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A CROSS-SECTIONAL STUDY ON ASSESSMENT OF CT PERFUSION IMAGING IN ACUTE ISCHEMIC STROKE: CLINICAL BENEFITS AND LIMITATIONS

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Abstract
Background: Acute ischemic stroke (AIS) is a leading cause of morbidity and mortality worldwide, necessitating rapid and accurate diagnosis for timely intervention [1]. CT perfusion (CTP) imaging is increasingly utilized to assess cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT), aiding in differentiation between salvageable tissue and irreversibly damaged infarct core CT perfusion (CTP) imaging has emerged as a crucial tool in the evaluation of acute ischemic stroke (AIS). This cross-sectional study assesses the clinical benefits and limitations of CTP in the diagnosis and management of AIS. **Materials and methods:** This cross-sectional study was conducted on 150 patients who presented with suspected AIS within 24 hours of symptom onset. Inclusion criteria comprised adult patients (≥18 years) with neurologic deficits consistent with stroke. Exclusion criteria included contraindications to contrast media or prior intracranial hemorrhage Data from 150 patients presenting with suspected AIS were analyzed for imaging accuracy, treatment decision impact, and functional outcomes. **Results and conclusion:** CTP effectively identified ischemic penumbra and core infarct in 87% of cases, improving thrombolysis decisions. However, limitations included radiation exposure, variability in perfusion thresholds, and technical artifacts. Overall, CTP enhances stroke triage and treatment but requires careful interpretation to minimize false positives and negatives.

Keywords: CT perfusion, acute ischemic stroke, imaging, clinical benefits, limitations

Introduction
Acute ischemic stroke (AIS) is a leading cause of morbidity and mortality worldwide, necessitating rapid and accurate diagnosis for timely intervention [1]. CT perfusion (CTP) imaging is increasingly utilized to assess cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT), aiding in differentiation between salvageable tissue and irreversibly damaged infarct core [2]. Despite its advantages, CTP has limitations, including technical variability, radiation exposure, and potential misclassification of infarct regions [3]. This study aims to evaluate the clinical benefits and limitations of CTP in AIS management.

Materials and Methods
This cross-sectional study was conducted on 150 patients who presented with suspected AIS within 24 hours of symptom onset. Inclusion criteria comprised adult patients (≥18 years) with neurologic deficits consistent with stroke. Exclusion criteria included contraindications to contrast media or prior intracranial hemorrhage [4].

All patients underwent non-contrast CT followed by CTP using a multi-detector scanner. Imaging parameters included a contrast bolus of 50 mL, scan duration of 60–90 seconds, and analysis using automated software [5]. Imaging data were compared with follow-up MRI or clinical outcomes. Statistical analysis was performed using SPSS software, with sensitivity, specificity, and predictive values calculated [6].

Results

A total of 150 patients (mean age: 67±10 years, 55% male) were included. The key findings are summarized in Tables 1, 2, and 3.

Table 1: Demographic Profile of Patients

Characteristic	Value
Total Patients	150
Mean Age (years)	67 ± 10
Male	55%
Hypertension	72%
Diabetes Mellitus	38%
Hyperlipidemia	45%
Smoking History	30%
Prior Stroke	18%

Table 2: Performance Metrics of CT Perfusion in AIS

Parameter	Value (%)
Sensitivity	91
Specificity	85
Positive Predictive Value	88
Negative Predictive Value	89
Successful Thrombectomy Selection	82
Radiation Concerns Reported	10

Table 3: Clinical Benefits of CTP in AIS

Clinical Outcome	Percentage (%)
Improved Thrombolysis Decision	87
Reduced Time to Treatment	76
Increased Thrombectomy Eligibility	82
Improved Functional Outcomes (mRS ≤2 at 90 days)	68
Reduced Hospital Stay (>3 days)	55
Avoidance of Unnecessary Intervention	15

CTP accurately delineated ischemic core and penumbra in 87% of cases, directly influencing thrombolysis decisions [7]. However, overestimation of infarct volume occurred in 12% of cases, leading to conservative treatment approaches in some patients [8].

Discussion

CTP imaging provides rapid assessment of ischemic brain tissue, guiding revascularization therapy selection in AIS [9]. The ability to differentiate core infarct from salvageable penumbra is pivotal in determining eligibility for thrombolysis or mechanical thrombectomy [10].

The results of this study demonstrate that CTP had high sensitivity (91%) and specificity (85%) for detecting ischemic stroke, which aligns with prior research conducted by Albers et al. [11], who reported similar diagnostic accuracy. Furthermore, our study found that 87% of cases benefited from improved thrombolysis decision-making due to CTP findings, consistent with the work of Wintermark et al. [12], who also highlighted the value of CTP in reducing treatment uncertainty.

In terms of treatment outcomes, our findings showed that CTP contributed to increased thrombectomy eligibility (82%) and improved functional outcomes (mRS ≤2 at 90 days in 68% of cases). These results compare favorably with the DAWN and DEFUSE-3 trials [13], which reported improved patient selection for thrombectomy using CTP criteria. Moreover, our study found that CTP reduced hospital stay (>3 days) in 55% of cases, reinforcing the economic and clinical benefits of this imaging modality.

Despite its benefits, CTP presents notable limitations. Our study found that overestimation of infarct volume occurred in 12% of cases, leading to conservative treatment approaches, similar to findings by Bivard et al. [14], who noted that variability in perfusion thresholds can result in misclassification. Additionally, technical issues such as motion artifacts and contrast injection variability, reported in 10% of cases, have been highlighted in past studies as key concerns affecting CTP reliability [15].

Another challenge is the risk of contrast-induced nephropathy, particularly in patients with renal impairment, which limits the universal applicability of CTP in stroke triage [16]. The need for standardization in perfusion thresholds and imaging protocols remains an ongoing concern, as differences in software algorithms may yield variable results across institutions [17].

Overall, while CTP significantly enhances AIS management, ongoing improvements in imaging standardization and artifact reduction techniques are needed to optimize its reliability. Future research should focus on refining automated analysis methods and integrating artificial intelligence to enhance CTP interpretation accuracy and clinical applicability [18].

Limitations of CT Perfusion in AIS

While CTP offers significant advantages in AIS management, several limitations must be considered: The use of ionizing radiation, although minimized with modern CT scanners, remains a concern, particularly in younger patients and those requiring multiple scans [19]. CTP requires the administration of iodinated contrast, which may pose risks in patients with renal impairment or allergies [20]. Differences in software algorithms and parameter thresholds can lead to inconsistencies in identifying ischemic core and penumbra [21]. Motion artifacts, incorrect contrast injection timing, and image noise can affect the accuracy of CTP analysis [22].

Conclusion

CTP is a valuable imaging tool in AIS, offering rapid and precise assessment of ischemic brain tissue to guide clinical decision-making. While its benefits in thrombolysis and thrombectomy selection are well-established, attention to its limitations, including technical artifacts and interobserver variability, is crucial. Future research should focus on standardizing perfusion thresholds and reducing radiation exposure to optimize CTP's clinical utility.

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