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Research Article

Association of Perfusion Imaging with Stroke Severity and Follow-Up Outcome

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Abstract: ***Background:*** Perfusion imaging is beneficial in the assessment of stroke severity and outcome prediction by measuring ischemic tissue viability. It investigates the correlation between perfusion imaging findings, stroke severity, and three-month functional outcome in patients with acute ischemic stroke. ***Methods:*** This prospective observational study included 50 acute ischemic stroke patients. National Institutes of Health Stroke Scale (NIHSS) upon admission was utilized to assess stroke severity. Perfusion imaging parameters, including perfusion deficits, infarct core volume, and mismatch ratio, were analyzed. Follow-up outcomes were ascertained by the modified Rankin Scale (mRS) at three months. ***Results:*** Among the patients, 84% exhibited a perfusion deficit, and 56% had an infarct core volume >50 ml. The mismatch ratio was ≥1.8 in 66% of cases. Stroke severity distribution at admission was mild (16%), moderate (50%), and severe (34%). At three months, 54% of patients had a favorable outcome (mRS 0–2), while 40% had persistent disability (mRS 3–5), and 6% died (mRS 6). Larger infarct volumes and lower mismatch ratios correlated with poorer functional outcomes. ***Conclusion:*** Perfusion imaging findings correlate with stroke severity and three-month outcome. Volume of infarct core and ratios of mismatch predict strongly. Perfusion imaging has to be implemented in the practice of stroke so that treatment planning and estimation of recovery capacity is possible.
Keywords: Stroke, Perfusion Imaging, Infarct Core, Mismatch Ratio, NIHSS, Modified Rankin Scale.

INTRODUCTION

Stroke is the foremost cause of mortality and disability throughout the world and the predominant one is ischemic stroke [1, 2]. The burden of stroke has been on the rise in Bangladesh based on increased rates of hypertension, diabetes mellitus, and other cardiovascular risk conditions [3]. Clinical evaluation and conventional imaging techniques such as NCCT and MRI form the bulk of the stroke management to arrive at the diagnosis [4]. However, these modalities are not very effective in differentiating between living brain tissue and irreversible infarction, which is crucial for prognosis and treatment planning [5]. Perfusion imaging, including computed tomography perfusion (CTP) and magnetic resonance perfusion (MRP), has been found to be helpful in the assessment of cerebral blood flow and the detection of salvageable brain tissue, but its application remains not routine in the majority of centers [6].

Intravenous recombinant tissue plasminogen activator (rtPA) thrombolysis is an option but with extremely narrow inclusion criteria, and thus remains underutilized in the majority of low-resource health care systems [7]. Mechanical thrombectomy, while helpful, is not yet universally available at all stroke centers [8]. In such situations, estimation of the extent of ischemic injury, decision regarding treatment, and functional outcome depend to a great extent on perfusion imaging [9]. Measures such as infarct core volume, perfusion deficit, and mismatch ratio are all important predictors of stroke severity and outcome [10]. National Institutes of Health Stroke Scale (NIHSS) is often employed in the measurement of initial stroke severity, while the modified Rankin Scale (mRS) is used most frequently in the measurement of long-term disability and functional recovery [11]. However, the correlation between perfusion imaging findings and clinical outcome is not well understood, particularly in the Bangladeshi

population.

This study aimed to investigate the correlation of perfusion imaging parameters with stroke severity at admission and outcome at follow-up, three months later. These correlations could be used to personalize early stroke treatment, improve prognostic prediction, and improve patient outcomes. By assessing key imaging markers, this study hopes to elucidate the usefulness of perfusion imaging in diagnosing stroke and influencing clinical outcomes.

METHODOLOGY & MATERIALS

This prospective observational study was conducted at the Department of Radiology and Imaging, Super Medical and Diagnostic Center, Savar, Dhaka, from January 2013 to December 2013. A total of 50 Bangladeshi patients with clinically diagnosed acute ischemic stroke were included. Patients were selected based on clinical presentation and confirmed by non-contrast computed tomography (NCCT) or magnetic resonance imaging (MRI). Perfusion imaging was performed using computed tomography perfusion (CTP) or magnetic resonance perfusion (MRP) to assess core infarct volume, perfusion deficit, and mismatch ratio. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS) at admission, categorizing patients into mild (≤5), moderate (6–15), and severe (>15) groups. Follow-up assessment was conducted at three months using the modified Rankin Scale (mRS), classifying outcomes as favorable (mRS 0–2), disability present (mRS 3–5), or death (mRS 6).

