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Role of Non-Contrast Multidetector Computed Tomography in the Initial Evaluation of Suspected Stroke: A Prospective Cross-Sectional Study from Hamdard Imaging Centre, New Delhi

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Abstract

Background: Stroke is a leading cause of mortality and long-term disability worldwide. Rapid differentiation between ischemic and hemorrhagic stroke is essential because early treatment decisions, including thrombolytic eligibility and neurosurgical referral, depend heavily on initial neuroimaging. Non-contrast multidetector computed tomography (NCCT/MDCT) remains the most widely available first-line imaging modality in emergency stroke evaluation due to its speed, accessibility, and high sensitivity for intracranial hemorrhage. ***Aim:*** To evaluate the role of non-contrast multidetector computed tomography in the initial radiological assessment of patients presenting with clinically suspected stroke and to describe the distribution of ischemic and hemorrhagic stroke patterns across age groups. ***Methods:*** This hospital-based prospective cross-sectional observational study was conducted at Hamdard Imaging Centre, New Delhi, from March 2024 to June 2024. A total of 88 adult patients (18–85 years) with clinical suspicion of stroke who underwent NCCT brain were included in the final analysis. Demographic details, presenting complaints, and CT findings were recorded. NCCT findings were classified into acute stroke-related, chronic stroke-related, and other intracranial/non-stroke abnormalities. Confirmed stroke cases were further categorized as ischemic or hemorrhagic. Descriptive statistics were used to summarize the data. Association between age group and temporal stroke pattern was assessed using the likelihood ratio chi-square test, with $p < 0.05$ considered statistically significant. ***Results:*** Among 88 patients, the mean age was 54.2 ± 17.8 years (range: 18–85 years), and 65.9% were male. Most patients (75.0%) belonged to the 40–90-year age group. NCCT demonstrated acute stroke-related findings in 73 patients (83.0%) and chronic stroke-related findings in 15 patients (17.0%). Among 72 radiologically confirmed stroke cases, ischemic stroke was identified in 47 patients (65.3%) and hemorrhagic stroke in 25 patients (34.7%). A statistically significant association was observed between age group and temporal pattern of stroke-related findings (likelihood ratio = 9.62, $p = 0.002$), with older patients more frequently represented in the chronic stroke-related imaging group. ***Conclusion:*** NCCT/MDCT is a practical and clinically valuable first-line imaging modality in the initial evaluation of suspected stroke, particularly for rapid exclusion of intracranial hemorrhage and early radiological classification of stroke type. In this cohort, ischemic stroke was more common than hemorrhagic stroke, and older patients were more frequently represented among chronic stroke-related imaging findings. Larger studies with standardized stroke severity measures and confirmatory imaging are recommended to further define diagnostic performance and clinical outcomes.

Keywords: Stroke; Ischemic stroke; Hemorrhagic stroke; Non-contrast CT; Multidetector computed tomography; Neuroimaging; Acute stroke

INTRODUCTION

Stroke is one of the leading causes of death and long-term disability worldwide and remains a major public health burden, particularly in low- and middle-income countries [1,2]. It is a neurological emergency caused by an abrupt interruption of cerebral blood flow or by rupture of a cerebral blood vessel, resulting in focal or global neurological dysfunction. Broadly, stroke is classified into ischemic stroke, which results from vascular occlusion and reduced cerebral perfusion, and hemorrhagic stroke, which results from intracranial bleeding due to vessel rupture. Accurate and rapid differentiation between these two major stroke subtypes is critical because treatment strategies differ substantially [1].

Non-contrast computed tomography (NCCT) of the brain remains the cornerstone of initial imaging in patients with suspected acute stroke [3]. It is widely available, rapid, non-invasive, and highly effective for identifying intracranial hemorrhage, mass effect, midline shift, and other urgent intracranial abnormalities [1,3,4]. Although NCCT may be less sensitive for very early ischemic changes in the hyperacute phase compared with magnetic resonance imaging (MRI), it remains the first-line modality in most emergency settings due to its accessibility and ability to rapidly exclude hemorrhage before thrombolytic consideration [5,6].

Multidetector computed tomography (MDCT) offers additional advantages over earlier CT systems, including faster acquisition, thinner slices, and improved image quality, thereby facilitating early assessment of stroke-related abnormalities [7,8]. In routine clinical practice, MDCT is frequently used to evaluate suspected stroke, characterize lesion patterns, and guide immediate management decisions [7,9].

