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Research Article

CT Angiography in Evaluation of Cerebrovascular Accidents: A Cross-Sectional Study

[1]Dr.Gundeti Dwethi, [2] Dr.Dondha Shravani, [3] Dr.Mushini Deepthi

[1]Assistant Professor , Department of Radiology , Government medical College and Hospital Nizamabad, Telangana, India
[2]Assistant Professor , Department of Radiology , Government medical College and Hospital ,Nizamabad, Telangana ,India
[3]Assistant Professor , Department of Radiology ,Government medical College and Hospital, Nizamabad, Telangana, India.

*Corresponding Author
Dr.Mushini Deepthi,
Assistant Professor Department of Radiology , Government medical College and Hospital, Nizamabad, Telangana, India.

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Abstract: ***Introduction:*** Cerebrovascular accidents (CVAs) are a major cause of morbidity and mortality worldwide. Rapid identification of vascular abnormalities is essential for accurate diagnosis and management. CT angiography (CTA) has emerged as a valuable non-invasive imaging modality for evaluating intracranial and extracranial cerebral vasculature in patients with stroke.**Material and Methods**: This hospital-based cross-sectional study included 156 patients with clinically suspected cerebrovascular accidents who underwent CT angiography. Demographic characteristics, risk factors, stroke subtype, and CT angiographic findings were analyzed. Data were evaluated using descriptive and inferential statistics, with $p<0.05$ considered statistically significant.**Results:** The mean age of the patients was 59.8±12.6 years, and 62.2% were males. Hypertension (66.7%) and diabetes mellitus (43.6%) were the most common risk factors. Ischemic stroke accounted for 80.8% of cases, while hemorrhagic stroke constituted 19.2%. Atherosclerotic plaques were the most frequent CTA finding (53.2%), followed by significant arterial stenosis (37.2%) and complete arterial occlusion (29.5%). Severe stenosis was observed in 44.9% of patients with stenotic lesions. The middle cerebral artery was the most commonly involved vessel (38.6%), and anterior circulation involvement was noted in 73.5% of cases. Significant vascular lesions were more prevalent among hypertensive (79.8% vs. 50.0%, $p<0.001$) and diabetic patients (80.9% vs. 61.4%, $p=0.006$).**Conclusion:** CT angiography effectively detects vascular abnormalities associated with cerebrovascular accidents, particularly atherosclerotic disease, arterial stenosis, and occlusion. It provides valuable information regarding vascular territory involvement and contributes significantly to the diagnostic evaluation and management of stroke patients.

Keywords: Cerebrovascular accident; CT angiography; Ischemic stroke; Arterial stenosis; Cerebral circulation; Stroke imaging.

INTRODUCTION

Cerebrovascular accident (CVA), commonly referred to as stroke, remains one of the leading causes of mortality and long-term disability worldwide. Advances in acute stroke management have highlighted the importance of rapid and accurate imaging for early diagnosis, identification of the underlying vascular pathology, and selection of appropriate therapeutic strategies. Contemporary stroke care increasingly relies on imaging techniques capable of evaluating both the brain parenchyma and cerebral vasculature in a timely manner [1,2].

Computed tomography (CT) is widely used as the initial imaging modality in patients presenting with suspected stroke because of its rapid acquisition, broad availability, and ability to detect intracranial hemorrhage. However, assessment of the cerebral vasculature is equally important, particularly in ischemic stroke, where large-vessel occlusion, arterial stenosis, and collateral circulation status influence treatment decisions and clinical outcomes. CT angiography (CTA) has emerged as an integral component of modern stroke imaging protocols, providing high-resolution visualization of intracranial and extracranial arteries with minimal delay in patient evaluation [2–4].

CTA offers several advantages, including rapid image acquisition, widespread accessibility, and the ability to identify vascular abnormalities such as atherosclerotic disease, arterial occlusion, aneurysms, and arteriovenous malformations. Furthermore, CTA plays a crucial role in the detection of large-vessel occlusions and assessment of collateral circulation, which are important determinants of eligibility for endovascular interventions and prognostication in acute ischemic stroke [3–5].

