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Original Article

Diagnostic Accuracy of Non-Contrast CT in Detection of Acute Ischemic Stroke Taking Diffusion-Weighted Magnetic Resonance Imaging as Gold Standard

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ABSTRACT

Background: Acute ischemic stroke requires rapid and accurate imaging diagnosis to guide time-sensitive treatment, particularly in emergency settings where non-contrast computed tomography is often the first-line modality. Although diffusion-weighted magnetic resonance imaging is considered the reference standard for early ischemic detection, its availability is limited in many resource-constrained environments. Objective: To determine the diagnostic accuracy of non-contrast CT in the detection of acute ischemic stroke using diffusion-weighted MRI as the gold standard. Methods: This prospective diagnostic accuracy study was conducted in the Department of Radiology, Combined Military Hospital, Kohat, from July 2024-Dec 2024. A total of 232 patients aged 40-80 years presenting with acute ischemic symptoms within 7 days of symptom onset underwent non-contrast CT followed by diffusion-weighted MRI within 24 hours. Imaging findings were compared using a 2 × 2 contingency table to calculate sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy. Results: Of 232 patients, 224 (96.6%) had acute ischemic stroke confirmed on diffusion-weighted MRI. Non-contrast CT showed 172 true-positive, 6 true-negative, 2 false-positive, and 52 false-negative findings, yielding a sensitivity of 76.8%, specificity of 75.0%, positive predictive value of 98.9%, negative predictive value of 10.3%, and diagnostic accuracy of 76.7%. In patients presenting within 4 hours, CT positivity was only 4.8% compared with 85.7% on MRI, whereas in those presenting after 4 hours, CT positivity increased to 90.5% versus 98.9% on MRI. Conclusion: Non-contrast CT remains a valuable initial imaging modality for suspected stroke because of its accessibility and high confirmatory value when positive, but it has limited sensitivity in the hyperacute phase and cannot reliably exclude acute ischemic stroke when negative. Diffusion-weighted MRI remains superior for early ischemic detection. Keywords: acute ischemic stroke, non-contrast computed tomography, diffusion-weighted magnetic resonance imaging, diagnostic accuracy, sensitivity, specificity

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INTRODUCTION

Stroke remains a major cause of mortality and long-term disability worldwide and continues to impose a substantial burden on health systems, patients, and caregivers. Acute ischemic stroke accounts for the majority of stroke cases and requires rapid diagnosis because therapeutic benefit from reperfusion strategies is highly time dependent. In recent years, advances in thrombolysis and endovascular thrombectomy have substantially changed the management paradigm of acute ischemic stroke, making early and accurate imaging assessment central to treatment selection and prognostication (1-4). In routine emergency practice, brain imaging is not only required to confirm the diagnosis of ischemic stroke but also to exclude intracranial hemorrhage, estimate the extent of early ischemic injury, and support timely decisions regarding reperfusion eligibility (5,6).

Among currently available imaging modalities, diffusion-weighted magnetic resonance imaging is widely regarded as the most sensitive technique for the early detection of acute cerebral ischemia because it can identify cytotoxic edema within minutes of arterial occlusion. Diffusion-weighted sequences, particularly when interpreted alongside apparent diffusion coefficient maps, provide a highly

reliable representation of the ischemic core and are therefore commonly considered the reference standard for early ischemic stroke detection (7,8). However, despite its superior diagnostic performance, MRI is not always readily accessible in emergency settings because of cost, limited availability, longer acquisition times, and contraindications in certain patient groups. These practical limitations are especially relevant in low- and middle-income countries, where emergency neuroimaging pathways are often constrained by infrastructure and resource availability (2,7).