The present study was undertaken to assess the utility of NCCT performed on an MDCT platform in the initial radiological evaluation of patients presenting with clinically suspected stroke at a tertiary imaging centre. The study also aimed to describe the demographic distribution of patients, characterize CT patterns, and determine the relative frequency of ischemic and hemorrhagic stroke in the study cohort.

MATERIALS AND METHODS

2.1 Study Design and Setting

This was a hospital-based prospective cross-sectional observational study conducted at Hamdard Imaging Centre, New Delhi, over a period of four months from March 2024 to June 2024.

2.2 Ethical Approval

Ethical approval was obtained from the Institutional Ethics Committee of Jamia Hamdard University, New Delhi (Ref. No. 05/24, dated 27/05/2024). The study was conducted in accordance with institutional ethical standards and the principles of the Declaration of Helsinki.

2.3 Study Population

The study included adult patients presenting with clinical suspicion of stroke who underwent non-contrast CT (NCCT) brain during the study period.

Inclusion Criteria

- Patients aged 18 years and above
- Clinically suspected stroke referred for NCCT brain
- Both male and female patients
- Patients with adequate clinical and imaging records for analysis

Exclusion Criteria

- Incomplete imaging or clinical documentation
- Repeat scans of the same patient during the study period
- Intracranial pathology unrelated to the presenting neurological event where stroke classification was not feasible
- Cases in which radiological categorization could not be reliably established

2.4 Sample Size

A total of 88 patients met the eligibility criteria and were included in the final analysis.

2.5 Imaging Protocol

All patients underwent non-contrast CT (NCCT) brain using a Siemens SOMATOM EMOTION 16-slice MDCT scanner. Images were acquired according to the standard institutional stroke protocol. The CT examinations were reviewed for:

- Presence of acute ischemic changes
- Evidence of intracranial hemorrhage
- Chronic infarcts or encephalomalacic changes
- Age-related atrophy and small-vessel ischemic changes
- Mass effect, edema, midline shift, or herniation
- Other intracranial abnormalities relevant to the clinical presentation

2.6 Operational Definitions

For the purpose of analysis, NCCT findings were categorized as follows:

- Acute stroke-related findings: Imaging features suggestive of acute or recent cerebrovascular insult, including acute ischemic infarction or acute intracranial hemorrhage.
- Chronic stroke-related findings: Chronic infarcts, encephalomalacia, gliosis, lacunar infarcts, or established chronic ischemic changes.
- Confirmed stroke cases: Cases with radiological findings consistent with cerebrovascular pathology and classifiable as ischemic or hemorrhagic stroke.
- Other intracranial/non-stroke findings: Cases with abnormalities not fulfilling radiological criteria for definite stroke classification or representing alternate intracranial pathology.

Radiological Stroke Classification

- Ischemic stroke: Focal hypodensity, loss of gray-white differentiation, sulcal effacement, hyperdense vessel sign, territorial or lacunar infarction, or chronic infarct-related parenchymal changes consistent with ischemic cerebrovascular disease.
- Hemorrhagic stroke: Hyperdense intraparenchymal, intraventricular, or subarachnoid

hemorrhage of non-traumatic cerebrovascular pattern on NCCT.

2.7 Data Collection

Clinical and demographic information was recorded using a structured proforma, including:

- Age
- Sex
- Presenting complaints
- Age group (18–40 years; 40–90 years)
- CT findings
- Temporal pattern of stroke-related findings (acute vs chronic)
- Radiological stroke subtype (ischemic vs hemorrhagic) among confirmed stroke cases

2.8 Statistical Analysis

Data were entered and analyzed using IBM SPSS Statistics version 29.0.10.

- Continuous variables were summarized as mean ± standard deviation (SD) and range.
- Categorical variables were expressed as frequency and percentage.
- The association between age group and temporal pattern of stroke-related findings (acute vs chronic) was assessed using the likelihood ratio chi-square test, given sparse cell counts.
- A p-value < 0.05 was considered statistically significant.

