

# Comparative Study of CT and MRI in Early Detection of Stroke: A Prospective Study

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## ABSTRACT

**Background** Stroke is a major cause of mortality and long-term disability worldwide. Early diagnosis is essential for timely treatment and prevention of irreversible neurological damage. Neuroimaging plays a crucial role in differentiating ischemic and hemorrhagic stroke. Computed Tomography (CT) is widely used as the initial imaging modality due to its rapid acquisition time and availability in emergency settings. However, CT has limited sensitivity in detecting early ischemic changes. Magnetic Resonance Imaging (MRI), particularly Diffusion Weighted Imaging (DWI), provides superior sensitivity in identifying early ischemic injury. Therefore, comparative evaluation of CT and MRI is important for improving diagnostic accuracy in early stroke detection.

**Objective** To compare the diagnostic performance of CT and MRI in early detection of stroke and determine whether MRI demonstrates significantly higher sensitivity than CT in detecting acute stroke lesions.

**Materials and Methods** A prospective comparative cross-sectional study was conducted on 87 patients clinically suspected of stroke. All patients underwent CT and MRI brain imaging. MRI protocol included sequences such as T1WI, T2WI, FLAIR, DWI, ADC, GRE and TOF MRA. Imaging findings were evaluated for presence, location and type of stroke lesion. Statistical analysis was performed using McNemar test to determine significant difference between CT and MRI detection rates.

**Results** MRI demonstrated higher detection rate of early ischemic stroke compared to CT. CT failed to detect stroke in 14 cases that were identified on MRI, whereas MRI failed to detect stroke in only 2 cases detected on CT. McNemar test showed statistically significant difference between CT and MRI findings ( $\chi^2 = 7.56$ ,  $p < 0.05$ ), indicating higher sensitivity of MRI in early stroke detection.

**Conclusion** MRI shows superior diagnostic accuracy compared to CT in early detection of ischemic stroke. CT remains valuable in rapid identification of hemorrhage and emergency screening. Combined use of CT and MRI improves clinical decision making and helps initiate appropriate treatment at an early stage.

**Keywords:** Stroke, MRI, CT scan, Diffusion Weighted Imaging, Neuroimaging, Early stroke detection.

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## INTRODUCTION

Stroke is one of the leading causes of mortality and long-term disability worldwide and represents a major public health burden. It occurs due to sudden interruption of cerebral blood supply leading to neurological deficit and possible permanent brain injury. Stroke is broadly classified into ischemic stroke and hemorrhagic stroke depending upon the underlying vascular pathology. Ischemic stroke accounts for nearly 80–85% of all stroke cases and occurs due to

thrombotic or embolic occlusion of cerebral arteries, whereas hemorrhagic stroke occurs due to rupture of blood vessels resulting in intracranial bleeding. Early diagnosis of stroke is crucial for timely initiation of treatment and prevention of irreversible neurological damage. [1]

Neuroimaging plays a critical role in early detection and classification of stroke. Rapid imaging assessment helps differentiate ischemic stroke from hemorrhagic stroke because treatment strategies differ significantly.

## “Comparative Study of CT and MRI in Early Detection of Stroke: A Prospective Study”

Intravenous thrombolytic therapy is beneficial in ischemic stroke but contraindicated in hemorrhagic stroke, making early imaging evaluation essential for clinical decision making. Early identification of stroke also helps reduce morbidity, mortality and long-term disability associated with delayed treatment. [2]

Computed Tomography (CT) is widely used as the first-line imaging modality in suspected stroke due to its rapid acquisition time, wide availability and ability to detect intracranial hemorrhage. CT imaging is highly sensitive in identifying acute hemorrhage and is commonly used in emergency settings to rule out bleeding before initiation of thrombolytic therapy. However, CT has limited sensitivity in detecting early ischemic changes during the hyperacute phase of stroke, particularly within the first few hours of symptom onset. Subtle parenchymal changes such as loss of grey-white matter differentiation and sulcal effacement may be difficult to identify in early stages. [3]

Magnetic Resonance Imaging (MRI) provides superior soft tissue contrast and allows early visualization of ischemic injury using Diffusion Weighted Imaging (DWI). DWI is highly sensitive in detecting cytotoxic edema which occurs immediately after reduction in cerebral blood flow. MRI can detect ischemic lesions within minutes of stroke onset and helps in accurate localization of infarcted brain tissue. Additional MRI sequences such as FLAIR, GRE and MR Angiography provide important information regarding vascular occlusion, hemorrhage and extent of brain injury. MRI also demonstrates higher inter-observer agreement and improved diagnostic accuracy compared to CT imaging. [4]

