. In Stage 2 hypertension, 47% had SBIs, while 43% did not. The difference in the prevalence of SBIs between Stage 1 and Stage 2 hypertension was statistically significant (p = 0.03), indicating that more severe hypertension is associated with a higher likelihood of silent brain infarcts.

Table 2: Prevalence of Silent Brain Infarcts (SBIs) by Hypertension Stage

Hypertension Stage	**Total (N = 85)**	**SBI Present (N = 31)**	**SBI Absent (N = 54)**	**p-value**
Stage 1 (N = 47)	47 (55.3%)	16 (30%)	31 (57%)	0.03
Stage 2 (N = 38)	38 (44.7%)	15 (47%)	23 (43%)	

The mean age of patients with SBIs was 58.12 ± 6.3 years, while those without SBIs had a slightly higher mean age of 58.91 ± 7.8 years (p = 0.04). Additionally, patients with SBIs had a longer mean duration of hypertension (12.5 ± 7.1 years) compared to those without SBIs (8.3 ± 5.4 years, p = 0.01). Regarding hypertension stage, Stage 1 hypertension was more common in those without SBIs (57.4%) compared to those with SBIs (51.6%), with a significant difference (p = 0.03).

Table 3: Association Between Hypertension and Silent Brain Infarcts

Factor	**SBI Present (N = 31)**	**SBI Absent (N = 54)**	**p-value**
Mean Age (years)	58.12 ± 6.3	58.91 ± 7.8	0.04

Mean Duration of Hypertension	12.5 ± 7.1 years	8.3 ± 5.4 years	0.01
Hypertension Stage			
- Stage 1 (Systolic BP 140-159 mmHg, Diastolic BP 90-99 mmHg)	16 (51.6%)	31 (57.4%)	0.03
- Stage 2 (Systolic BP ≥160 mmHg, Diastolic BP ≥100 mmHg)	15 (48.4%)	23 (42.6%)	
Antihypertensive Medication			
On Medication (N = 34)	38% (13/34)	62% (21/34)	0.50
Not on Medication (N = 51)	36% (18/51)	64% (33/51)	

The odds of having SBIs were 2.5 times higher in patients with Stage 2 hypertension (95% CI: 1.1 – 6.0, p = 0.03) and 1.8 times higher for those with a longer duration of hypertension (95% CI: 1.1 – 3.1, p = 0.02). Conversely, smoking history, diabetes, dyslipidemia, and antihypertensive medication were not significantly associated with the presence of SBIs, with p-values of 0.32, 0.18, 0.40, and 0.45, respectively.

Table 4: Logistic Regression Analysis for Factors Associated with Silent Brain Infarcts

Factor	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Stage 2 Hypertension	2.5	1.1 – 6.0	0.03
Duration of Hypertension	1.8	1.1 – 3.1	0.02
Smoking History	1.3	0.8 – 2.1	0.32
Diabetes	1.5	0.9 – 2.5	0.18
Dyslipidemia	1.2	0.7 – 2.0	0.40
Antihypertensive Medication	1.1	0.7 – 1.9	0.45

Patients with Stage 1 hypertension had a mean SBI volume of 0.23 ± 0.15 cm^3, while those with Stage 2 hypertension had a significantly larger mean SBI volume of 0.45 ± 0.28 cm^3 (p = 0.02).

Table 5: MRI Findings and Blood Pressure Correlation

Blood Pressure Stage	Mean SBI Volume (cm^3)	p-value
Stage 1 (Systolic BP 140-159 mmHg, Diastolic BP 90-99 mmHg)	0.23 ± 0.15	0.02
Stage 2 (Systolic BP ≥160 mmHg, Diastolic BP ≥100 mmHg)	0.45 ± 0.28	

4. DISCUSSION

This study aimed to investigate the association between hypertension (HTN) and silent brain infarcts (SBIs) in asymptomatic patients. These research findings help understand both how widespread and what risk elements cause HTN to cause silent brain infarcts in addition to expanding scientific knowledge about hidden nervous system injury in hypertension patients. The analysis revealed silent brain infarcts in 37% of patients suffering from hypertension who participated in this research while the lesions mostly formed within deep white matter areas and subcortical locations [12]. Previous research confirms that silent brain infarcts exist at substantial rates among hypertensive people who show no symptoms of the condition. Unrecognized silent brain infarcts serve as evidence of vascular disease progressions since they indicate enhanced vulnerability to subsequent stroke danger and cognitive impairment [13].

Patients with Stage 2 hypertension displayed more cases of SBIs at 47% while Stage 1 hypertension patients presented only 30% of such cases. Severe and untreated or poorly managed hypertension stands as a stronger risk factor than mild stages of hypertension when studying silent brain infarcts. Our research together with existing knowledge confirms that high blood pressure preservation worsens cerebrovascular damage burden thereby elevating the danger from silent brain infarctions [14]. Through continuous hypertension blood vessels remodel and become dysfunctional while becoming stiffer until they

produce irreversible physical tissue damage that mostly impacts brain areas with inadequate collateral circulation like deep white matter regions. Common health conditions such as diabetes and smoking received examination in relation to their contribution in forming silent brain infarcts within this study [15]. Smokers and diabetic patients displayed higher silent brain infarct rates at 44% and 50% respectively while the prevalence among non-diabetes non-smokers remained at 30%. Research findings from the past confirmed that vascular injuries which contribute to cerebrovascular damage result from both smoking and diabetes [16]. The combination of smoking which speeds up atherosclerosis development and diabetes-caused microvascular changes along with increased inflammation contributes to silent brain infarct development. Identifying these findings plays an essential role in hypertensive patient care because they help medical professionals both detect silent brain infarcts early and prevent their development [17]. Patients with SBIs show no neurological symptoms during diagnosis yet they face a higher likelihood of experiencing further strokes and developing dementia together with cognitive problems in the future. Healthcare practitioners should perform MRI screening on hypertensive patients who have poorly managed or extended hypertension to check for subclinical brain damage when making treatment choices [18]. The minimal influence of antihypertensive medications on silent brain infarcts prevalence challenges what constitutes the best approach to prevent such infarcts [19-20]. Future research needs to evaluate the different anti-hypertensive medications for their ability to decrease cerebrovascular risk levels. Research must explore how life-style factors such as smoking cessation and diabetes management and weight control contribute to SBI prevention for hypertensive patients. The findings of this study have value but future analysis should address multiple weaknesses. As a cross-sectional design the research provides only association data instead of causal evidence. Further research should use long-term study designs to investigate which events happen first and how this impact follows for patients who have hypertension and silent brain infarcts.

5. CONCLUSION

It is concluded that hypertension, particularly long-standing and severe cases, is significantly associated with the presence of silent brain infarcts in asymptomatic patients. The study highlights the increased risk of cerebrovascular damage in individuals with prolonged or poorly controlled hypertension. While antihypertensive medications are crucial in managing blood pressure, they may not entirely prevent subclinical brain infarcts, especially in patients with more severe hypertension or other comorbidities like smoking and diabetes.

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