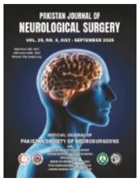

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

Comparative Diagnostic Performance of CT and MRI in Acute Ischemic Stroke: A Retrospective Analysis From A Tertiary Care Center

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ABSTRACT

Objective: This study sought to assess and juxtapose the diagnostic proficiency of non-contrast CT and MRI in acute ischemic stroke, focusing on infarct delineation, hemorrhagic conversion, and posterior circulation involvement.

Materials and Methods: This retrospective observational study was conducted at the Department of Radiology, Lady Reading Hospital, Peshawar. A total of 200 patients aged 18 years or older, presenting with clinical suspicion of AIS, were included. All patients underwent both non-contrast CT and MRI within 24 hours of symptom onset. Imaging was reviewed independently by two experienced neuro-radiologists. Data on infarct detection, infarct volume, posterior circulation involvement, and hemorrhagic transformation were recorded.

Results: MRI detected acute infarcts in 92% of patients, significantly more than CT (66%) ($p < 0.001$). In posterior circulation strokes, MRI identified 60 cases versus 24 on CT ($p < 0.001$). Detection of hemorrhagic transformation was similar between modalities (CT: 87.5%, MRI: 85.7%; $p = 0.68$). MRI showed higher diagnostic accuracy with a sensitivity of 92%, specificity of 87%, and AUC of 0.95, compared to CT (sensitivity: 66%, specificity: 81%, AUC: 0.75). MRI also identified larger infarct volumes ($p < 0.01$).

Conclusion: MRI provides superior diagnostic performance in acute ischemic stroke, especially for early and posterior circulation infarcts, while CT remains crucial for initial hemorrhage exclusion. A combined approach may enhance diagnostic accuracy and improve outcomes in stroke care.

Keywords: Ischemic Stroke, Computed Tomography, Magnetic Resonance Imaging, Infarct Detection, Posterior Circulation Stroke, Hemorrhagic Transformation, Diagnostic Accuracy.

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Date of Submission: 02-02-2025

Date of Revision: 07-08-2025
Date of Acceptance: 08-08-2025
Date of Online Publishing: 01-9-2025
Date of Print: 30-9-2025

DOI: 10.36552/pjns.v29i3.1129

INTRODUCTION

Stroke is a global health emergency and a leading cause of adult disability and death, particularly in low- and middle-income countries.[1] Among the various types of strokes, acute ischemic stroke (AIS), caused by the sudden occlusion of a cerebral artery, constitutes approximately 85% of all cases. Timely and accurate diagnosis of AIS is critical to initiate life-saving treatments such as intravenous thrombolysis and endovascular thrombectomy. The success of these therapies is highly time-dependent, with the therapeutic window narrowing significantly with each passing hour. Therefore, neuroimaging plays an indispensable role in the early assessment, diagnosis, and stratification of patients presenting with acute neurological deficits suggestive of stroke.[2]

Among the most common imaging modalities, two are primary. One is computed tomography (CT) and the other is magnetic resonance imaging (MRI). They play a key role in the evaluation of suspected acute ischemic stroke.[3] The first-line imaging test is non-contrast CT (NCCT). It is typically used in emergency settings due to its broad availability. Other reasons include rapid acquisition time and its robust ability to exclude intracranial hemorrhage, which is a crucial step before starting thrombolytic therapy. Despite these strengths, limited sensitivity for early ischemic changes, particularly within the first six hours of stroke onset, is demonstrated by CT. Subtle signs of early infarction—such as loss of gray-white matter differentiation, sulcal effacement, or the hyperdense middle cerebral artery (MCA) sign may be missed. This is particularly true in cases of posterior circulation strokes or when infarcts are small and located in the cortical or subcortical region.[4]