RESULTS

3.1 Demographic Characteristics

A total of 88 patients with clinically suspected stroke were included in the study. The age of the patients ranged from 18 to 85 years, with a mean age of 54.2 ± 17.8 years. Most patients (75.0%, n = 66) belonged to the 40–90-year age group, while 25.0% (n = 22) were in the 18–40-year age group. Of the 88 patients:

- 58 (65.9%) were male
- 30 (34.1%) were female

Table 1: Descriptive statistics for age

Variable	Range	Mean	SD
Age (years)	18–85	54.2	17.8

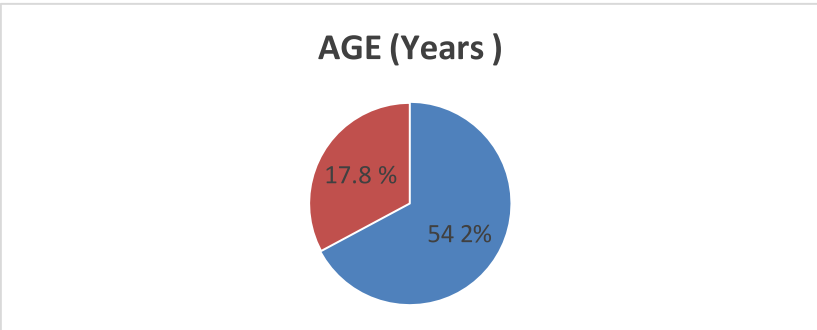

Figure 1: Graph Showing Mean 54.2, S.D 17.8

Table 2: Sex distribution

Sex	Frequency	Percentage (%)
Male	58	65.9
Female	30	34.1

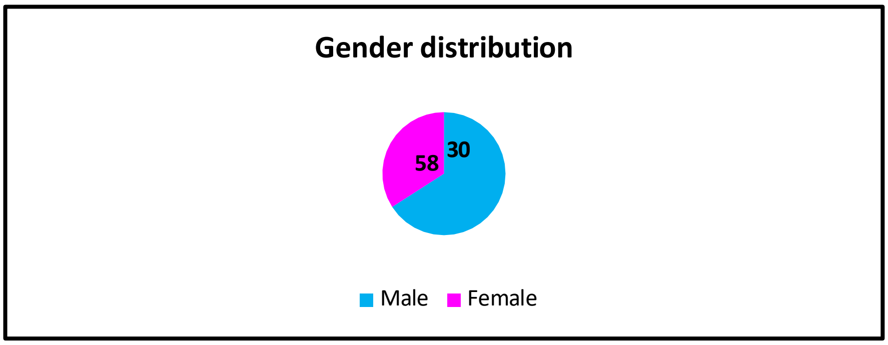

Figure 2: Graph depicts the male participants were predominant with 65.9% than females with only 34.1%

Table 3: Age-group distribution

Age group (years)	Frequency	Percentage (%)
18–40	22	25.0
40–90	66	75.0

3.2 Age Distribution According to Sex

Among males, 69.0% (n = 40) were aged 40–90 years and 31.0% (n = 18) were aged 18–40 years. Among females, 86.7% (n = 26) were aged 40–90 years and 13.3% (n = 4) were aged 18–40 years.

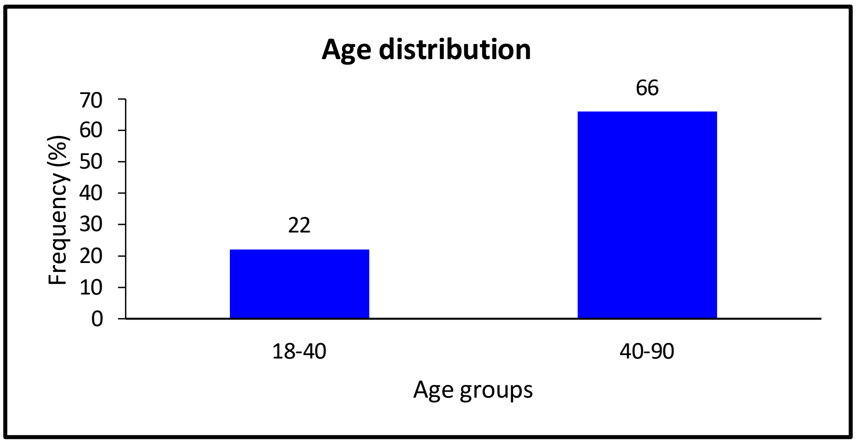

Figure 3: Graph showing the majority of participants under the category of age distribution more than 40-90 years with 75 % followed

