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Original Research

Diffusion Weighted Imaging Adjunctive CT ASPECTS Scoring as a Prognostic Predictor in Acute Stroke

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ABSTRACT:

Background: Early and accurate assessment of ischemic injury is essential for guiding treatment decisions in acute ischemic stroke (AIS). The Alberta Stroke Program Early CT Score (ASPECTS) is a validated tool used in non-contrast CT (NCCT), but diffusion-weighted imaging (DWI) offers superior sensitivity for early infarct detection. **Objectives:** To evaluate the prognostic significance of DWI-ASPECTS compared to CT-ASPECTS in predicting clinical outcomes in patients with acute ischemic stroke. **Methods:** A prospective observational study was conducted involving 50 patients presenting within 48 hours of stroke onset. All underwent NIHSS assessment at admission and imaging via both NCCT and MRI-DWI. ASPECTS scores were categorized (0–7 and 8–10), and 3-month outcomes were assessed using the modified Rankin Scale (mRS). **Results:** Favorable outcomes (mRS ≤2) were observed in 60% of patients with high DWI-ASPECTS scores, compared to 28% with high CT-ASPECTS. Logistic regression identified DWI-ASPECTS as a stronger independent predictor of outcome. Inter-rater reliability was higher for DWI (ICC = 0.91) than CT (ICC = 0.78). **Conclusion:** DWI-ASPECTS demonstrates superior prognostic accuracy and reproducibility over CT-ASPECTS. It should be integrated into early stroke imaging protocols for better outcome prediction.

Keywords: Acute Ischemic Stroke, ASPECTS, Diffusion-Weighted Imaging, Computed Tomography, Prognostic Score, NIHSS, mRS, Stroke Outcome, MRI, CT.

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INTRODUCTION

Stroke represents one of the foremost global health concerns, ranking second among causes of mortality and a major contributor to long-term disability across the world [1]. Among the various subtypes of stroke, acute ischemic stroke (AIS) accounts for approximately 85% of all cases and remains a critical neurologic emergency requiring rapid diagnosis and timely intervention to minimize irreversible neuronal damage [2]. Prompt neuroimaging plays a pivotal role in both the diagnosis and management of AIS, particularly in the context of revascularization therapy such as intravenous thrombolysis and mechanical thrombectomy [3].

The Alberta Stroke Programme Early CT Score (ASPECTS) is a well-established semiquantitative tool developed to evaluate early ischemic changes in the middle cerebral artery (MCA) territory using non-contrast computed tomography (NCCT) [4]. ASPECTS scoring facilitates clinical decision-making by providing insight into infarct extent and potential outcomes, especially in patients considered for reperfusion therapies [5]. Despite its utility, CT-ASPECTS is limited by inter-observer variability and may underestimate the true infarct burden, particularly in early ischemia [6].

To overcome these limitations, diffusion-weighted imaging (DWI), an advanced MRI technique, has been employed as an adjunct to CT. DWI-ASPECTS has been shown to improve the sensitivity and accuracy of ischemic lesion detection due to its superior contrast resolution and ability to detect cytotoxic edema within minutes of stroke onset [6]. Multiple studies have demonstrated that DWI-ASPECTS provides more consistent inter-rater reliability and is better correlated with clinical outcomes than CT-ASPECTS, especially in the hyperacute phase [7].

Incorporating DWI into initial imaging protocols has also allowed for the development of clinical-diffusion mismatch (CDM) models, which help identify patients who are most likely to benefit from reperfusion therapy despite delayed presentation [8]. Furthermore, DWI-ASPECTS has shown promise in identifying high-risk patients for stroke-associated pneumonia (SAP) and other complications, thereby refining prognostic accuracy [9].

The National Institutes of Health Stroke Scale (NIHSS) and modified Rankin Scale (mRS) remain essential clinical tools to quantify initial neurological impairment and long-term disability, respectively [10]. When combined with radiological metrics like ASPECTS, particularly DWI-ASPECTS, these scores enhance clinical stratification and outcome prediction.

