

# Association between Carotid Intima-Media Thickness and Acute Ischaemic Stroke

Dr. Sanjay Regulapati<sup>1</sup>, Dr. Srividyalakshmi<sup>2</sup>, Dr. Gandra Sumanth Kumar<sup>3</sup>, Dr. Jeevika Ujjappa<sup>4</sup>

<sup>1</sup>Junior Resident Department of Radiodiagnosis, J J M Medical College, Davangere, Karnataka, India  
Corresponding Author Email: [Sanjayregulapati\[at\]gmail.com](mailto:Sanjayregulapati[at]gmail.com)

<sup>2</sup>Department of Radiodiagnosis, J J M Medical College, Davangere, Karnataka, India.  
Email: [Vidyarathnam.1802\[at\]gmail.com](mailto:Vidyarathnam.1802[at]gmail.com)

<sup>3</sup>Junior Resident Department of Radiodiagnosis, J J M Medical College, Davangere, Karnataka, India  
Email: [sumanth24988\[at\]gmail.com](mailto:sumanth24988[at]gmail.com)

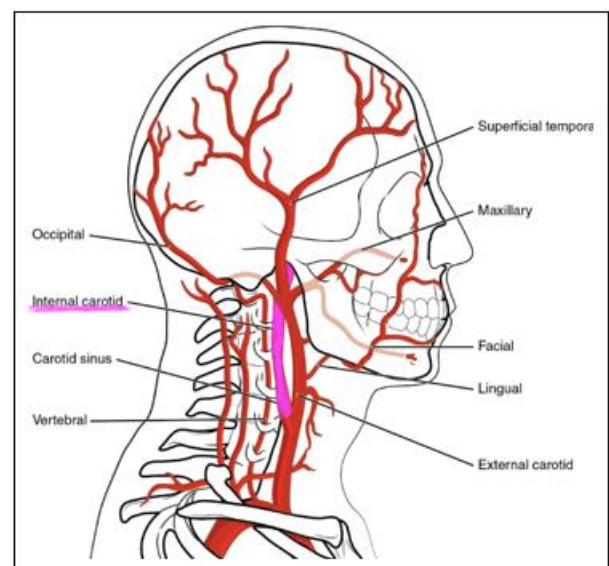
<sup>4</sup>Professor & Head of Department of Radiodiagnosis, J J M Medical College, Davangere, Karnataka, India

**Abstract:** **Background:** Stroke is a major public health concern and the second leading cause of death globally. In India, modifiable risk factors like hypertension, smoking, and diabetes mellitus are highly prevalent and significantly contribute to cerebrovascular events. Carotid intima-media thickness (CIMT) is a non-invasive ultrasonographic marker of subclinical atherosclerosis and vascular remodeling. Identifying a link between CIMT and acute ischemic stroke can help predict stroke risk early and guide preventive interventions. **Objective:** To evaluate the association between common carotid artery intima-media thickness (CCA-IMT), carotid plaque scores, and acute ischemic stroke, and to assess how these ultrasound findings correlate with established vascular risk factors. **Methods:** This statistically powered, cross-sectional, case-control study included 80 participants (cases and controls) at Bapuji Hospital, Davangere, over a 3-month period (May–July 2024). All subjects underwent carotid Doppler ultrasonography using a 9–15 MHz linear transducer to measure CIMT and detect carotid plaques. Cases were first-time acute ischemic stroke patients confirmed by clinical and radiological criteria, while controls presented with non-stroke neurological complaints. Data on hypertension, diabetes, dyslipidemia, smoking status, and fasting biochemical profiles were collected. CIMT > 0.8 mm was considered abnormal. **Results:** Patients with acute ischemic stroke demonstrated significantly higher CIMT and plaque scores compared to controls. Abnormal CIMT correlated strongly with elevated fasting blood sugar (mean  $130 \pm 20$  mg/dL), total cholesterol (mean  $220 \pm 30$  mg/dL), male gender, hypertension ( $p < 0.01$ ), dyslipidemia ( $p < 0.01$ ), and diabetes mellitus ( $p < 0.05$ ). The presence and number of carotid plaques also showed a direct association with stroke risk. **Conclusion:** Increased CIMT and carotid plaque scores are significantly associated with acute ischemic stroke and reflect cumulative exposure to modifiable cerebrovascular risk factors. While CIMT itself may not be a direct cause, it serves as a reliable surrogate marker of atherosclerotic burden. Early detection via carotid ultrasound, along with aggressive management of hypertension, diabetes, dyslipidemia, and smoking, is crucial in reducing stroke risk.