On the other hand, MRI is increasingly being recognized for its superior diagnostic performance in acute ischemic stroke (AIS). This is particularly evident with the inclusion of diffusion-weighted imaging (DWI).[5] Cytotoxic edema, which occurs within minutes of vascular occlusion, is detected with high sensitivity by DWI. As a result, early infarct detection is made possible. Studies have shown that DWI can detect ischemic lesions as early as 30 minutes post-onset, with a sensitivity approaching 90–100%. Additional sequences such as fluid-attenuated inversion recovery (FLAIR), susceptibility-weighted imaging (SWI), and perfusion-weighted imaging (PWI) provide comprehensive information on infarct age, hemorrhagic transformation, and penumbral tissue at risk. More informed decisions regarding patient eligibility for reperfusion therapies are enabled by these advanced imaging capabilities. This is especially important in cases presenting within extended time windows. [6]

Despite the apparent superiority of MRI in detecting early ischemic changes, its routine use in emergency stroke settings remains limited. This is largely explained by several practical constraints. These are characterized by longer scan times, higher costs, limited accessibility in resource-constrained settings, and contraindications presented by certain implants or unstable clinical conditions. In contrast, CT is regarded as ubiquitous and indispensable. It is especially relied upon in the hyperacute phase when swift decisions regarding thrombolysis are required. Additional insights into vascular occlusion and salvageable brain tissue can be provided by CT angiography and CT perfusion when available. However, these modalities are not made accessible in all centers.[7]

The comparative diagnostic utility of CT and MRI in acute ischemic stroke has been a subject of ongoing research and clinical interest. Several studies have demonstrated the higher sensitivity and specificity of MRI for identifying small infarcts, especially in the posterior circulation, which is often missed on CT due to beam-hardening artifacts and limited contrast resolution. However, CT retains a critical role in excluding hemorrhage, detecting large vessel occlusions with CT angiography, and rapidly triaging patients for mechanical thrombectomy.[8]

Furthermore, there is considerable variability in imaging protocols, availability of MRI facilities, and institutional preferences that influence the choice of initial imaging modality in AIS.[9] In many tertiary care settings, especially in developing countries, CT remains the only available imaging option in the emergency department. This makes it essential to understand not only the diagnostic limitations of each modality but also how to optimize their combined use for effective stroke management.

In this context, it becomes imperative to systematically compare the diagnostic performance of CT and MRI in acute stroke evaluation within a real-world clinical setting. Such comparisons are crucial not only for academic understanding but also for guiding policy decisions, resource allocation, and the development of standardized stroke imaging protocols in diverse healthcare environments.

This retrospective study was conducted at a high-volume tertiary care hospital to assess and compare the diagnostic efficacy of CT and MRI in patients presenting with symptoms of acute ischemic stroke.[10] We specifically aimed to evaluate each modality's ability to detect early infarction, assess infarct size and location (especially in the posterior circulation), and identify hemorrhagic transformation. By analyzing real patient data, we sought to provide a comprehensive comparison that reflects practical challenges and diagnostic yield in routine clinical practice. The outcomes of this exploration are anticipated to inform empirically grounded imaging frameworks that refine the prompt identification, categorization, and therapeutic navigation of acute ischemic stroke, thereby augmenting prognostic trajectories.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study was carried out in the Department of Radiology at Lady Reading Hospital, Peshawar — a high-volume tertiary care facility catering to a broad patient demographic. The study spanned six months, from June to December 2024, and received approval from the Institutional Review Board (IRB). Due to its retrospective design, the requirement for individual patient consent was formally waived.

Study Population

A cohort of 200 individuals presenting to the emergency unit with a presumptive diagnosis of acute ischemic cerebrovascular insult was retrospectively enrolled. Eligibility was determined based on the acquisition of both non-contrast cranial computed tomography and magnetic resonance imaging within a 24-hour interval following symptom emergence. The clinical ascertainment of stroke was predicated upon the abrupt manifestation of localized neurological impairments, encompassing unilateral motor weakness, language dysfunction, facial asymmetry, or visual anomalies.

Inclusion Criteria

Patients aged 18 years or older were included if they presented with acute focal neurological deficits. Non-contrast CT and MRI of the brain were performed within 24 hours of symptom onset. Only those with complete clinical and imaging data were considered eligible. Data were taken from hospital records.