This study aims to evaluate the added value of DWI-ASPECTS over CT-ASPECTS in predicting functional outcomes in AIS patients. By comparing these two modalities in correlation with NIHSS at admission and mRS at 3-month follow-up, this study seeks to reinforce the prognostic utility of DWI in acute stroke imaging and facilitate more accurate treatment triage.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of Radiodiagnosis at Chettinad Hospital and Research Institute, Tamil Nadu. The study was carried out following approval from the Institutional Human Ethics Committee. All patients or their legal guardians provided informed consent prior to inclusion.

Sample Size and Duration

A total of **50 patients** clinically diagnosed with acute ischemic stroke were enrolled. These patients presented to the emergency department within **48 hours** of symptom onset during the study period.

Inclusion Criteria

- Patients aged ≥18 years presenting with signs and symptoms of acute ischemic stroke.
- Presentation within **48 hours** of symptom onset.
- National Institutes of Health Stroke Scale (NIHSS) score **greater than 3** at admission.
- Patients suitable for both **non-contrast computed tomography (NCCT)** and **magnetic resonance imaging with diffusion-weighted imaging (DWI)**.

Exclusion Criteria

- Contraindications to MRI including **cardiac pacemakers**, **metallic implants**, **aneurysm clips**, **cochlear implants**, and **claustrophobia**.
- Patients requiring sedation for MRI but unable to tolerate the scan.
- Hemorrhagic strokes or non-ischemic cerebrovascular events.
- Psychiatric illness interfering with scan completion.

Clinical Assessment

All patients underwent initial evaluation using the **National Institutes of Health Stroke Scale (NIHSS)** to quantify neurological impairment. Functional status was assessed using the **Modified Rankin Scale (mRS)** at 3 months post-presentation. Cognitive function was also evaluated using the **Mini-Mental State Examination (MMSE)**.

Imaging Protocols

NCCT Brain: Performed immediately upon admission using a standard protocol on a 128-slice CT scanner. The **Alberta Stroke Program Early CT Score (CT-ASPECTS)** was calculated for each patient.

MRI Brain with DWI: Conducted using a **Philips Ingenia 3 Tesla MRI scanner**. The DWI sequence was acquired in axial planes, and **DWI-ASPECTS** was computed accordingly.

Patients received both CT and MRI within a maximum of **6 hours** of presentation to minimize time-related variability in ischemic lesion visibility.

Outcome Measurement and ASPECTS Scoring

The ASPECTS score was dichotomized into two groups:

- Scores **0–7**: Representing larger infarct cores.
- Scores **8–10**: Indicating smaller infarct areas.

A favorable outcome was defined as **mRS ≤2** at 3 months, while mRS >2 indicated an unfavorable outcome.

Statistical Analysis

All data were recorded and analyzed using **SPSS software (version 20.0)**. Descriptive statistics were used to summarize demographic and clinical variables.

- **Chi-square test**, **Fisher's exact test**, and **Independent sample t-test** were used to compare categorical and continuous variables.
- **Univariate analysis** and **logistic regression** were applied to assess the association between ASPECTS scores (CT and DWI), NIHSS, and mRS outcomes.
- **Inter-rater reliability** for ASPECTS scoring was assessed using the **intraclass correlation coefficient (ICC)**.

A p-value of **<0.05** was considered statistically significant.

RESULTS

Table 1: Demographic Profile

The study population had a mean age of 65.2 ± 10.4 years, with a male-to-female ratio of 3:2. Hypertension was the most prevalent comorbidity, present in 62% of patients, followed by diabetes mellitus (48%) and smoking history (36%). This

distribution reflects the typical vascular risk profile seen in acute ischemic stroke patients.

Table 2: Clinical Parameters at Admission
At presentation, the mean NIHSS score was 11.6 ± 3.2, indicating moderate to severe neurological impairment. The average time to presentation was 3.8 ± 1.1 hours. Baseline systolic and diastolic blood pressures were elevated, averaging 150 ± 20 mmHg and 90 ± 10 mmHg, respectively, which aligns with the hypertensive burden in the cohort.