For these reasons, non-contrast computed tomography remains the first-line imaging modality in most acute stroke pathways. It is rapid, widely available, comparatively inexpensive, and highly effective in excluding hemorrhage, which makes it indispensable during the initial evaluation of suspected stroke. Nevertheless, the sensitivity of non-contrast CT for detecting acute ischemic stroke, particularly during the hyperacute phase, is considerably lower than that of diffusion-weighted MRI. Early ischemic changes on CT may be subtle and include faint hypoattenuation, obscuration of the lentiform nucleus, loss of insular ribbon, and reduced gray-white matter differentiation, all of which are subject to observer variability and may be difficult to appreciate in the first few hours after symptom onset (5,9,10). Although structured approaches such as the Alberta Stroke Program Early CT Score have improved standardization, interobserver agreement remains imperfect, and diagnostic performance is still influenced by reader expertise and infarct timing (9,10).

Interest has therefore grown in validating the real-world diagnostic utility of non-contrast CT against diffusion-weighted MRI, particularly in settings where CT remains the only practical first-line option. This question is especially important in Pakistan, where stroke burden is substantial but local prospective evidence on imaging accuracy remains limited. In resource-constrained clinical environments, demonstrating acceptable diagnostic performance of non-contrast CT could support more efficient triage and decision-making, whereas identifying its limitations could help define when MRI is essential despite logistical barriers (2,11,12). The existing local evidence is limited and does not adequately clarify how well non-contrast CT performs across different symptom-onset windows in routine emergency populations.

The present study was therefore designed to determine the diagnostic accuracy of non-contrast CT in the detection of acute ischemic stroke using diffusion-weighted MRI as the reference standard in patients presenting with acute ischemic symptoms. It was hypothesized that non-contrast CT would demonstrate high specificity but comparatively lower sensitivity than diffusion-weighted MRI, with reduced performance in patients presenting earlier after symptom onset (12).

MATERIALS AND METHODS

This prospective diagnostic accuracy study was conducted in the Department of Radiology, Combined Military Hospital, Kohat, over a six-month period from July 2024-Dec 2024. The study was designed to evaluate the performance of non-contrast CT in detecting acute ischemic stroke by comparing index-test findings with those of diffusion-weighted MRI as the reference standard. A prospective design was selected to ensure temporal alignment between clinical presentation, CT acquisition, and confirmatory MRI, thereby reducing recall bias and allowing uniform application of eligibility criteria and imaging interpretation procedures.

Patients of either sex aged 40 to 80 years who presented with acute ischemic symptoms, including weakness in one or more limbs, dysarthria, or dysphagia, and who arrived within 7 days of symptom onset were considered eligible for inclusion. Patients were excluded if they had any contraindication to MRI, had received antithrombotic or thrombolytic treatment before completion of both imaging examinations, had a previous history of stroke or prior reperfusion therapy, or declined to provide consent. Consecutive non-probability sampling was used, and all patients fulfilling the eligibility criteria during the study period were enrolled in order to improve precision and strengthen the diagnostic analysis.

Sample size estimation was based on anticipated diagnostic performance parameters for non-contrast CT in acute ischemic stroke, using an expected sensitivity of 86%, specificity of 87%, prevalence of acute ischemic stroke of 22%, a 95% confidence level, and an absolute precision of 12%, yielding a minimum required sample of 151 participants (12,13). To enhance study power and improve the stability of subgroup estimates, all eligible patients presenting during the study interval were included.

After ethical approval from the hospital ethical committee, potentially eligible patients presenting to the emergency department and referred for non-contrast CT brain were screened for recruitment. Written informed consent was obtained from patients after clinical stabilization; when orientation was impaired, relevant demographic and clinical information was obtained from the next of kin in accordance with institutional practice. Demographic and baseline clinical data, including age, sex, educational status, residential status, presenting symptoms, and duration of symptoms, were recorded on a structured proforma before final analysis. To preserve procedural consistency, all enrolled patients underwent non-contrast CT as part of the initial emergency assessment followed by diffusion-weighted MRI within 24 hours.