**Keywords:** Carotid Intima-Media Thickness (CIMT), Acute Ischemic Stroke, Atherosclerosis, Carotid Plaque Score Doppler Ultrasonography, Common Carotid Artery (CCA), Hypertension, Stroke Risk Prediction Cerebrovascular Disease, IMT-Intima media thickness.

## 1. Introduction

- Stroke or cerebrovascular accidents are debilitating emergent neurological conditions characterized by acute cerebral hypoperfusion, and are the third most common cause of disability and the second leading cause of death worldwide. The mortality rate associated with stroke in India (except in is higher than that in other Asian countries
- The most common risk factors for stroke in India include a high prevalence of active tobacco smoking, followed by hypertension and type-2 diabetes mellitus (T2DM). Active smoking is a significant risk factor for vascular dysfunction, lipid profile alteration, and impaired platelet and endothelial dysfunction
- The consequent inflammatory processes primarily cause the progression of three atherosclerotic diseases: coronary heart disease (CHD), stroke, and peripheral artery disease (PAD).
- This study aims to show association of carotid intima-media thickness (CIMT) and plaque progression with elevated risk of stroke/atherosclerosis.



**Figure 1:** Common carotid and bifurcation illustration image

## 2. Materials and Methods

**Study design and setting:** This Cross-sectional study comparison was conducted at Department of radio-diagnosis JJM Medical college Davangere, Karnataka.

**Study population:** This is a case-control study of 80 individuals performed over a period of three months from May 2024 to July 2024. Individuals presenting to outpatient department with no previous history of cerebrovascular ischemia were recruited and underwent detailed history and Carotid Doppler examination.

**Inclusion criteria:** The cases of acute first-time ischemic stroke in who visited our institution were collected for a period of three months.

**Exclusion criteria:** Patients with isolated transient ischemic attack, stroke as a result of apparent cardioembolic origin, or a history of previous stroke were excluded. Patients prescribed with Diuretics /antiplatelet drugs, CKD, congestive heart failure/history of alcohol consumption were also excluded.

**Ethical committee** approval obtained from institution and consent of participants was taken prior to ultrasound examination

**Sample size:** Intended to study a minimum of 80 cases

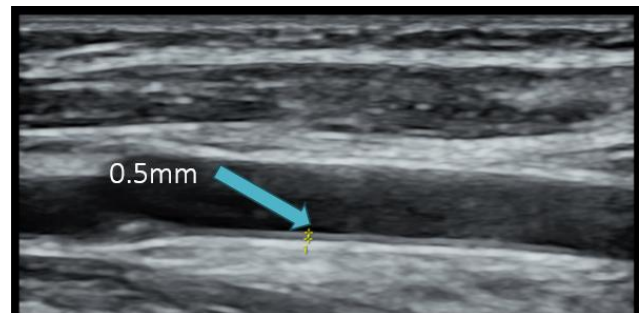
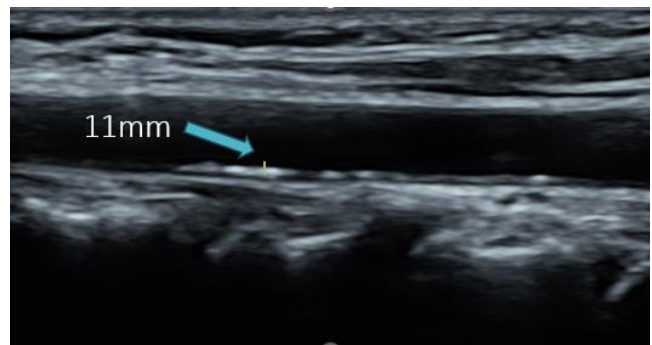
**Sample technique:** Cohran's equation used for estimation of sample size and stratified random sampling was used to divide patients into cases and controls

### Statistical analysis

In this study of 80 asymptomatic individuals, those with abnormal carotid intima-media thickness (CIMT > 0.8 mm) demonstrated significantly higher fasting blood sugar (FBS) and total cholesterol levels compared to those with normal CIMT, with mean FBS and cholesterol levels of  $130 \pm 20$  mg/dL and  $220 \pm 30$  mg/dL, respectively, in the abnormal group versus  $110 \pm 15$  mg/dL and  $180 \pm 20$  mg/dL in the normal group ( $p < 0.01$ ).

