IJMPR 2025, 9(7), 53-57

International Journal of Modern Pharmaceutical Research

www.ijmpronline.com

ISSN: 2319-5878
IJMPR
Research Article

SJIF Impact Factor: 6.669

PROGNOSTIC AND THERAPEUTIC VALUE OF MRI IN ACUTE STROKE: A COMPREHENSIVE ANALYSIS

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Article Received on: 21/05/2025

Article Revised on: 11/06/2025

Article Accepted on: 01/07/2025

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ABSTRACT

Background: MRI is an important tool for early diagnosis, prognosis, and treatment of acute ischemic stroke. This study assesses the effects of MRI parameters on stroke diagnosis, functional outcome, and treatment. **Methods:** 200 patients with acute ischemic stroke were subjected to MRI, through diffusion-weighted imaging (DWI), fluid-attenuated inversion recovery (FLAIR), susceptibility-weighted imaging (SWI), magnetic resonance angiography (MRA), and magnetic resonance venography (MRV). MRI results were compared with clinical outcomes using modified Rankin Scale (mRS) and National Institutes of Health Stroke Scale (NIHSS). Variations in MRI parameters and their effects on treatment choices were evaluated. **Results:** Positive DWI lesions were noted in 83.5% of patients, with cortical infarcts being the most frequent (48.5%). On presentation, the mean volume of DWI lesions was 45.3 ± 22.7 ml, which was significantly reduced to 28.4 ± 18.6 ml on discharge ($p < 0.0001$). The percentage of patients with FLAIR positivity was raised from 67% to 79% ($p = 0.0069$). Hemorrhagic transformation on SWI identified fell from 13% to 10.5% ($p = 0.4381$). MRV abnormalities at presentation were identified in 8%, falling to 5.5% on discharge ($p = 0.3196$). DWI lesion volume and mRS outcomes were strongly correlated ($r = 0.86$, $p < 0.001$). MRI results directed treatment, where 41% of patients had thrombolysis and 13.5% had thrombectomy. A noteworthy decrease in NIHSS scores was observed on discharge ($p < 0.001$). **Conclusion:** MRI-based assessment of acute ischemic stroke yields essential information on infarct patterns, progression of the lesion, and effectiveness of treatment.

KEYWORDS: Acute Ischemic Stroke, Magnetic Resonance Imaging, Diffusion-Weighted Imaging, Functional Outcomes, Modified Rankin Scale, NIHSS.

INTRODUCTION

The burden of acute stroke is tremendous worldwide, it is the second most significant cause of death worldwide, and approximately 12 million new cases are encountered annually. It results in millions of deaths as well as a significant number of people with disability in low- and middle-income countries.[1-3] Indian stroke is the 4th leading cause of mortality and 5th leading cause of disability and has an incidence rate of 105-152 strokes per 100,000 population annually.[4] Stroke requires prompt and accurate diagnosis because interventions such as thrombolysis (clot-busting treatment) and thrombectomy (surgical removal of a clot) have their best outcomes when given within a limited time frame from the onset of stroke. "Time is brain" in managing this condition, so early detection minimises neurological damage.[5,6] MRI is typically preferred over a CT scan, being more sensitive for acute ischemic strokes, or the ability to detect brain tissue injury due to a blood clot more accurately, particularly early on; but CT scans are sometimes employed initially because they are more readily available and take less time to scan, especially if an immediate brain bleed must be eliminated.[7,8] Although CT remains the primary imaging modality for early stroke care, however MRI with DW measure is more sensitive than noncontrast CT for acute ischamia identification and more efficient than the first CT. It may not be able to distinguish between a true stroke and other conditions that mimic stroke symptoms ("stroke mimics") and lead to misdiagnosis and inappropriate treatment. DWI can detect lesions within minutes of symptom onset; it can reveal infarction site, size, and severity. DWI can distinguish acute and chronic lesions, determining stroke start time and guiding therapy choices.[9-12] But CT scans are often more readily available and less expensive than MRIs, making them the initial imaging choice in some situations.[13] This research was designed to determine

the changes in treatment driven by MRI, the relationship between DWI lesion volume and mRS, and evaluate the outcome based on MRI findings.