The index test was non-contrast CT of the brain. Acute ischemic stroke on non-contrast CT was operationally defined as the presence of a hypodense area in the brain parenchyma consistent with acute infarction. The reference standard was diffusion-weighted MRI. Acute ischemic stroke on MRI was defined by the presence of marked hyperintensity on diffusion-weighted imaging with corresponding low signal on apparent diffusion coefficient images, with consideration of exponential image appearance and early diffusion-weighted reversal where applicable. For MRI acquisition, a 1.5 Tesla scanner (GE Signa, General Electric, USA) was used. Eligible MRI examinations included gradient-echo imaging and diffusion-weighted imaging sequences. Gradient-echo parameters included a field of view of 24 cm, repetition time of 800 ms, echo time of 20 ms, flip angle of 30 degrees, and acquisition matrix of 256 × 192. Diffusion-weighted imaging parameters included a field of view of 24 cm, repetition time of 6000 ms, echo time of 72 ms, acquisition matrix of 128 × 128, and b values of 0 and 1000 s/mm² applied isotropically. Both sequences generated 20 contiguous axial-oblique slices of 7 mm thickness. For non-contrast CT, either a Somatom Plus scanner (Siemens, Iselin, NJ, USA) or a Lightspeed scanner (General Electric) was used, and images were obtained in the orbitomeatal plane with 5 mm slice thickness from the skull base to the vertex.

To reduce observer-related bias, CT and MRI studies were interpreted by two different radiologists, and all digital images were stripped of patient identifiers before review. Readers were provided with commercially available viewing software that allowed adjustment of image size, brightness, and contrast. MRI readers assessed gradient-echo and diffusion-weighted sequences, whereas CT readers assessed both bone-window and conventional brain-window image sets with freedom to optimize image display parameters. CT and MRI studies were randomly sorted, and paired examinations from the same patient were presented on different days to minimize recall and recognition bias. The radiologists were therefore separated by modality, temporally separated in review, and protected from direct paired-image comparison during reporting, which improved internal validity of the diagnostic comparison.

The primary outcome was diagnostic accuracy of non-contrast CT for acute ischemic stroke using diffusion-weighted MRI as the reference standard. Secondary diagnostic indices included sensitivity, specificity, positive predictive value, and negative predictive value. True positive results were defined as cases positive for acute ischemic stroke on non-contrast CT and confirmed positive on diffusion-weighted MRI. True negative results were cases negative on non-contrast CT and negative on diffusion-weighted MRI. False positive results were defined as CT-positive but MRI-negative cases, whereas false negative results were CT-negative but MRI-positive cases. Diagnostic accuracy was calculated from a 2 × 2 contingency table as the proportion of all correctly classified patients among the total study population. Sensitivity was calculated as true positives divided by the sum of true positives and false negatives, specificity as true negatives divided by the sum of true negatives and false positives, positive predictive

value as true positives divided by all CT-positive cases, and negative predictive value as true negatives divided by all CT-negative cases.

Duration from symptom onset was treated as a clinically relevant stratification variable because CT conspicuity of ischemic changes is known to evolve over time. Patients were therefore categorized into an early presentation group, defined as presentation within 4 hours of symptom onset, and a late presentation group, defined as presentation after 4 hours. Additional stratification variables included age, sex, residential status, and educational status. These variables were incorporated to examine potential effect modification in diagnostic performance and to improve clinical interpretability across patient subgroups.

Data were entered and analyzed using SPSS version 23. Distributional normality for continuous variables was assessed using the Shapiro-Wilk test. Normally distributed continuous variables were summarized as mean and standard deviation, whereas skewed data were to be described using median and interquartile range. Categorical variables were summarized as frequencies and percentages. A 2 × 2 diagnostic table was constructed to calculate sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy, each with 95% confidence intervals. Stratified analyses were performed according to symptom-onset window and relevant demographic covariates to evaluate variation in diagnostic performance across clinically important subgroups. Because imaging was completed within a tightly defined clinical workflow and case documentation was recorded prospectively on a structured proforma, data completeness was maintained at the point of collection and only complete paired imaging records were included in the final diagnostic analysis. All data were cross-checked before entry to preserve reproducibility and analytic integrity.