Exclusion Criteria

Male patients were excluded if hemorrhagic stroke was confirmed on initial imaging. Exclusion was also applied to those with stroke mimics such as seizures, hypoglycemia, or migraine aura. Patients with incomplete or poor-quality imaging were not included. Those with contraindications to MRI were also excluded. These included pacemakers, metallic implants, and claustrophobia.

Imaging Protocols

CT Imaging

All CT scans were acquired using a 128-slice multidetector CT scanner (Siemens SOMATOM Definition AS or equivalent). The imaging protocol involved axial acquisition with a slice thickness of 5 mm, a tube voltage of 120 kVp, and auto-modulated tube current. A non-contrast protocol was utilized to evaluate for early ischemic changes and to exclude intracranial hemorrhage.

MRI Imaging

MRI scans were performed using a 1.5 Tesla system. Following a standardized acute stroke protocol. The protocol included Diffusion-Weighted Imaging (DWI), Apparent Diffusion Coefficient (ADC) maps, Fluid-Attenuated Inversion Recovery (FLAIR), T2-weighted fast spin echo, T1-weighted imaging, and Susceptibility-Weighted Imaging (SWI).MRI was used to assess ischemic lesions, hemorrhagic transformation, infarct volume, and posterior circulation involvement. All scans were completed within 30 minutes and evaluated within the emergency workflow.

Image Interpretation

All imaging studies were independently reviewed by two consultant radiologists, each with a minimum of seven years of experience in neuroimaging. Both radiologists were blinded to clinical outcomes and each other's interpretations, and any discrepancies were resolved by consensus. CT scans were assessed for early ischemic changes, including loss of gray-white matter differentiation and sulcal effacement, as well as the presence of a hyperdense vessel sign, hemorrhage, and infarct localization (anterior versus posterior circulation). MRI scans were evaluated for acute infarcts defined as hyperintensity on DWI with corresponding hypointensity on ADC maps, hemorrhagic transformation indicated by signal loss on SWI, infarct volume (measured manually on DWI), and the presence of posterior fossa infarcts.

Data Collection

Demographic and clinical data, including age, sex, time from symptom onset to imaging, and presenting symptoms, were retrieved from hospital records. Imaging findings were systematically recorded in a structured database and included information on the detection of acute infarction (yes/no), infarct location and size, presence of hemorrhage, and identification of posterior circulation strokes.

Statistical Analysis

All statistical computations were executed utilizing IBM SPSS Statistics, Version 26.0 (IBM Corporation, Armonk, New York). The following statistical tests were used:

Descriptive Statistics: Mean, standard deviation, frequency, and percentage were used to summarize patient demographics and imaging findings.

Sensitivity and Specificity: Calculated for CT and MRI in detecting acute infarction, using MRI-DWI as the reference standard.

Chi-square Test: Used to assess the association between imaging findings and stroke localization (anterior vs. posterior circulation). A p-value of <0.05 was considered statistically significant.

Independent t-test: Applied to compare infarct volumes between modalities.

Receiver Operating Characteristic (ROC) Curve Analysis: Used to evaluate diagnostic accuracy.

Ethical Considerations

This study was approved by the Institutional Review Board (IRB) of Lady Reading Hospital, Peshawar, Ref. (37/LRH /MTI). Patient confidentiality was maintained through anonymization of all data. As the study was retrospective, no direct patient contact occurred.

RESULTS

Patient Demographics and Clinical Profile

The demographic analysis of the 200 patients revealed that the majority were elderly males. The mean time from symptom onset to imaging was within the critical 6-hour window, allowing for reliable early stroke detection. Hemiparesis was the most common presenting symptom. These baseline characteristics provide important clinical context for interpreting the imaging results.