MATERIALS AND METHODS

This observational study was carried out among 200 patients with acute stroke on OPD and ED department of Vijaya group of Hospitals and Mercury Hospital, Chennai. Data were collected between a duration of 18 months, July 2023 to December 2024.

Study population

A total of 200 patients presented with acute stroke in OPD and ED department from July 2023 to December 2024 at Vijaya group of Hospitals and Mercury Hospital, Chennai were enrolled in this study.

Inclusion criteria

- Patients above the age of 18 years.
- Presentation within 12 hours of symptom onset.
- No contraindications to MRI.

Exclusion criteria

- Patients unable to undergo MRI.
- History of stroke with pre-existing severe disability

All the subjects who had gone through an MRI were assessed through Diffusion-Weighted Imaging (DWI) for recent infarction, Fluid-Attenuated Inversion Recovery (FLAIR) for determining the ischemic lesion, Susceptibility-Weighted Imaging (SWI) for hemorrhage transformation, Magnetic Resonance Angiography (MRA) for extensive vessel occlusion and Magnetic Resonance Venography (MRV) for venous dysfunction were conducted for all patients. MRI scans were employed within 6 hours of admission for early and effective detection of ischemic changes. DWI lesion volumes were measured by employing automated volumetric analysis software to evaluate brain tissue injury.

Participants were assessed using the National Institutes of Health Stroke Scale (NIHSS) to determine stroke severity upon admission. Functional recovery was measured were compared at time of presentation and discharge.

Modified Rankin Scale (mRS) was used to assess the severity of stroke in patients and the correlation between DWI lesion volume and mRS were assesed.

Outcome

The primary outcome of the study was to assess the treatment changes influenced by MRI. Secondary objectives included examining the association between DWI lesion volume and mRS score and comparison of NIHSS scores, and MRI findings at presentation and discharge.

Statistical analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics were used for baseline characteristics. Chi-square tests were applied for categorical variables. Pearson's correlation was calculated to assess the relationship between DWI lesion volume and mRS scores. Paired T-test is used in comparison of NIHSS score at presentation and discharge. A p-value < 0.05 was considered statistically significant.

RESULTS

The mean age of the patients was 65.2 ± 12.4 years, and 61% (122) were men while 39% (78) were women. Hypertension (126 (63%)) occurred more than Diabetes mellitus (92 (46%)). Smoking history was seen in 35.5% (71) patients, and prior stroke was experienced by 14.5% (29). The average time taken from onset of symptoms to the MRI was 4.8 ± 3.2 hours. The initial neurological severity NIHSS (National Institutes of Health Stroke Scale) score was 11.5 ± 4.

Table 1: Baseline Characteristics of patients admitted with acute stroke.

Baseline Characteristics	n = 200 (Mean ± SD / n (%))
Age (years)	65.2 ± 12.4
Gender (Male/Female)	122 (61%) / 78 (39%)
Hypertension	126 (63%)
Diabetes Mellitus	92 (46%)
Smoking History	71(35.5%)
Previous Stroke	29 (14.5%)
Time from Symptom Onset to MRI (hours)	4.8 ± 3.2
Initial NIHSS Score	11.5 ± 4.3

Most of the participants (167(83.5%)) had a positive DWI lesion, FLAIR positivity was present in 134 (67%) participants. Hemorrhagic transformation was detected in 26 (13%) participants by Susceptibility-Weighted Imaging (SWI), MRA was positive for large vessel occlusion (LVO) in 25.5% of the patients and magnetic resonance venography (MRV) reveals venous abnormalities in 8% of the patients. Infarct location was diverse, with cortical infarcts being predominant in 97 (48.5%) of the participants, followed by subcortical infarcts in 59 (29.5%) and lacunar infarcts in 44 (22%).