RESULTS

A total of 232 patients with acute ischemic symptoms were included in the final paired imaging analysis. Of these, 173 (74.6%) were male and 59 (25.4%) were female. The mean age of the cohort was 60 ± 7 years, with most patients falling in the 51-60 year age group (49.1%), followed by 61-70 years (38.3%). Educational attainment was highest in the matric-or-higher category, which comprised 96 patients (41.4%), while the majority of participants were from rural areas (77.6%). Forty-two patients (18.1%) presented within 4 hours of symptom onset, whereas 190 (81.9%) presented after 4 hours, indicating that most patients were evaluated outside the hyperacute window. These baseline characteristics are summarized in Table 1.

Table 1. Sociodemographic and Clinical Characteristics of the Study Population (n = 232)

Variable	Category	n (%)
Gender	Male	173 (74.6)
	Female	59 (25.4)
Educational status	No education	5 (2.2)
	Primary education	55 (23.7)
	Secondary education	76 (32.8)
	Matric or higher	96 (41.4)
Residential status	Rural	180 (77.6)
	Urban	52 (22.4)
Age group (years)	41-50	15 (6.5)
	51-60	114 (49.1)
	61-70	89 (38.4)
	71-80	14 (6.0)
Symptom-onset window	<=4 hours	42 (18.1)
	>4 hours	190 (81.9)

The diagnostic yield of NCCT differed markedly according to time from symptom onset. In patients presenting within 4 hours, NCCT identified acute ischemic stroke in only 2 of 42 patients, corresponding to a positivity rate of 4.8% (95% CI 0.6%-16.2%), whereas DWI-MRI was positive in 36 of 42 patients, yielding a positivity rate of 85.7% (95% CI 71.5%-94.6%). In contrast, among patients presenting after 4 hours, NCCT was positive in 172 of 190 patients, giving a positivity rate of 90.5% (95% CI 85.4%-94.2%),

while DWI-MRI was positive in 188 of 190 patients, corresponding to 98.9% (95% CI 96.2%-99.9%). The absolute difference between NCCT and DWI-MRI positivity was therefore 81.0 percentage points in the early window and 8.4 percentage points in the late window. NCCT positivity was substantially higher in late than early presenters (90.5% vs 4.8%, $p < 0.001$), with a relative risk of 19.01 (95% CI 4.91-73.57) and an odds ratio of 191.11 (95% CI 42.61-857.22). DWI-MRI positivity was also higher in late presenters (98.9% vs 85.7%, $p < 0.001$), although the between-window contrast was smaller, with a relative risk of 1.15 (95% CI 1.02-1.31). These findings are shown in Table 2.

Table 2. Imaging Positivity Stratified by Symptom-Onset Window

Imaging modality	<=4 hours n/N (%)	>4 hours n/N (%)	Absolute difference (percentage points)	Effect estimate	p-value
NCCT positive	2/42 (4.8)	172/190 (90.5)	85.7	RR 19.01 (95% CI 4.91-73.57); OR 191.11 (95% CI 42.61-857.22)	<0.001
DWI-MRI positive	36/42 (85.7)	188/190 (98.9)	13.2	RR 1.15 (95% CI 1.02-1.31); OR 15.67 (95% CI 3.04-80.73)	<0.001

Overall cross-classification of NCCT against DWI-MRI showed that 172 patients were true positive, 6 were true negative, 2 were false positive, and 52 were false negative. Thus, 224 of 232 patients (96.6%) were confirmed to have acute ischemic stroke on DWI-MRI, indicating an extremely high disease prevalence within this clinically selected population. False-negative NCCT findings accounted for 52 of 224 MRI-confirmed stroke cases, representing 23.2% of all true disease cases, while false-positive NCCT findings were uncommon, occurring in 2 of 8 MRI-negative patients. These data indicate that when NCCT showed ischemic change, the finding was usually correct, but a negative NCCT result frequently failed to exclude stroke. The full diagnostic classification table is presented in Table 3.