Recent developments in stroke imaging have further emphasized the role of CTA in comprehensive cerebrovascular assessment. Advances in image reconstruction, vessel analysis, and integration with other CT-based techniques have enhanced the diagnostic value of CTA in routine clinical practice. Despite these advances, the spectrum and distribution of CTA findings may vary across populations due to differences in demographic characteristics and vascular risk factors [4–6].

The present study was undertaken to evaluate the role of CT angiography in patients with cerebrovascular

accidents and to analyze the pattern of vascular abnormalities detected on CTA in a tertiary care hospital setting.

MATERIALS AND METHODS

Study Design and Setting: This hospital-based cross-sectional observational study was conducted at a tertiary care teaching hospital in India. Written informed consent was obtained from all participants or their legally authorized representatives prior to enrollment.

Study Population: Patients presenting with clinical features suggestive of cerebrovascular accident (CVA) and referred for CT angiography of the cerebral vessels were considered for inclusion in the study.

Sample Size: A total of 156 consecutive patients fulfilling the eligibility criteria were included in the study. Consecutive sampling was employed to minimize selection bias and to ensure representation of the spectrum of cerebrovascular pathology encountered in routine clinical practice.

Inclusion Criteria:

- Patients aged 18 years and above.
- Patients with clinical suspicion of acute or subacute cerebrovascular accident.
- Patients who underwent non-contrast CT brain followed by CT angiography of intracranial and extracranial cerebral vessels.
- Patients willing to participate in the study and provide informed consent.

Exclusion Criteria:

- Patients with known hypersensitivity to iodinated contrast agents.
- Patients with severe renal impairment (estimated glomerular filtration rate <30 mL/min/1.73 m^2).
- Pregnant women.
- Patients with a history of traumatic cerebrovascular injury.
- Patients with previously diagnosed intracranial vascular malformations or treated cerebrovascular lesions.
- CT angiographic examinations with significant motion artifacts or technically inadequate image quality.

Imaging Protocol: All patients initially underwent non-contrast CT examination of the brain to identify intracranial hemorrhage and early ischemic changes. Subsequently, CT angiography was performed using a multidetector CT scanner. Non-ionic iodinated contrast medium (70–90 mL) was administered intravenously through an 18–20 gauge cannula at a flow rate of 4–5 mL/s using a power injector, followed by a saline flush. Image acquisition extended from the aortic arch to the cranial vertex. Multiplanar reformations (MPR), maximum intensity projection (MIP), and volume-rendered (VR) images were generated for detailed vascular assessment.

Image Analysis: CT angiographic images were independently evaluated by two experienced radiologists who were blinded to each other's findings. The following parameters were assessed:

- Presence and location of arterial stenosis.
- Degree of luminal narrowing.
- Complete arterial occlusion.
- Vessel wall calcification.
- Intracranial aneurysms.
- Arteriovenous malformations.
- Distribution of vascular involvement in anterior and posterior circulation.
- Associated non-contrast CT findings.

The severity of stenosis was categorized as:

- Mild: <50% luminal narrowing.
- Moderate: 50–69% luminal narrowing.
- Severe: ≥70% luminal narrowing.
- Occlusion: Complete absence of contrast opacification.

Outcome Measures: The primary outcome was to evaluate CT angiographic findings in patients with cerebrovascular accidents and determine the pattern and distribution of vascular abnormalities.

Secondary outcomes included:

- Correlation of vascular lesions with demographic characteristics.
- Assessment of risk factors associated with cerebrovascular abnormalities.
- Identification of the most commonly affected arterial territories.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 156 patients with clinically suspected cerebrovascular accident who underwent CT angiography were included in the study. The mean age of the study population was 59.8 ± 12.6 years. The largest proportion of patients belonged to the 51–60 years age group (28.8%), followed by the 61–70 years age group (26.9%). Males constituted 62.2% of the study population, while females accounted for 37.8%. Hypertension was the most common risk factor, present in 66.7% of patients, followed by diabetes mellitus (43.6%), smoking (37.8%), dyslipidemia (33.3%), and coronary artery disease (18.6%) (Table 1).