Table 2: MRI findings in patients with acute stroke.

MRI Parameter	n (%)
Positive DWI Lesion	167(83.5%)
FLAIR Positive	134 (67%)
SWI (Hemorrhagic Transformation)	26 (13%)
MRA (Large Vessel Occlusion)	51 (25.5%)
MRV (Venous Abnormalities)	16 (8%)
Location of Infarct:	
- Lacunar	44 (22%)
- Cortical	97 (48.5%)
- Subcortical	59 (29.5%)

Figure 1, represents the correlation analysis between DWI and mRS outcomes revealed a strong positive correlation ($r = 0.86$, $p < 0.001$). Smaller DWI lesion volumes were associated with good functional outcomes (mRS 0-1), larger volumes were associated with moderate to severe disability or mortality (mRS 4-6).

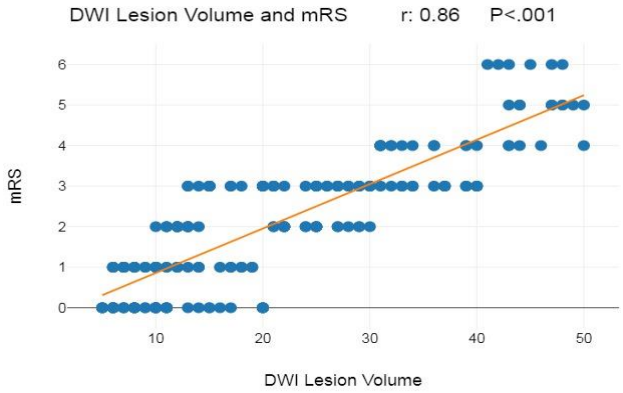

Figure 1: Correlation of DWI lesion volume and mRS.

The mean DWI lesion volume significantly decreased from 45.3 ± 22.7 ml at presentation to 28.4 ± 18.6 ml at discharge ($p < 0.0001$). The proportion of patients with positive FLAIR findings increased from 67% at presentation to 79% at discharge with a significant difference ($p = 0.0069$). Hemorrhagic transformation detected on SWI was observed in 13% of patients at presentation decreasing to 10.5% at discharge ($p = 0.4381$). Venous abnormalities on MRV were present in 8% of patients at presentation to 5.5% at discharge ($p = 0.3196$.

Table 3: Comparison of MRI findings at presentation and discharge.

MRI Parameter	At Presentation	At Discharge	p-value
DWI Lesion Volume (Mean ± SD)ml	45.3 ± 22.7	28.4 ± 18.6	< 0.0001*
FLAIR Positive	134 (67%)	158 (79%)	0.0069*
SWI (Hemorrhagic Transformation)	26 (13%)	21 (10.5%)	0.4381
MRV (Venous Abnormalities)	16 (8%)	11 (5.5%)	0.3196

The treatment decisions that were adjusted or initiated based on MRI findings in patients, 41% of patients receiving thrombolysis and 13.5% undergoing thrombectomy, adjustments in medication or dosing for 6% of patients and contributed to identifying alternative diagnoses or management plans in 4% of patients. 3% of patients experienced a change in their revascularization approach, and 2% of patient's previous treatments were discontinued.

Table 4: Treatment decisions influenced by MRI.

Treatment decisions	n (%)
Thrombolysis Initiated/Adjusted	82 (41%)
Thrombectomy Initiated/Adjusted	27 (13.5%)
Change in Medication or Dosing	12 (6%)
Alternative Diagnosis/Management	8 (4%)
Change in Revascularization Approach	6 (3%)
Discontinuation of Prior Treatment	4 (2%)

Figure 2, represents the comparison of NIHSS score during at presentation and discharge. A significant reduction in NIHSS scores is observed at discharge compared to presentation ($p < 0.001$).