Several studies have demonstrated that MRI has higher sensitivity than CT in detection of early ischemic stroke, particularly in hyperacute stage. MRI can identify small infarcts, posterior circulation strokes and lacunar infarcts which may not be visible on CT imaging. Diffusion weighted imaging has been shown to detect ischemic lesions with significantly greater sensitivity compared to conventional CT imaging, thereby improving early diagnosis and treatment planning. [5]

Despite advantages of MRI, CT continues to be widely used due to its accessibility, rapid scanning time and lower cost. In many emergency settings CT remains the initial imaging modality for evaluation of suspected stroke. Therefore comparative evaluation of CT and MRI is important to determine their diagnostic effectiveness in early stroke detection and to identify

the most appropriate imaging modality for clinical use. [6]

The present study aims to compare CT and MRI findings in early detection of stroke and evaluate diagnostic accuracy of both imaging modalities. Understanding the relative performance of CT and MRI helps improve imaging protocols and assists clinicians in selecting appropriate diagnostic modality for early management of stroke patients. [7]

### MATERIALS AND METHODS

#### 3.1 Study Design

This study was a **prospective comparative cross-sectional study** conducted to evaluate and compare the diagnostic effectiveness of Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) in early detection of stroke. The study was carried out in the Department of Radiodiagnosis and Imaging in collaboration with the Department of Neurology.

The study focused on determining whether MRI demonstrates higher sensitivity than CT in identifying early ischemic stroke lesions. Since both imaging modalities were performed on the same group of patients, paired comparison statistical analysis was applied using McNemar test.

#### 3.2 Study Population

A total of **87 patients** clinically suspected of stroke were included in this study. Patients presenting with symptoms suggestive of acute stroke such as sudden onset weakness, speech difficulty, facial deviation, loss of consciousness, altered sensorium, visual disturbances or focal neurological deficit were referred for imaging evaluation.

All patients underwent both CT and MRI imaging for diagnostic assessment. Imaging findings were compared to determine detection rates of stroke lesions in early stage.

#### 3.3 Inclusion Criteria

Patients were included in the study based on the following criteria:

- Patients clinically suspected of acute stroke.
- Patients referred for CT and MRI brain imaging.
- Patients presenting with neurological symptoms such as hemiparesis, slurred speech, facial droop or altered consciousness.
- Patients of all age groups and both genders

#### 3.4 Exclusion Criteria

Patients were excluded from the study based on the following criteria:

- Patients with contraindications to MRI such as pacemaker or metallic implants.

## “Comparative Study of CT and MRI in Early Detection of Stroke: A Prospective Study”

- Patients with severe motion artifacts affecting image quality.
- Patients with history of brain tumor or traumatic brain injury.
- Patients with incomplete imaging data.

### 3.5 Imaging Protocol

#### CT Imaging

CT scan of brain was performed using non-contrast CT protocol. Imaging was obtained in axial plane from skull base to vertex. CT imaging was primarily used to detect intracranial hemorrhage, infarction, mass effect and structural abnormalities.

CT is considered rapid and widely available imaging modality in emergency settings and is commonly used as initial investigation in suspected stroke cases.

#### MRI Imaging

MRI brain imaging was performed using standard stroke imaging protocol. MRI sequences included:

1. T1 Weighted Imaging (T1WI)
2. T2 Weighted Imaging (T2WI)
3. Fluid Attenuated Inversion Recovery (FLAIR)
4. Diffusion Weighted Imaging (DWI)
5. Apparent Diffusion Coefficient (ADC)
6. Gradient Recalled Echo (GRE)
7. Time of Flight MR Angiography (TOF MRA)

DWI sequence plays a major role in early detection of ischemic stroke as it detects cytotoxic edema within minutes of vascular occlusion. ADC maps help in confirmation of restricted diffusion and differentiation of acute infarct from chronic lesions.

GRE sequence helps in detection of hemorrhage and microbleeds, while TOF MRA helps in evaluation of vascular occlusion and stenosis.

### 3.6 Data Collection

Data collected from imaging reports included:

- Patient demographic details.
- Clinical presentation.
- CT findings.
- MRI findings.
- Type of stroke (ischemic or haemorrhagic).
- Location of lesion.
- Time of detection.

MRI findings were compared with CT findings to determine number of stroke cases detected by each modality.