Male gender was also significantly associated with abnormal CIMT ( $p = 0.03$ ).

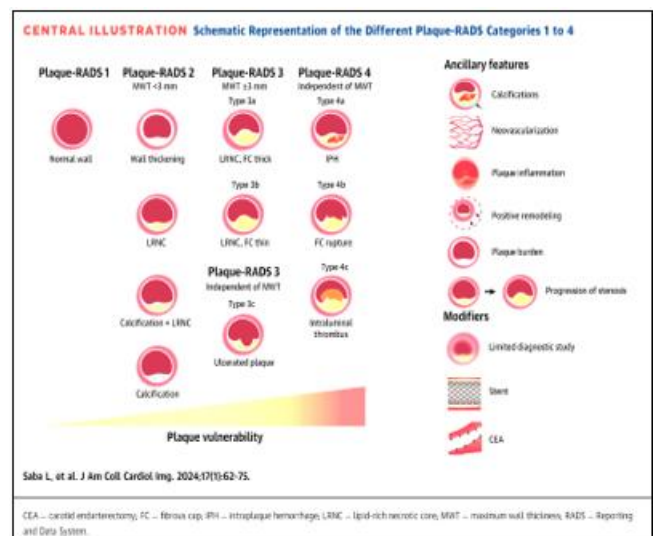
Hypertension showed the strongest correlation ( $p < 0.01$ ), underscoring its critical role in vascular remodeling and atherosclerosis progression. Similarly, dyslipidemia ( $p < 0.01$ ) was strongly linked to increased CIMT, reflecting its impact on lipid deposition and arterial wall thickening. Diabetes ( $p < 0.05$ ) also emerged as a significant factor, highlighting its contribution to endothelial dysfunction and accelerated atherogenesis



Longitudinal scan of carotid ultrasonogram. Measurement of CCA-IMT (large arrows) at the far wall of the common carotid artery is shown.

### Plaque score:

In this study, the **carotid plaque score** was used as a semi-quantitative measure to assess the burden of atherosclerosis across multiple carotid artery segments. Plaques were defined as focal thickening of the arterial wall with either calcified or non-calcified components protruding into the vessel lumen. The plaque score was calculated by evaluating six anatomical sites bilaterally: the common carotid arteries (CCA), carotid bifurcations, and internal carotid arteries (ICA). Each site was assigned a score of 0 or 1 based on the presence or absence of plaque, with a **total score ranging from 0 to 6**. A higher plaque score was positively correlated with acute ischemic stroke and reflected greater exposure to vascular risk factors such as hypertension, diabetes, and dyslipidemia, thus serving as an important indicator of cerebrovascular disease severity.



### 3. Results

**Cases:** Individuals presenting to outpatient department with definitive clinical criteria for stroke were recruited as cases. Acute ischemic stroke was confirmed based on clinical presentation, diffusion-weighted MR imaging, and apparent diffusion coefficient maps. Patients with isolated transient ischemic attack, stroke as a result of apparent cardioembolic origin, or a history of previous stroke were excluded.

**Controls:** Control subjects were recruited from patients with symptoms such as headache, migraine, and dizziness during the same period.