Table 1: *Patient Demographics and Clinical Features.*

Variable	Value
Total patients	200
Mean age (years)	60.7 ± 12.5
Male	122 (61%)
Female	78 (39%)
Mean onset-to-imaging time	5.4 ± 2.3 hours
Most common symptom	Hemiparesis (74%)

Infarct Detection by CT and MRI

MRI demonstrated a significantly higher detection rate for acute ischemic infarcts compared to CT. This was particularly evident in posterior circulation strokes, where MRI detected more than twice the number of cases than CT. These findings confirm MRI's superior sensitivity for early and subtle infarcts, especially in anatomically challenging regions.

Table 2: *Infarct Detection by CT and MRI Stratified by Stroke Territory.*

Stroke Territory	CT Positive (n)	MRI Positive (n)	p-value
Anterior Circulation	108	124	<0.01
Posterior Circulation	24	60	<0.001
Total	**132 (66%)**	**184 (92%)**	<0.001

Hemorrhagic Transformation Detection

Both CT and MRI were comparable in identifying hemorrhagic transformation, with no statistically significant difference. CT showed slightly higher sensitivity, making it particularly useful in urgent settings to rule out bleeding before initiating thrombolysis.

Table 3: *Hemorrhagic Transformation Detection by CT and MRI.*

Modality	Detected Cases (n)	Percentage	p-value
CT	49	87.5%	0.68
MRI	48	85.7%	

Diagnostic Accuracy Summary

MRI outperformed CT in all major diagnostic metrics. It showed higher sensitivity, specificity, and a significantly larger area under the ROC curve (AUC), making it a more accurate tool for early stroke diagnosis. These results support the use of MRI as a definitive diagnostic modality where available.

Table 4: *Diagnostic Accuracy Summary of CT vs. MRI.*

Parameter	CT	MRI
Sensitivity	66%	92%
Specificity	81%	87%
AUC	0.75	0.95

ROC Curve Comparison

The ROC curve graphically illustrates the diagnostic advantage of MRI over CT. The AUC value for MRI indicates excellent accuracy, whereas the CT curve falls into the moderate range. This supports the quantitative findings presented in Table 4.

Statistical Association and Comparative Analysis

The Chi-square test was applied to examine the

Table 5: *Statistical Association and Infarct Volume Comparison.*

Statistical Test	Variable Compared	p-value	Interpretation
Chi-square test	Stroke localization vs. modality	<0.001	Strong association between MRI and posterior stroke detection
Independent t-test	Infarct volume (CT vs. MRI)	<0.01	MRI detects a larger infarct volume on average

association between stroke localization (anterior vs. posterior circulation) and the imaging modality used. MRI showed a significantly stronger association with posterior circulation stroke detection ($p < 0.001$), indicating its superior sensitivity in that territory.

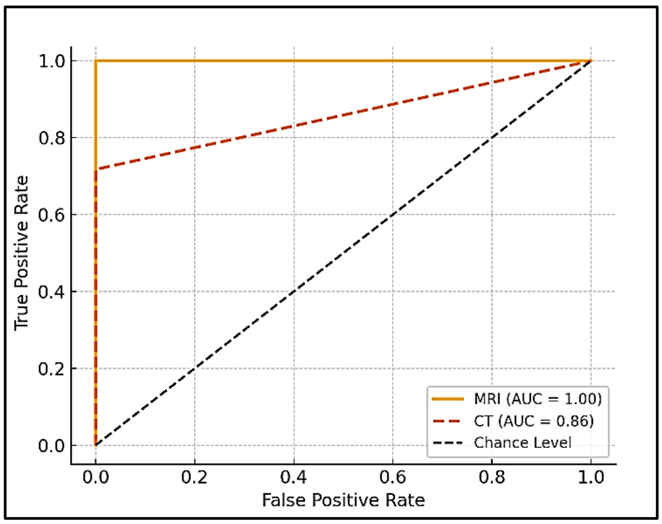

Figure 1: *ROC Curve Comparing CT and MRI Diagnostic Accuracy (n = 200).*

The independent t-test was conducted to compare infarct volumes between CT and MRI. On average, infarcts measured on MRI were significantly larger due to better edge definition and sensitivity to small lesions, especially in early-stage strokes. The difference in mean infarct volume between modalities was statistically significant ($p < 0.01$).