Ischemic stroke was the predominant type of cerebrovascular accident, observed in 126 (80.8%) patients, whereas hemorrhagic stroke was identified in 30 (19.2%) patients. CT angiography demonstrated atherosclerotic plaques in 53.2% of patients, making it the most frequent vascular abnormality. Significant arterial stenosis and complete arterial occlusion were detected in 37.2% and 29.5% of patients, respectively. Intracranial aneurysms and arteriovenous malformations were identified in 7.1% and 2.6% of cases, respectively. Normal CT angiographic findings were observed in 15.4% of patients (Table 2).

Among the 58 patients with arterial stenosis, severe stenosis (≥70% luminal narrowing) was the most common category, accounting for 44.9% of cases, followed by moderate stenosis (31.0%) and mild stenosis (24.1%). Evaluation of vascular territories revealed that the middle cerebral artery was the most frequently involved vessel (38.6%), followed by the internal carotid artery (25.8%). Involvement of the posterior cerebral artery, anterior cerebral artery, vertebral artery, and basilar artery was observed less frequently (Table 3).

Assessment of cerebral circulation demonstrated a predominance of anterior circulation involvement, which was present in 73.5% of patients, while posterior circulation involvement was noted in 26.5% of patients (Table 4).

A significant association was observed between hypertension and the presence of major vascular lesions on CT angiography. Significant vascular abnormalities were detected in 79.8% of hypertensive patients compared with 50.0% of non-hypertensive patients ($p<0.001$). Similarly, diabetic patients exhibited a significantly higher prevalence of vascular lesions than non-diabetic patients (80.9% vs. 61.4%, $p=0.006$) (Table 5).

Among patients with ischemic stroke, atherosclerotic plaques were identified in 62.7% of cases. Significant arterial stenosis and complete arterial occlusion were present in 43.7% and 34.9% of patients, respectively. Intracranial aneurysms were detected in 4.0% of ischemic stroke patients, while only 9.5% demonstrated normal CT angiographic findings. These findings indicate that a substantial proportion of ischemic strokes were associated with demonstrable vascular abnormalities on CT angiography (Table 6).

Table 1. Demographic Characteristics and Risk Factors of Study Participants (n=156)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
≤40	14	9.0
41–50	28	17.9
51–60	45	28.8
61–70	42	26.9
>70	27	17.3
Mean age	59.8 ± 12.6 years	
Gender		
Male	97	62.2
Female	59	37.8
Risk Factors		
Hypertension	104	66.7
Diabetes Mellitus	68	43.6
Smoking	59	37.8
Dyslipidemia	52	33.3
Coronary Artery Disease	29	18.6

Table 2. Distribution of Stroke Types and CT Angiographic Findings (n=156)

Variable	Frequency (n)	Percentage (%)
Type of Stroke		
Ischemic Stroke	126	80.8
Hemorrhagic Stroke	30	19.2
CT Angiographic Findings		
Atherosclerotic Plaques	83	53.2
Significant Arterial Stenosis	58	37.2
Complete Arterial Occlusion	46	29.5

Intracranial Aneurysm	11	7.1
Arteriovenous Malformation	4	2.6
Normal CTA Findings	24	15.4

Table 3. Severity of Stenosis and Distribution of Vascular Involvement on CT Angiography

Variable	Frequency (n)	Percentage (%)
Degree of Stenosis (n=58)		
Mild (<50%)	14	24.1
Moderate (50–69%)	18	31.0
Severe (≥70%)	26	44.9
Arterial Territory Involved (n=132)		
Middle Cerebral Artery	51	38.6
Internal Carotid Artery	34	25.8
Posterior Cerebral Artery	15	11.4
Anterior Cerebral Artery	12	9.1
Vertebral Artery	10	7.6
Basilar Artery	10	7.6

Table 4. Distribution According to Cerebral Circulation Involved (n=132)

Circulation Territory	Frequency (n)	Percentage (%)
Anterior Circulation	97	73.5
Posterior Circulation	35	26.5
Total	132	100.0

Table 5. Association Between Risk Factors and Significant Vascular Lesions on CT Angiography (n=156)

Risk Factor	Lesion Present n (%)	Lesion Absent n (%)	p-value
Hypertension (n=104)	83 (79.8)	21 (20.2)	<0.001
No Hypertension (n=52)	26 (50.0)	26 (50.0)	
Diabetes Mellitus (n=68)	55 (80.9)	13 (19.1)	0.006
No Diabetes (n=88)	54 (61.4)	34 (38.6)	