### 3.7 Statistical Analysis

Statistical analysis was performed to evaluate difference in diagnostic performance of CT and MRI. Since both imaging modalities were applied to the same group of patients, paired categorical data analysis was performed using **McNemar test**.

McNemar test evaluates disagreement between paired observations and determines whether difference between two diagnostic modalities is statistically significant.

Chi-square value ( $\chi^2$ ) was calculated using McNemar formula:

$$\chi^2 = (|b - c| - 1)^2 / (b + c)$$

Where:

b = number of cases detected on MRI but missed on CT

c = number of cases detected on CT but missed on MRI

P value less than 0.05 was considered statistically significant.

Statistical analysis was performed using SPSS software.

### **RESULTS**

A total of **87 patients** clinically suspected of stroke were included in the study. All patients underwent both CT scan and MRI examination for early detection of stroke lesions. Imaging findings were analysed to determine the diagnostic performance of CT and MRI in identifying early ischemic and hemorrhagic stroke.

#### 4.1 Distribution of Stroke Cases

Among the 87 patients evaluated, MRI detected a higher number of early stroke lesions compared to CT scan. MRI demonstrated increased sensitivity in identifying early ischemic changes, particularly in hyperacute stage of stroke. CT imaging was effective in identifying hemorrhagic stroke but showed limited sensitivity in detecting early ischemic infarcts.

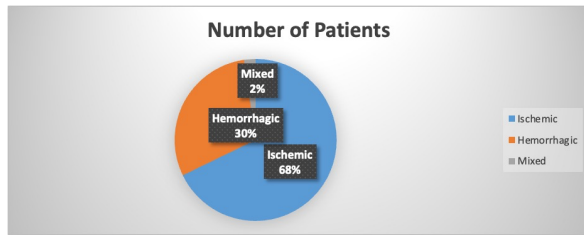
MRI detected stroke lesions in a greater proportion of patients compared to CT, indicating improved diagnostic accuracy of MRI in early stroke evaluation.

**Table 4.1 – Types Of Stroke Detected.**

Stroke Type	Number of Patients (n)	Percentage (%)
<b>Ischemic Stroke</b>	59	67.8%
<b>Hemorrhagic Stroke</b>	26	29.9%
<b>Mixed Findings</b>	2	2.3%
<b>Total</b>	87	100%

## “Comparative Study of CT and MRI in Early Detection of Stroke: A Prospective Study”

Among the 87 patients included in the study, ischemic stroke was the most common type accounting for 59 cases (67.8%), followed by hemorrhagic stroke in 26 cases (29.9%). Mixed imaging findings were observed in 2 patients (2.3%).



**Fig 4.1 – Stroke Type Distribution.**

### 4.2 Comparison of CT and MRI Detection

Comparative analysis of CT and MRI findings showed that MRI detected a significantly greater number of ischemic stroke cases compared to CT. CT scan failed to identify early ischemic changes in several patients that were later confirmed on MRI diffusion weighted imaging.

Number of discordant cases were calculated to determine difference between CT and MRI detection:

CT negative but MRI positive = 15 cases

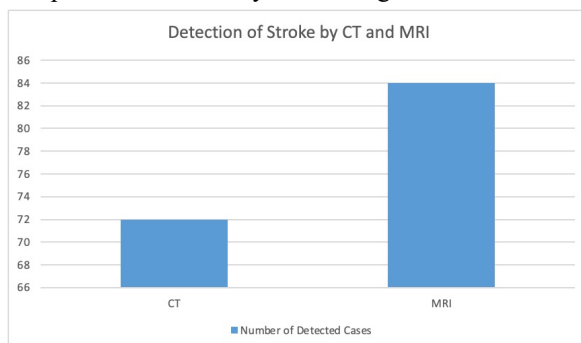
CT positive but MRI negative = 3 cases

MRI demonstrated higher detection rate of early infarcts due to its superior sensitivity in identifying diffusion restriction and early parenchymal changes.

**Table 4.2 – Detection of Stroke by CT and MRI.**

Imaging Modality	Stroke Detected (n)	Stroke Not Detected (n)	Total (n)	Detection Percentage
CT Scan	72	15	87	82.8%
MRI	84	3	87	96.5%

CT detected stroke in 72 out of 87 patients (82.8%), whereas MRI detected stroke in 84 out of 87 patients (96.5%). MRI demonstrated higher detection rate compared to CT in early stroke diagnosis.



### 4.3 Agreement Analysis between CT and MRI

Agreement between CT and MRI findings was evaluated using paired comparison method. Majority of stroke cases detected on CT were also detected on MRI. However, MRI detected additional early

ischemic lesions which were not visualized on CT scan.