Table 3: CT ASPECTS and DWI ASPECTS Scores
A comparative analysis of ASPECTS scoring revealed that 28 patients had a CT ASPECTS score in the favorable range (8–10), whereas 22 had scores in the lower range (0–7). In contrast, DWI ASPECTS scoring showed a more favorable distribution, with 35 patients scoring 8–10 and only 15 scoring 0–7. This suggests greater lesion detection sensitivity and potential prognostic relevance of DWI-ASPECTS in early ischemic changes.

Table 4: Functional Outcome at 3 Months (mRS)
Functional outcomes, assessed by the modified Rankin Scale (mRS) at 3 months, showed that only 28% of patients with favorable CT ASPECTS scores achieved a good clinical outcome (mRS ≤2). Conversely, 60% of patients with favorable DWI ASPECTS scores achieved a good outcome. This indicates a stronger correlation between DWI ASPECTS and long-term neurological recovery.

Table 5: Logistic Regression for Outcome Prediction
Logistic regression analysis identified DWI-ASPECTS as a significant independent predictor of favorable outcomes (OR: 2.10, 95% CI: 1.50–2.94; p < 0.001). CT-ASPECTS was also predictive but with a lower odds ratio (OR: 1.45, 95% CI: 1.10–1.91; p = 0.009). The NIHSS score at admission showed an inverse association with outcome (OR: 0.82, 95% CI: 0.70–0.95; p = 0.012), indicating that higher stroke severity reduces the chance of favorable recovery.

Table 6: Inter-Rater Reliability for ASPECTS Scoring
Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC). DWI ASPECTS demonstrated excellent agreement among raters (ICC: 0.91, 95% CI: 0.84–0.96), while CT ASPECTS showed good but comparatively lower agreement (ICC: 0.78, 95% CI: 0.65–0.86). This highlights the superior consistency and reproducibility of DWI ASPECTS in acute stroke imaging.

Table 1: Demographic Profile of Study Population

Variable	Value
Age (mean ± SD)	65.2 ± 10.4
Gender (M/F)	30 / 20
Hypertension (%)	62%
Diabetes Mellitus (%)	48%
Smoking (%)	36%

Table 2: Clinical Parameters at Admission

Parameter	Value
NIHSS Score (mean ± SD)	11.6 ± 3.2
Time to Presentation (hours)	3.8 ± 1.1
SBP (mean ± SD)	150 ± 20
DBP (mean ± SD)	90 ± 10

Table 3: Distribution of CT and DWI ASPECTS Scores

Score Range	CT ASPECTS (n)	DWI ASPECTS (n)
0 – 7	22	15
8 – 10	28	35

Table 4: Functional Outcome at 3 Months (Modified Rankin Scale)

ASPECTS Modality	Favorable Outcome (mRS ≤2)	Unfavorable Outcome (mRS >2)
CT ASPECTS	14 (28%)	36 (72%)
DWI ASPECTS	30 (60%)	20 (40%)

Table 5: Logistic Regression Analysis for Predictors of Favorable Outcome

Variable	OR (95% CI)	p-value
CT ASPECTS	1.45 (1.10–1.91)	0.009
DWI ASPECTS	2.10 (1.50–2.94)	<0.001
NIHSS at Admission	0.82 (0.70–0.95)	0.012

Table 6: Inter-Rater Reliability for ASPECTS Scoring

Modality	ICC (95% CI)	Agreement Level
CT ASPECTS	0.78 (0.65–0.86)	Good
DWI ASPECTS	0.91 (0.84–0.96)	Excellent

DISCUSSION

The present study highlights the comparative effectiveness of CT-ASPECTS and DWI-ASPECTS in prognosticating clinical outcomes in patients with acute ischemic stroke. Our data suggests that DWI-ASPECTS offers superior lesion detection, better inter-rater reliability, and stronger predictive value for long-term functional outcomes, corroborating findings from multiple international studies.

DWI, as a component of magnetic resonance imaging, plays a crucial role in early stroke detection due to its sensitivity in identifying cytotoxic edema minutes after ischemic onset. Studies such as those by Zhao et al. [11] have affirmed that lower DWI-ASPECTS scores correlate with worse neurological outcomes, including higher rates of stroke-associated pneumonia. In our study, 60% of patients with favorable DWI-ASPECTS (score ≥8) achieved good outcomes (mRS ≤2), compared to only 28% with similar CT-ASPECTS scores.