Table 4: Age group according to sex

Age group (years)	Male n (%)	Female n (%)
18–40	18 (31.0)	4 (13.3)
40–90	40 (69.0)	26 (86.7)

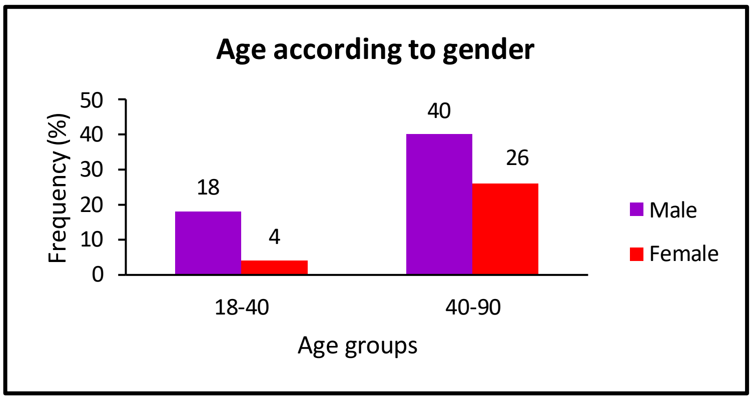

Figure 4: Graph showing according to gender

3.3 Temporal Pattern of Stroke-Related Findings on NCCT

NCCT findings were categorized into acute and chronic stroke-related patterns.

- 73 patients (83.0%) demonstrated acute stroke-related findings
- 15 patients (17.0%) demonstrated chronic stroke-related findings

Table 5. Temporal pattern of stroke-related findings

Stroke-related imaging pattern	Frequency	Percentage (%)
Acute	73	83.0
Chronic	15	17.0

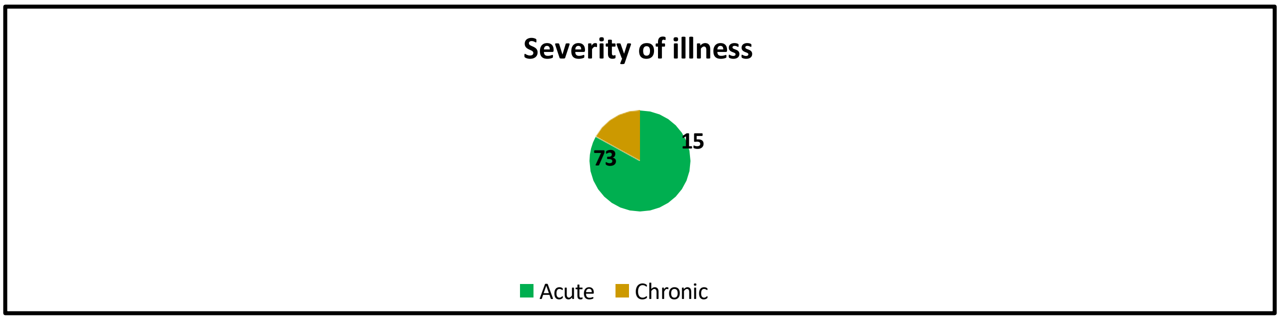

Figure 5: Graph revealed that 83 % Acute were found

3.4 Association Between Age Group and Temporal Pattern of Stroke-Related Findings

A statistically significant association was observed between age group and temporal pattern of stroke-related findings on NCCT. Among patients aged 18–40 years, all 22 (100%) demonstrated acute stroke-related findings, and none had chronic stroke-related findings. Among patients aged 40–90 years, 51 (77.3%) had acute findings and 15 (22.7%) had chronic findings. The likelihood ratio chi-square test showed a statistically significant association between age group and temporal pattern of stroke-related findings (likelihood ratio = 9.62, p = 0.002).

Table 6. Association between age group and temporal pattern of stroke-related findings

Age group (years)	Acute n (%)	Chronic n (%)	Likelihood ratio	p-value
18–40	22 (30.1*)	0 (0.0)	9.62	0.002*
40–90	51 (69.9*)	15 (100.0)		

*Percentages shown within acute/chronic column totals.
Statistically significant at p < 0.05.