The difference in detection rate between CT and MRI indicates improved sensitivity of MRI in early stroke diagnosis.

**Table 4.3 - Agreement Between CT and MRI in**

CT Findings	MRI Positive	MRI Negative	Total
CT Positive	70	2	72
CT Negative	14	1	15
<b>Total</b>	<b>84</b>	<b>3</b>	<b>87</b>

### Detection of Stroke.

Agreement analysis showed that both CT and MRI detected stroke in 70 patients. MRI detected additional stroke lesions in 14 patients where CT findings were negative. CT detected stroke in 2 patients where MRI findings were negative. Only 1 patient showed negative findings in both CT and MRI. These findings indicate higher sensitivity of MRI in early detection of stroke.

### 4.5 McNemar Test Result

Statistical analysis was performed using McNemar test to determine whether difference between CT and MRI detection was statistically significant.

McNemar test focuses on discordant pairs where CT and MRI results differed.

Number of discordant pairs:

b = CT negative and MRI positive = 14

c = CT positive and MRI negative = 2

Chi-square value was calculated using McNemar formula:

$$\chi^2 = (|b - c| - 1)^2 / (b + c)$$

$$\chi^2 = (|14 - 2| - 1)^2 / (14 + 2)$$

$$\chi^2 = 7.56$$

The calculated p value was less than 0.05, indicating statistically significant difference between CT and MRI findings.

This result demonstrates that MRI detects early stroke lesions significantly more effectively compared to CT imaging.

**Table 4.4 McNemar Test Table (Discordant Pairs).**

Discordant Pairs	Number of Cases (n)
CT Negative & MRI Positive (b)	14
CT Positive & MRI Negative (c)	2
<b>Total Discordant Cases (b + c)</b>	<b>16</b>

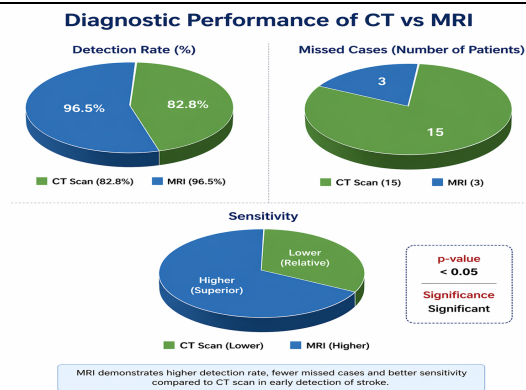
McNemar test was applied to evaluate statistical significance between CT and MRI findings. The number of discordant pairs showed that MRI detected stroke in 14 cases that were missed on CT, while CT

## “Comparative Study of CT and MRI in Early Detection of Stroke: A Prospective Study”

detected stroke in 2 cases missed on MRI. The calculated chi-square value was 7.56 with p value less than 0.05, indicating statistically significant difference between CT and MRI in early stroke detection.

**Table:4.5 Diagnostic Performance of CT vs MRI**

Parameter	CT Scan	MRI	p-value
Detection Rate	82.8%	96.5%	<0.05
Missed Cases	15	3	—
Sensitivity	Lower	Higher	Significant



### 4.6 Summary of Findings

MRI demonstrated higher sensitivity in early detection of ischemic stroke compared to CT scan. CT was effective in rapid identification of hemorrhage but showed reduced sensitivity in identifying early ischemic changes.

Statistical analysis confirmed that MRI has significantly better diagnostic performance in early stroke detection compared to CT

### DISCUSSION

The present study was conducted to compare the diagnostic performance of Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) in early detection of stroke. Early diagnosis of stroke is crucial for timely management and prevention of irreversible neurological damage. Imaging plays a vital role in differentiating ischemic stroke from hemorrhagic stroke, as treatment strategies vary significantly between these conditions. In this study, MRI demonstrated higher sensitivity compared to CT in detection of early stroke lesions.