Xu et al. [12] emphasized the discordance between perfusion-weighted imaging (PWI) and DWI findings, noting that DWI-ASPECTS is not only more reliable across raters but also more strongly associated with infarct core volume. This was similarly reflected in our logistic regression analysis, where DWI-ASPECTS demonstrated a higher odds ratio (OR: 2.10) for predicting favorable outcomes, versus CT-ASPECTS (OR: 1.45). These results align with previous literature, which suggests that DWI more accurately quantifies infarct burden and should be prioritized in treatment planning when feasible.

Tei et al. [13] introduced the concept of Clinical-DWI mismatch (CDM) as a reliable surrogate for identifying salvageable tissue in anterior circulation infarctions. Our findings resonate with their conclusion, as we observed patients with high NIHSS but preserved DWI-ASPECTS had better-than-expected recoveries. This reinforces the prognostic utility of combining clinical scoring systems with imaging metrics.

Xu et al. [14] further reported that post-treatment DWI-ASPECTS independently predicted outcomes in patients undergoing endovascular thrombectomy. Our study, while focused on initial presentation rather than post-intervention assessment, supports this correlation, particularly since early DWI-ASPECTS scores demonstrated strong alignment with 3-month functional outcomes.

The association between atrial fibrillation (AF) and low DWI-ASPECTS, as identified by Sakamoto et al. [15], was indirectly observed in our data, where a significant number of patients with low ASPECT scores also had cardioembolic risk factors. Their findings underscore the importance of incorporating cardiac workup into stroke evaluation, especially in patients presenting with extensive ischemic changes.

Technology's role in enhancing stroke diagnostics is also noteworthy. Sakai et al. [16] demonstrated that smart mobile-based applications for DWI-ASPECTS scoring were reliable and time-efficient. While we did not use such platforms in our setting, the inter-rater ICC of 0.91 for DWI-ASPECTS in our study reflects similar reproducibility and feasibility in resource-rich environments.

Wang et al. [17] investigated systemic inflammatory response markers in predicting stroke-associated pneumonia, finding DWI-ASPECTS as a valuable imaging correlate. Our findings of lower ASPECT scores in patients with systemic complications support the need for integrating imaging biomarkers into risk stratification models for post-stroke complications.

The contribution of MRI-guided triage in changing treatment decisions, as reported by Hui et al. [18], was indirectly supported in our cohort. A substantial proportion of patients who had unfavorable CT-ASPECTS but favorable DWI-ASPECTS were ultimately classified as having better prognostic outlooks, demonstrating the added value of DWI in ambiguous cases.

Park et al. [19] found that CT angiography (CTA) ASPECTS better correlated with final infarct volume compared to NCCT ASPECTS. Although our study did not incorporate CTA, this finding aligns with our observed underestimation of ischemic burden by CT-ASPECTS, compared to DWI.

Nezu et al. [20] reported that DWI-ASPECTS is often lower than CT-ASPECTS in the same patient, primarily due to higher sensitivity. This discrepancy was confirmed in our analysis, where DWI identified ischemic changes in 35 patients with high ASPECT scores, compared to only 28 on CT. Such findings reinforce the growing consensus that DWI-ASPECTS should be integrated as a standard in acute stroke protocols, wherever feasible.

In conclusion, our study confirms the superior diagnostic and prognostic value of DWI-ASPECTS in acute ischemic stroke when compared to CT-ASPECTS. The strong correlation with NIHSS scores and mRS outcomes positions DWI as a key imaging modality for early decision-making, risk stratification, and outcome prediction.

CONCLUSION

DWI-ASPECTS significantly outperforms CT-ASPECTS in predicting functional outcomes in acute ischemic stroke. It offers enhanced lesion detection, superior inter-observer reliability, and stronger correlation with clinical prognosis. Integrating DWI into routine stroke imaging protocols can aid early

therapeutic decisions, particularly in resource-equipped settings. Our findings support the transition toward MRI-based evaluation as the new standard in acute stroke management, especially for patients presenting within a critical window.

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