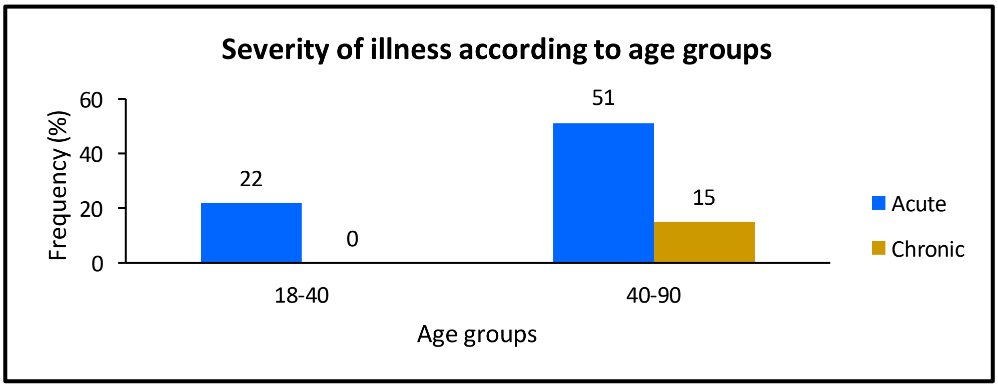

Figure 6: The Likelihood ratio test was used to find the association between severity of illness and age groups. There was an association (p < 0.05) between severity of illness and age groups.

3.5 Association Between Sex and Temporal Pattern of Stroke-Related Findings

Among male patients:

- 48 (82.8%) had acute stroke-related findings
- 10 (17.2%) had chronic stroke-related findings

Among female patients:

- 25 (83.3%) had acute stroke-related findings
- 5 (16.7%) had chronic stroke-related findings

No statistically significant association was observed between sex and temporal pattern of stroke-related findings (chi-square = 0.01, p = 0.946).

Table 7. Association between sex and temporal pattern of stroke-related findings

Sex	Acute n (%)	Chronic n (%)	Chi-square	p-value
Male	48 (65.8*)	10 (66.7*)	0.01	0.946
Female	25 (34.2*)	5 (33.3*)		

*Percentages shown within acute/chronic column totals.

Not statistically significant.

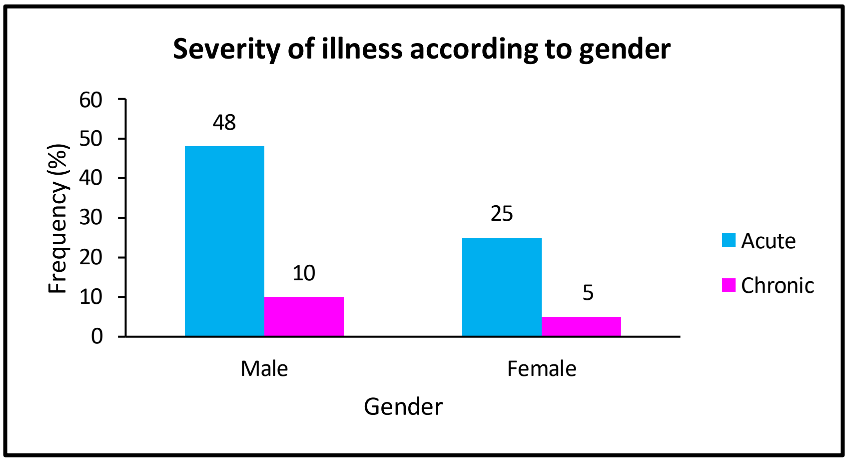

Figure 7: The Chi square test was used to find the association between severity of illness and gender. There was no association (p > 0.05) between severity of illness and gender.

3.6 Presenting Clinical Features

Patients presented with a heterogeneous range of neurological and related symptoms. For analytical clarity, presenting complaints were grouped into broader clinical categories. The most frequent presenting patterns included:

- Falls / trauma-related presentation
- Headache
- Weakness or hemiparesis
- Loss of consciousness / altered sensorium
- Vomiting
- Speech disturbance
- Dizziness / giddiness
- Seizure-like activity
- No documented complaints in some referred imaging cases

Given the wide variety of individual presenting complaints and overlapping symptom descriptions, grouped symptom categories were considered more clinically meaningful than reporting each complaint as a separate single-frequency variable.