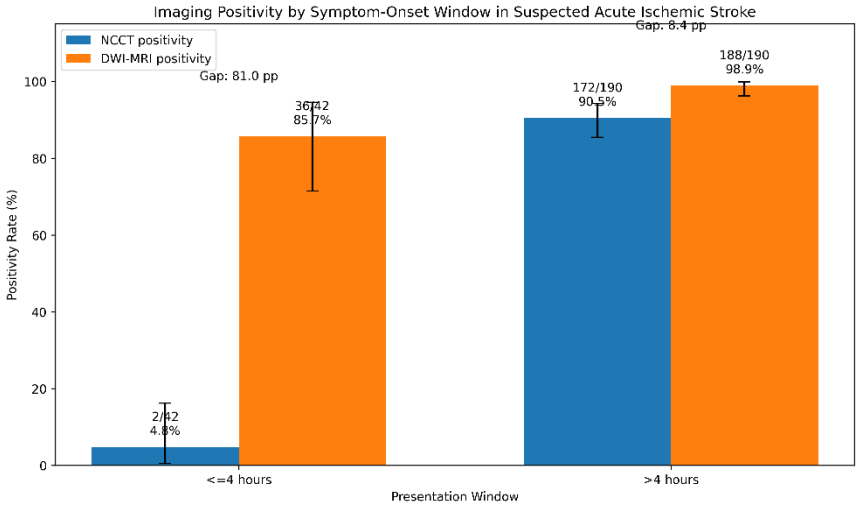

Figure 1 Pronounced time-dependent gradient in NCCT performance The figure demonstrates a pronounced time-dependent gradient in NCCT performance. Within 4 hours of symptom onset, NCCT positivity was only 4.8% (2/42), whereas DWI-MRI positivity was 85.7% (36/42), producing an absolute detection gap of 81.0 percentage points. After 4 hours, NCCT positivity increased sharply to 90.5% (172/190), while DWI-MRI remained consistently high at 98.9% (188/190), narrowing the gap to 8.4 percentage points. This pattern indicates that the major diagnostic limitation of NCCT was concentrated in the hyperacute presentation window, whereas its performance improved substantially with infarct evolution, although DWI-MRI still maintained superior detection across both time strata.

Table 3. Diagnostic Cross-Classification of NCCT Against DWI-MRI (n = 232)

	DWI-MRI Positive	DWI-MRI Negative	Total
NCCT Positive	172	2	174
NCCT Negative	52	6	58
Total	224	8	232

Diagnostic performance analysis demonstrated that NCCT had a sensitivity of 76.8% (172/224; 95% CI 70.7%-82.1%), specificity of 75.0% (6/8; 95% CI 34.9%-96.8%), positive predictive value of 98.9% (172/174; 95% CI 95.9%-99.9%), negative predictive value of 10.3% (6/58; 95% CI 3.9%-21.2%), and overall

diagnostic accuracy of 76.7% (178/232; 95% CI 70.7%-82.0%). The high positive predictive value indicates that a positive NCCT finding was strongly concordant with DWI-MRI confirmation.

Table 4. Diagnostic Performance of NCCT for Acute Ischemic Stroke Using DWI-MRI as Reference Standard

Metric	Formula	Value %	95% CI
Sensitivity	TP / (TP + FN)	76.8	70.7-82.1
Specificity	TN / (TN + FP)	75.0	34.9-96.8
Positive predictive value	TP / (TP + FP)	98.9	95.9-99.9
Negative predictive value	TN / (TN + FN)	10.3	3.9-21.2
Diagnostic accuracy	(TP + TN) / Total	76.7	70.7-82.0
False-negative rate	FN / (TP + FN)	23.2	17.9-29.3
False-positive rate	FP / (FP + TN)	25.0	3.2-65.1

However, the negative predictive value was very low, showing that a negative NCCT result did not reliably exclude acute ischemic stroke in this cohort. These performance indices are summarized in Table 4.