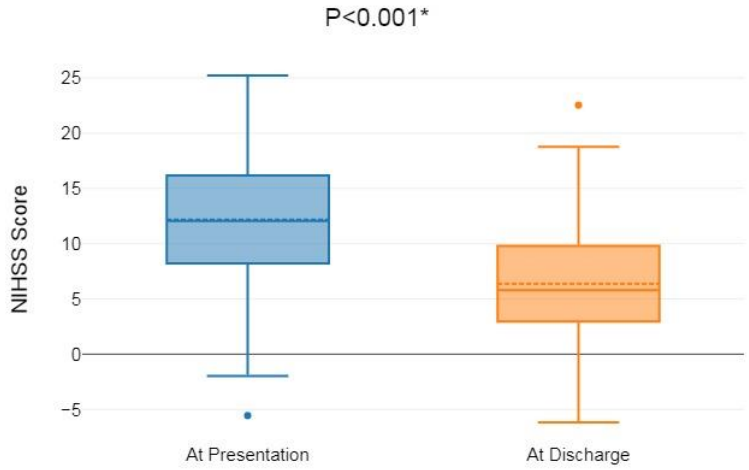

Figure 2: Comparison of NIHSS score at presentation and discharge.

DISCUSSION

This study was conducted among 200 patients presentedwith acute stroke in OPD and ED department over a period of 18 months, from July 2023 to December 2024 to assess the treatment changes influenced by MRI, examining the association between DWI lesion volume and mRS and to assess the MRI findings at presentation and discharge. The high sensitivity of MRI, particularly Diffusion-Weighted Imaging (DWI), in detecting acute ischemic changes has been well-documented. Immediate non-contrast MRI is approximately five times more sensitive than and twice as accurate as immediate non-contrast CT for diagnosing ischemic stroke.[14] A strong positive correlation was observed between DWI lesion volume and functional outcomes measured by the Modified Rankin Scale (mRS). This is consistent with study of **Eric Hartono Tedyanto et al.,** found a significant association between DWI infarct volume and short-term recovery in patients with middle cerebral artery occlusion undergoing intravenous thrombolysis.[15] A study by **Italo Linfante et al.,** found DWI lesion volume did not significantly correlate with NIHSS scores, NIHSS scores are more heavily weighted towards symptoms of anterior-circulation stroke.[16] The integration of MRI findings into clinical decision-making resulting in the implementation of interventions such as thrombolysis and thrombectomy. **Meien Jiang et al.** found that CTP combined with multi-modal MRI provide a better evaluation in patients with acute ischemic stroke with early neurological deterioration and implementation of interventions.[17] Study of **Nidhi Kapoor et al.,** assert that that emergent brain detect stroke mimics and prevents unnecessry tPA, reduces hospital stay and costs.[18] Improvements in functional outcomes over time, seen by increasing proportions of patients were observed based on their MRI findings during discharge, corresponding with results. **Mukesh Kumar et al** in his study fund brain MRI in AIS patients is linked to reduced rates of inpatient mortality and complications.[19] Unnecessary thrombolysis can be reduced by a transition from CT to MRI for first-line AIS imaging in identification of stroke mimics.[20] In their study, **Xie et al.** demonstrated that a 0.23-Tesla MRI can distinguish between cerebral hemorrhage and infarction rapidly and accurately, making it accessible and cost-effective.[21] The American Academy of Neurology recommends diffusion MRI over CT for stroke diagnosis due to its higher accuracy.[22] Research indicates that acute ischemic changes is most effectively detected by MRI.[23]

CONCLUSION

MRI-based assessment of acute ischemic stroke offers essential information regarding infarct patterns, lesion progression, and treatment response. DWI lesion volume is highly predictive of functional outcome, and MRI results have a significant influence on therapeutic decision-making. The research emphasizes the utility of MRI in stroke management and clinical outcome improvement.

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