3.7 Distribution of Major CT Findings

NCCT findings were heterogeneous and included acute ischemic infarcts, chronic infarcts, hemorrhagic lesions, age-related atrophy, chronic small-vessel ischemic changes, and other intracranial abnormalities. For publication-quality reporting, findings were grouped into major radiological categories rather than listing raw report phrases.
The major CT patterns observed included:

- Acute ischemic infarction
- Chronic infarcts / encephalomalacia / gliosis
- Intraparenchymal hemorrhage
- Subarachnoid hemorrhage
- Subdural hemorrhage / extra-axial hemorrhage
- Lacunar infarcts
- Age-related cerebral atrophy and chronic small-vessel ischemic changes
- Other non-stroke intracranial abnormalities

Because several patients demonstrated more than one imaging feature (e.g., acute lesion with background chronic ischemic change), CT findings were interpreted in an integrated radiological context rather than as mutually exclusive single-line report labels.

3.8 Distribution of Confirmed Stroke Type

Among the 88 clinically suspected stroke patients, 72 cases were radiologically classifiable as confirmed stroke.
Within these 72 confirmed stroke cases:

- 47 patients (65.3%) had ischemic stroke
- 25 patients (34.7%) had hemorrhagic stroke

The remaining 16 patients (18.2% of the total cohort) had imaging findings that were not classified as definite ischemic or hemorrhagic stroke for the purpose of final stroke subtype analysis (e.g., chronic non-specific ischemic changes, traumatic intracranial findings, or other non-stroke intracranial abnormalities).

Table 8. Distribution of confirmed stroke subtype (n = 72)

Stroke subtype	Frequency	Percentage (%)
Ischemic stroke	47	65.3
Hemorrhagic stroke	25	34.7

DISCUSSION

This prospective cross-sectional study evaluated the role of non-contrast multidetector computed tomography (NCCT/MDCT) in the initial assessment of 88 adult patients with clinically suspected stroke at a tertiary imaging centre. The study demonstrates that NCCT remains a highly practical first-line imaging modality for the emergency evaluation of suspected stroke, particularly for rapid lesion detection, identification of hemorrhage, and preliminary radiological classification of stroke subtype [10–12].

4.1 Demographic Profile

The mean age of the study population was 54.2 ± 17.8 years, and the majority of patients (75.0%) belonged to the 40–90-year age group. This age distribution is consistent with the established epidemiology of stroke, which shows increasing incidence with advancing age due to cumulative vascular risk exposure, including hypertension, diabetes mellitus, atherosclerosis, and small-vessel disease [13,14]. A male predominance was observed (65.9% male vs 34.1% female), which is also in agreement with many hospital-based stroke series reported in the literature. The higher proportion of male patients may reflect greater burden of vascular risk factors, healthcare-seeking patterns, or referral bias in the study setting [15,16].

4.2 NCCT/MDCT in Initial Stroke Evaluation

NCCT performed on an MDCT platform remains the most commonly used emergency imaging technique for suspected stroke because it is:

- rapidly available,
- widely accessible,
- non-invasive,
- effective for detecting intracranial hemorrhage,
- useful for identifying mass effect, edema, hydrocephalus, and herniation,
- and suitable for triage in acute stroke pathways [10–12].

In the present study, NCCT demonstrated acute stroke-related findings in 83.0% of patients and chronic stroke-related findings in 17.0%. These findings emphasize the value of CT in identifying both recent cerebrovascular events and pre-existing chronic ischemic sequelae [11,12].

However, it is important to acknowledge that while NCCT is highly sensitive for acute hemorrhage, its sensitivity for hyperacute ischemic stroke, especially within the first few hours of symptom onset, is lower than MRI diffusion-weighted imaging. Early ischemic changes on CT may be subtle and include loss of gray-white differentiation, sulcal effacement, or hyperdense vessel signs. Therefore, the role of NCCT in acute stroke is best understood as an initial triage and exclusion tool, particularly for ruling out hemorrhage and identifying major early ischemic changes [17].