DISCUSSION

Early and accurate identification of acute ischemic stroke remains central to time-sensitive therapeutic decision-making, particularly where eligibility for reperfusion depends on rapid imaging-based confirmation of cerebral ischemia. In the present study, non-contrast CT demonstrated an overall sensitivity of 76.8%, specificity of 75.0%, positive predictive value of 98.9%, negative predictive value of 10.3%, and diagnostic accuracy of 76.7% when compared with diffusion-weighted MRI. These findings indicate that NCCT retained useful confirmatory value when ischemic changes were visible, but its capacity to exclude stroke was poor, especially in the earliest period after symptom onset. The most clinically important finding was the marked time dependence of NCCT detection. Among patients presenting within 4 hours, NCCT identified stroke in only 2 of 42 patients, whereas DWI-MRI was positive in 36 of 42 patients, yielding an absolute detection gap of 81.0 percentage points. By contrast, in patients presenting after 4 hours, NCCT positivity increased to 172 of 190 patients, while DWI-MRI remained positive in 188 of 190 patients, reducing the gap to 8.4 percentage points. These results support the view that the diagnostic performance of NCCT improves substantially with infarct evolution but remains distinctly inferior to DWI-MRI in the hyperacute phase (13,14).

The observed pattern is biologically and radiologically plausible. Diffusion-weighted MRI detects acute ischemia on the basis of restricted water diffusion associated with cytotoxic edema, a process that begins within minutes of arterial occlusion and therefore becomes visible before gross parenchymal attenuation changes are appreciable on CT. In contrast, early NCCT findings such as subtle hypoattenuation, loss of gray-white differentiation, and effacement of normal anatomic landmarks may be faint, reader-dependent, and easily overlooked in the first few hours after symptom onset. The very low NCCT positivity in early presenters in this study, at only 4.8%, illustrates this limitation clearly and explains the large number of false-negative examinations. Overall, 52 of 224 MRI-confirmed stroke cases were missed on NCCT, corresponding to a false-negative rate of 23.2%. From a clinical standpoint, this is a substantial diagnostic burden because delayed or missed recognition of ischemic stroke may affect triage, transfer decisions, and timely initiation of therapy in patients who are still within critical treatment windows (13-15).

At the same time, the very high positive predictive value of 98.9% indicates that once NCCT demonstrated ischemic change, the finding was almost always corroborated by DWI-MRI. This suggests that NCCT remains highly useful as an initial emergency imaging modality in patients with more established infarction or when obvious early ischemic changes are present. Its widespread availability, short acquisition time, and central role in excluding intracranial hemorrhage continue to make it indispensable in acute stroke pathways, particularly in centers where MRI access is limited or delayed. However, the low negative predictive value of 10.3% in the present study confirms that a normal NCCT cannot be used to rule out acute ischemic stroke in clinically suspicious cases. This point is particularly

important in resource-limited settings, where there may be a tendency to rely on CT alone because of logistic or financial constraints. The data from this study argue strongly against such reliance in early presenters and support escalation to diffusion-weighted MRI whenever feasible in patients with persistent clinical suspicion despite a negative CT scan (14,15).