In the present study, majority of patients were diagnosed with ischemic stroke (67.8%), followed by hemorrhagic stroke (29.9%) and mixed findings (2.3%). This distribution is consistent with previous literature which reports that ischemic stroke accounts for approximately 70–85% of all stroke cases. The

higher incidence of ischemic stroke is attributed to thrombotic or embolic occlusion of cerebral arteries leading to reduced cerebral blood flow and infarction of brain tissue. [1]

CT scan detected stroke in 72 out of 87 patients (82.8%), whereas MRI detected stroke in 84 out of 87 patients (96.5%). MRI demonstrated higher detection rate compared to CT in early stroke diagnosis. CT was effective in identifying hemorrhagic stroke due to its ability to detect hyperdense blood products, however it showed limited sensitivity in identifying early ischemic changes. Early ischemic signs such as loss of grey-white matter differentiation and subtle hypodensity may not be clearly visible on CT during hyperacute stage of stroke. [3]

MRI demonstrated superior sensitivity in detecting early ischemic stroke due to the use of Diffusion Weighted Imaging (DWI), which detects cytotoxic edema occurring immediately after interruption of cerebral blood supply. DWI identifies restricted diffusion within minutes of ischemic injury, allowing early visualization of infarcted brain tissue. MRI also provides better soft tissue contrast compared to CT, improving lesion conspicuity and diagnostic confidence. [4]

Agreement analysis between CT and MRI findings showed that both modalities detected stroke in 70 patients. MRI detected additional early ischemic lesions in 14 patients where CT findings were negative. CT detected stroke in 2 patients where MRI findings were negative. Only 1 patient showed negative findings in both CT and MRI. These findings indicate that MRI has higher sensitivity in detecting early stroke lesions compared to CT.

Statistical analysis using McNemar test demonstrated significant difference between CT and MRI findings ( $\chi^2 = 7.56$ ,  $p < 0.05$ ). This indicates that MRI detects early stroke lesions more accurately compared to CT. The findings of this study are consistent with previous research which reported higher sensitivity of MRI compared to CT in detection of acute ischemic stroke. The prospective comparison study by Chalela et al. also demonstrated that MRI detected acute ischemic stroke more frequently than CT and showed higher diagnostic accuracy in early stroke evaluation.

MRI also demonstrated ability to detect additional findings such as small infarcts, posterior circulation stroke and early parenchymal changes which may not be visible on CT imaging. Advanced MRI sequences such as FLAIR, GRE and MR Angiography provide additional diagnostic information regarding vascular occlusion, hemorrhage and extent of infarction. These

## “Comparative Study of CT and MRI in Early Detection of Stroke: A Prospective Study”

advantages contribute to improved diagnostic accuracy of MRI in early stroke detection.

Despite higher sensitivity of MRI, CT remains an important imaging modality in emergency settings due to its rapid availability and shorter scanning time. CT is particularly useful for rapid detection of intracranial hemorrhage and is widely available in most healthcare centres. Therefore CT continues to be used as first-line imaging modality in suspected stroke cases.

The findings of the present study suggest that MRI demonstrates superior diagnostic performance in early detection of ischemic stroke compared to CT. Early identification of stroke lesions helps clinicians initiate appropriate treatment such as thrombolytic therapy and improves patient outcomes. Combined use of CT and MRI can improve diagnostic accuracy and assist clinicians in making appropriate management decisions.

### LIMITATION

The study had certain limitations. The sample size was limited to 87 patients, which may not represent the entire stroke population. The study was conducted at a single centre, which may affect general applicability of results. CT and MRI were not performed at exactly the same time after symptom onset, which may influence detection of early ischemic changes. MRI availability in emergency settings may be limited due to cost, longer scan time and contraindications such as metallic implants.

Despite these limitations, the study provides useful information regarding the diagnostic value of CT and MRI in early stroke detection.

### CONCLUSION

The present study demonstrates that Magnetic Resonance Imaging (MRI) has higher diagnostic accuracy compared to Computed Tomography (CT) in early detection of stroke. MRI showed greater sensitivity in identifying early ischemic changes due to its ability to detect diffusion restriction using Diffusion Weighted Imaging. CT was effective in detecting hemorrhagic stroke and remains a rapid and widely available imaging modality in emergency settings.

In this study, MRI detected stroke lesions in a greater number of patients compared to CT, and statistical analysis using McNemar test showed a significant difference between the two imaging modalities ( $\chi^2 = 7.56$ ,  $p < 0.05$ ). These findings indicate that MRI is more sensitive in detecting early ischemic stroke lesions that may not be visible on CT imaging during hyperacute stage.

Although CT continues to be used as the initial imaging modality due to its availability and speed, MRI

provides superior soft tissue contrast and improved lesion detection. Early and accurate diagnosis of stroke plays an important role in guiding appropriate treatment decisions and improving patient outcomes.

The findings of this study support the use of MRI as a more sensitive imaging modality for early stroke detection. Combined use of CT and MRI can improve diagnostic confidence and assist clinicians in selecting appropriate treatment strategies in patients with suspected acute stroke.

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