Table 6. Summary of Major Vascular Lesions Detected in Ischemic Stroke Patients (n=126)

Vascular Lesion	Frequency (n)	Percentage (%)
Atherosclerotic Plaques	79	62.7
Significant Stenosis	55	43.7
Complete Occlusion	44	34.9
Intracranial Aneurysm	5	4.0
Normal CTA Findings	12	9.5

DISCUSSION

The present study evaluated the role of CT angiography in patients with cerebrovascular accidents and demonstrated that ischemic stroke constituted the majority of cases (80.8%), with vascular abnormalities being identified in a substantial proportion of patients. The mean age of the study population was 59.8 years, and males were more frequently affected than females. These findings are consistent with contemporary stroke literature, which indicates that stroke incidence increases with advancing age and remains more prevalent among men in many populations [7,8].

Hypertension and diabetes mellitus emerged as the most common vascular risk factors in the present study. Furthermore, both conditions showed a significant association with the presence of major vascular lesions on CT angiography. These observations are in agreement with recent evidence highlighting the strong relationship between traditional cardiovascular risk factors and the development of intracranial and extracranial atherosclerotic disease, arterial stenosis, and large-vessel occlusion in ischemic stroke patients [9,10].

Atherosclerotic plaques represented the most frequent CT angiographic abnormality in our study, followed by arterial stenosis and complete vessel occlusion. Intracranial atherosclerosis remains an important mechanism of ischemic stroke, particularly in Asian populations, and CTA has been shown to provide valuable information regarding plaque burden, luminal narrowing, and vascular occlusion. Recent studies have emphasized the utility of CTA in identifying

atherosclerotic lesions and predicting the underlying mechanism of vessel occlusion in acute ischemic stroke [10,11].

Among stenotic lesions, severe stenosis accounted for the largest proportion of cases. This finding is clinically relevant because higher grades of arterial narrowing are associated with impaired cerebral perfusion and increased risk of recurrent ischemic events. Recent advances in CT-based vascular imaging have improved the detection and characterization of intracranial arterial stenosis, enhancing diagnostic confidence and facilitating treatment planning [11,12].

The middle cerebral artery was the most commonly affected vessel in the present study, followed by the internal carotid artery. Additionally, anterior circulation involvement was observed in nearly three-fourths of patients. These findings are consistent with contemporary stroke imaging studies, which report that anterior circulation large-vessel occlusions, particularly involving the middle cerebral artery, account for a substantial proportion of acute ischemic strokes and are frequently evaluated using CT angiography because of their therapeutic implications [13,14].

The ability of CTA to rapidly identify large-vessel occlusion has become increasingly important in the era of mechanical thrombectomy. Recent investigations have demonstrated that CTA-based assessment of vascular occlusion and collateral circulation provides important prognostic information and contributes significantly to patient selection for endovascular therapy. The widespread availability and rapid acquisition time of CTA make it particularly suitable for emergency stroke evaluation [13–15].

Another important observation in the present study was the high prevalence of demonstrable vascular abnormalities among ischemic stroke patients. Only a small proportion of patients exhibited normal CT angiographic findings. This underscores the value of CTA as a comprehensive vascular imaging technique capable of detecting clinically significant abnormalities that may not be apparent on non-contrast CT alone. Emerging technologies, including automated vessel analysis and artificial intelligence-assisted CTA interpretation, are expected to further improve diagnostic performance and workflow efficiency in stroke imaging [15,16].

CONCLUSION

CT angiography is a valuable non-invasive imaging modality for the evaluation of cerebrovascular accidents, providing detailed assessment of intracranial and extracranial vascular anatomy and pathology. In the present study, ischemic stroke was the predominant subtype, with atherosclerotic plaques, arterial stenosis, and vessel occlusion representing the most common CT angiographic abnormalities. The middle cerebral artery and anterior circulation were the most frequently involved vascular territories. Furthermore, hypertension and diabetes mellitus showed significant associations with major vascular lesions. CT angiography facilitates early identification of underlying vascular abnormalities, assists in determining the etiology of stroke, and contributes to timely therapeutic decision-making, thereby playing an important role in the comprehensive evaluation of patients with cerebrovascular accidents.

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