Demographic data was obtained for all cases and controls prior to further evaluation these include sex, current smoking habit, history of hypertension and diabetes and dietary intake

All the cases and controls were then subjected to non-invasive ultrasound neck and CT/MRI brain imaging

Parameter	Normal CIMT ( $\leq 0.8$ mm)	Abnormal CIMT ( $> 0.8$ mm)	p-value
Fasting Blood Sugar	$110 \pm 15$ mg/dL	$130 \pm 20$ mg/dL	$< 0.01$
Total Cholesterol	$180 \pm 20$ mg/dL	$220 \pm 30$ mg/dL	$< 0.01$

Risk Factor	Association with Abnormal CIMT	p-value
Male Gender	Positive Association	0.03
Hypertension	Strongest Correlation	$< 0.01$
Dyslipidemia	Strong Association	$< 0.01$
Diabetes Mellitus	Moderate Association	$< 0.05$

### 4. Discussion

The development of sonography technology has allowed the noninvasive evaluation of atherosclerosis in the carotid arteries. The initial manifestation of carotid atherosclerosis is characterized by a subtle increase in vascular IMT, the progression of which leads to plaque formation and vascular narrowing.

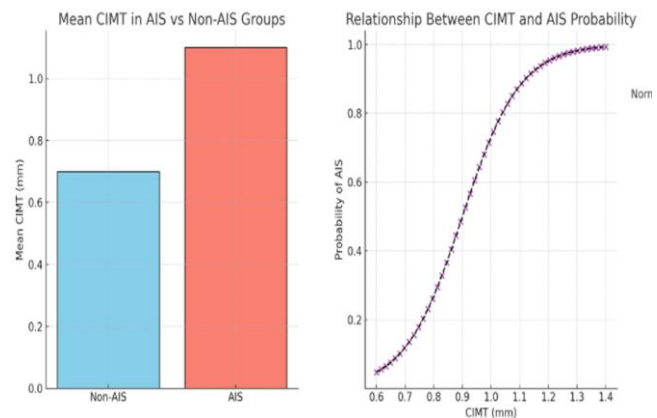
The existence of carotid artery plaques is associated with increased risk of stroke, irrespective of their location. Hence Carotid atherosclerosis, even in the absence of advanced stenosis, appears to be associated with a risk of stroke. Therefore, we evaluated the value of CCA-IMT and plaque score for identifying patients at high risk of cerebral infarction.

Hence, in our study we emphasize that IMT reflects exposure to cerebrovascular risk factors, IMT itself may not play a direct role in ischemic infarction and that it can be considered an intermediate factor in the causal pathway between clinical risk factors and stroke.

Therefore, to prevent atherosclerosis of the carotid arteries in patients at risk for stroke, strict control of hypertension, hyperglycemia, smoking habits, and dyslipidemia seem to be important.

Therapeutic interventions with blood pressure-lowering agents and lipid-lowering agents, as well as multifactorial interventions in patients with diabetes, can slow the progression of or even reduce carotid IMT.

Carotid IMT has been recently recognized as a surrogate marker for evaluating therapeutic interventions in atherosclerotic disease



AIS: Acute ischemic stroke, CIMT: Carotid intimal thickness

#### Limitation of present study:

Only limitation in our study was that we focused on acute stroke only and did not include diabetic subjects with chronic ischemic stroke or isolated transient ischemic attack (TIA).

In future, the relationship between IMT and plaque score and ischemic stroke must be examined in all patients with diabetes, segregating them into patients with strokes (TIA, acute, and chronic) and without strokes.

Major proportion of the epidemiological and metabolic risk factors seem to show a positive correlation with increased intimal thickness.

### 5. Conclusions

Increased CCA-IMT and plaque score were correlated with acute ischemic stroke. However, the greater CCA-IMT and plaque score found in ischemic stroke for patients seem to be induced by cerebrovascular risk factors, and CCA-IMT and plaque score seem to be vascular risk factors that reflect the degree of exposure to cerebrovascular risk factors.

Therefore, CCA-IMT and plaque score in our study can be considered intermediate factors in the causal pathway between cerebrovascular risk factors and ischemic stroke, not independent factors for ischemic stroke. To prevent ischemic stroke in progressive atherosclerosis, strict control of hyperglycemia, hypertension, smoking, and dyslipidemia, together with monitoring of CCA-IMT and carotid plaque, may be important.

Our study concluded that abnormal intimal thickness and risk factors assessed in the study showed positive correlation and both of them combined predict risk of cerebrovascular ischaemia

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