The apparent discrepancy between moderately acceptable overall sensitivity and very poor hyperacute detection deserves emphasis. The overall sensitivity of 76.8% was driven largely by the strong performance of NCCT in patients presenting after 4 hours, where the positivity rate reached 90.5%. If this temporal effect is not considered, the summary diagnostic statistics may give an overly favorable impression of CT performance in the earliest treatment-relevant window. Accordingly, the present findings should be interpreted not as evidence of uniform CT utility across all presentations, but rather as evidence of pronounced time-dependent diagnostic heterogeneity. This distinction is clinically meaningful because treatment urgency is greatest precisely in the interval where NCCT was least sensitive. In practice, therefore, the usefulness of NCCT lies less in excluding early ischemia and more in rapidly screening for hemorrhage, identifying established infarction, and supporting immediate decisions where MRI is unavailable (13,16).

The disease prevalence in this cohort was very high, with DWI-MRI confirming acute ischemic stroke in 224 of 232 patients, corresponding to 96.6%. This likely reflects the clinical selection of patients with strong ischemic symptomatology referred for urgent neuroimaging rather than the prevalence expected in an unselected emergency population. While such enrichment strengthens the clinical relevance of the findings for suspected stroke pathways, it also affects predictive values, especially the positive predictive value, which rises with increasing disease prevalence. The high PPV observed here should therefore be interpreted in the context of the study setting and should not be generalized uncritically to broader screening populations. Similarly, the specificity estimate of 75.0% was derived from only 8 MRI-negative patients and therefore carries substantial statistical imprecision, as reflected by the wide confidence interval. This limitation does not negate the findings but does warrant cautious interpretation of specificity-based comparisons (14,15).

The study has several strengths. It used a prospective design, applied the same reference standard to all enrolled participants, and ensured that MRI was performed within 24 hours of CT, reducing the likelihood of major temporal misclassification. The use of separate radiologists for CT and MRI interpretation, random sorting of image sets, and temporal separation of paired image review also enhanced internal validity by minimizing recall bias and direct modality-to-modality recognition effects. These methodological features improve confidence that the observed differences were related primarily to imaging performance rather than systematic interpretive contamination. Nevertheless, the study also has important limitations. It was conducted at a single center, which may limit external generalizability. Inter-reader agreement was not formally quantified, so the degree to which observer variability influenced CT performance remains uncertain. The mismatch between the originally planned sample size and the larger enrolled cohort improved precision but should be described transparently in the final manuscript. In addition, most patients presented after 4 hours, resulting in unequal timing strata, and the very high prevalence of MRI-confirmed stroke reduced the stability of specificity estimates. These factors should be acknowledged explicitly in the final version (15,16).

Taken together, the findings suggest that NCCT should continue to be viewed as an essential first-line tool in acute stroke imaging pathways, but not as a definitive rule-out test for early ischemic stroke. Its diagnostic value is strongest when positive and when infarct evolution has progressed sufficiently to produce visible parenchymal change. Diffusion-weighted MRI remains the more sensitive modality for early ischemic detection and should be used whenever available in patients with a negative or equivocal NCCT but persistent clinical suspicion. In settings with limited MRI access, these findings may help refine imaging triage by identifying the patient subgroup in whom CT alone is least reliable, namely those presenting within the hyperacute window. Future multicenter studies incorporating standardized

reader training, interobserver agreement analysis, and time-stratified diagnostic modeling may further clarify the role of NCCT in contemporary stroke protocols (14-16).

CONCLUSION

Non-contrast CT demonstrated moderate overall diagnostic accuracy for acute ischemic stroke when compared with diffusion-weighted MRI, with sensitivity of 76.8%, specificity of 75.0%, and a very high positive predictive value of 98.9%, but its performance was strongly dependent on time from symptom onset. In patients presenting within 4 hours, NCCT missed a substantial proportion of MRI-confirmed strokes, whereas detection improved markedly in later presenters. These findings confirm that NCCT remains indispensable for rapid initial stroke assessment and exclusion of hemorrhage, particularly in resource-constrained settings, but a normal NCCT does not reliably exclude acute ischemic stroke, especially in the hyperacute phase. Diffusion-weighted MRI therefore remains the preferred modality for early ischemic confirmation whenever available.

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