4.3 Distribution of Stroke Subtype

Among 72 radiologically confirmed stroke cases, ischemic stroke (65.3%) was more common than hemorrhagic stroke (34.7%). This pattern is consistent with the broad epidemiological trend that ischemic stroke is generally more prevalent than hemorrhagic stroke across most populations [13,16]. Although the proportion of hemorrhagic stroke in this cohort appears somewhat higher than in some community-based datasets, this may reflect:

- tertiary referral bias,
- selective imaging of clinically severe cases,
- hospital-based case enrichment,
- and the inclusion of patients presenting with acute neurological emergencies requiring urgent CT evaluation [10,16].

4.4 Age Group and Temporal Pattern of Stroke-Related Findings

A statistically significant association was observed between age group and temporal pattern of stroke-related findings on NCCT ($p = 0.002$). All patients in the 18–40-year group showed acute stroke-related findings, whereas chronic stroke-related findings were observed only in the 40–90-year group. This likely reflects the expected age-related accumulation of chronic cerebrovascular changes, including:

- lacunar infarcts,
- chronic infarcts,

- encephalomalacia,
- diffuse cerebral atrophy,
- and small-vessel ischemic disease [13,14].

Importantly, this finding should be interpreted as an association between age and chronicity of radiological findings, not stroke severity, because validated clinical severity measures such as the NIH Stroke Scale (NIHSS), Glasgow Coma Scale (GCS), or modified Rankin Scale (mRS) were not assessed in the present study.

4.5 Sex and Temporal Pattern of Stroke-Related Findings

No significant association was found between sex and temporal pattern of stroke-related findings ($p = 0.946$). This suggests that, in this cohort, acute and chronic stroke-related imaging patterns were similarly distributed between male and female patients, despite the higher overall number of male presentations [15,16].

4.6 Clinical Relevance

The findings of this study reinforce the practical role of NCCT/MDCT in emergency neuroimaging workflows. In routine clinical practice, NCCT is particularly valuable for:

- rapid exclusion of intracranial hemorrhage,
- preliminary differentiation between ischemic and hemorrhagic stroke,
- identification of space-occupying hemorrhage, edema, or herniation,
- and recognition of chronic cerebrovascular disease that may influence interpretation and management [10–12,17].

This makes NCCT indispensable in settings where MRI is not immediately available or where rapid decision-making is required [10,11,17].

4.7 Limitations

Several limitations of the present study should be acknowledged:

1. Single-centre design: The study was conducted at one imaging centre, limiting generalizability.
2. Modest sample size: The final sample size of 88 patients, with 72 confirmed stroke cases, limits statistical power.
3. Lack of confirmatory reference standard: The study did not compare NCCT findings with MRI, follow-up imaging, angiography, or standardized neurological diagnosis; therefore, formal diagnostic accuracy (sensitivity/specificity) could not be assessed.
4. Heterogeneous imaging findings: Some patients demonstrated mixed or non-specific intracranial abnormalities, and not all suspected stroke cases were classifiable into definitive ischemic or hemorrhagic categories.
5. No validated severity or outcome measures: Stroke severity and functional outcomes were not assessed using NIHSS, GCS, or mRS.
6. Potential referral bias: As a hospital-based imaging study, the cohort may overrepresent clinically severe or radiologically evident cases.

4.8 Future Directions

Future research should focus on:

- larger multicentre cohorts,
- strict exclusion of traumatic intracranial pathology when studying spontaneous stroke,
- comparison of NCCT with MRI diffusion-weighted imaging and/or CT angiography/perfusion,
- incorporation of stroke severity scales and functional outcomes,
- and evaluation of artificial intelligence-assisted CT interpretation for rapid stroke triage.

CONCLUSION

Non-contrast multidetector computed tomography (NCCT/MDCT) remains a practical, rapid, and clinically valuable first-line imaging modality in the initial evaluation of patients presenting with suspected stroke. In this prospective cohort of 88 patients, NCCT enabled identification of acute and chronic stroke-related findings and facilitated radiological classification of confirmed stroke cases into ischemic and hemorrhagic subtypes. Among the 72 confirmed stroke cases, ischemic stroke (65.3%) was more frequent than hemorrhagic stroke (34.7%). Older patients were more commonly represented among chronic stroke-related imaging findings, suggesting an age-related burden of established cerebrovascular disease. While NCCT is particularly useful for rapid detection of intracranial hemorrhage and early triage, further studies incorporating confirmatory imaging, standardized stroke severity measures, and longitudinal outcomes are needed to better define its diagnostic performance and prognostic value in acute stroke pathways.

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