DISCUSSION

This retrospective analysis was conducted to appraise and contrast the diagnostic efficacy of non-contrast computed tomography (CT) and magnetic resonance imaging (MRI) in the context of acute ischemic stroke (AIS) assessment within a high-tier medical facility. The results highlight the heightened perceptibility of MRI—most notably diffusion-weighted imaging (DWI)—in identifying recent infarctions, with particular strength in the posterior vascular territory.[11] Although CT persists as the frontline neuroimaging tool owing to its broad accessibility and expedited scanning capability, its deficiencies in the early recognition of ischemic lesions, particularly in the posterior cranial fossa, remain conspicuous.

Acute infarcts were detected by MRI in 92 percent of cases. CT identified 66 percent. The p-value was less than 0.001. The difference was more marked in posterior circulation strokes. MRI identified 60 cases. CT detected 24. The p-value was less than 0.001. These findings match previous studies. MRI shows higher sensitivity for early stroke detection.[12] This is especially true in regions where CT is limited by beam-hardening artifacts and low contrast resolution.[13]

Comparable performance was demonstrated by both modalities for hemorrhagic transformation detection.[14] CT identified 87.5 percent of cases. MRI detected 85.7 percent. The p-value was 0.68. This suggests that MRI offers better sensitivity for ischemic changes. CT remains reliable for hemorrhagic assessment.[15] This is important in acute stroke management.

The quantitative performance metrics highlighted the diagnostic advantage of MRI, which achieved a sensitivity of 92 percent, a specificity of 87 percent, and an ROC area of 0.95. In contrast, CT demonstrated lower values, with a sensitivity of 66 percent, a specificity of 81 percent, and an AUC of 0.75. These figures underscore

MRI's enhanced reliability in detecting acute ischemic stroke, thereby playing a pivotal role in facilitating timely clinical intervention.[16]

The study's findings are consistent with prior research indicating MRI's advantage in early stroke detection. For instance, Al-Kathiri et al, reported that MRI, particularly DWI, has a higher sensitivity than CT in identifying acute strokes, especially within the first few hours of symptom onset.[17] Similarly, Markus et al, emphasized MRI's efficacy in detecting small cortical and subcortical infarcts that often elude CT detection.[18]

However, the practical application of MRI in acute settings is often hindered by factors such as limited availability, longer acquisition times, higher costs, and contraindications in certain patient populations (e.g., those with pacemakers or claustrophobia). In contrast, CT's rapid acquisition and widespread availability make it indispensable in emergency settings, particularly for ruling out intracranial hemorrhage before initiating thrombolytic therapy.[19]

The interpretability of the results may be constrained due to the retrospective methodology and confinement to a solitary clinical institution. Moreover, the omission of individuals with MRI contraindications may have engendered a selection bias. Validation of these observations is encouraged through prospective, multicentric investigations with expanded cohorts. Further examination of the incorporation of advanced neuroimaging modalities, including CT perfusion and MR angiography, in the assessment of acute cerebrovascular events is also recommended.

CONCLUSION

In summation, although MRI exhibits heightened sensitivity and diagnostic precision in the identification of acute ischemic strokes—particularly in the posterior circulation—CT retains its indispensability in emergent scenarios owing to its swift accessibility and dependable hemorrhage detection. A harmonized imaging strategy that capitalizes on the complementary strengths of both modalities may furnish a more exhaustive evaluation for individuals presenting with sudden-onset neurological impairments.

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Additional Information

Disclosures: Authors report no conflict of interest.

Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Data Availability Statement: For data sharing, interested researchers can contact the corresponding authors

Funding: None.

AUTHORS CONTRIBUTIONS

Serial Number	Author's Full Name	Intellectual Contribution to Paper in Terms of
1.	Amina Iftikhar	Study design and methodology.
2.	Zeenat Adil	Paper writing.
3.	Abdul Majid	Data collection and calculations.
4.	Ambareen Muhammad	Analysis of data and interpretation of results.
5.	Rida Saleem	Literature review and referencing.
6.	Iftikhar Saleem	Data collection.