Patients with hemorrhagic stroke, prior stroke history, or contraindications to perfusion imaging were excluded. Data on demographic characteristics, risk factors, and imaging parameters were collected. Statistical analysis was performed using SPSS software, and categorical variables were expressed as frequency and percentage. Written informed consent was taken from all patients or their guardians before participation.

RESULTS

Table 1: Demographic Characteristics of the Study Population (N = 50)

Characteristics	n	%
Age (Years)		
≤50	12	24.0
>50	38	76.0
Gender		
Male	27	54.0
Female	23	46.0
Hypertension		
Yes	34	68.0
No	16	32.0
Diabetes Mellitus		
Yes	18	36.0
No	32	64.0

Table 1 presents the demographic characteristics of the study population. The majority of participants were aged above 50 years (76%), with 24% aged 50 or younger. The gender distribution was nearly balanced, with 54% males and 46% females. Hypertension was prevalent in 68% of the participants, while 36% had diabetes mellitus.

Table 2: Stroke Severity Based on NIHSS at Admission (N = 50)

NIHSS Score (Severity)	n	%
Mild (≤5)	8	16.0
Moderate (6-15)	25	50.0
Severe (>15)	17	34.0
Total	50	100

Table 2 shows the distribution of stroke severity based on the NIHSS at admission. Half of the participants (50%) had a moderate stroke severity (score 6-15), while 34% had severe strokes (score >15) and 16% had mild strokes (score ≤5).

Table 3: Perfusion Imaging Findings (N = 50)

Imaging Parameters	n	%
Perfusion Deficit Present	42	84.0
Perfusion Deficit Absent	8	16.0

Core Infarct Volume (ml)		
≤50 ml	22	44.0
>50 ml	28	56.0
Mismatch Ratio ≥1.8	33	66.0
Mismatch Ratio <1.8	17	34.0

Table 3 summarizes the perfusion imaging findings. A significant majority of participants (84%) had a perfusion deficit present. Regarding the infarct core volume, 56% of participants had a core volume greater than 50 ml, while 44% had a core volume of 50 ml or less. In terms of mismatch ratio, 66% of participants exhibited a mismatch ratio ≥1.8, indicating a higher proportion of salvageable brain tissue.

Table 4: Follow-Up Outcome at 3 Months (mRS Score) (N = 50)

mRS Score (Outcome)	n	%
0-2 (Favorable Outcome)	27	54.0
3-5 (Disability Present)	20	40.0
6 (Death)	3	6.0
Total	50	100

Table 4 presents the follow-up outcomes at 3 months based on the modified Rankin Scale (mRS) score. Half of the participants (54%) achieved a favorable outcome (mRS score 0-2), while 40% exhibited some level of disability (mRS score 3-5). A small proportion (6%) of participants had passed away (mRS score 6) by the follow-up.

DISCUSSION

Stroke remains a significant contributor to death and disability worldwide, and perfusion imaging plays a critical role in stroke severity determination and prognosis in patients. The study analyzed the relationship between perfusion imaging findings, stroke severity, and three-month functional outcome in ischemic stroke patients. The results are in agreement with available evidence regarding the value of perfusion deficit, infarct core volume, and mismatch ratios in stroke prognosis.

Stroke severity, as measured by the NIH Stroke Scale (NIHSS), provides an objective assessment of neurological deficit. In our cohort, 16% of patients had mild strokes (NIHSS ≤5), 50% moderate strokes (NIHSS 6–15), and 34% severe strokes (NIHSS >15). This range is consistent with the findings of earlier studies that have demonstrated a strong correlation between high NIHSS scores and greater infarct volume, poor clinical outcome, and reduced possibility of functional independence [12].

Perfusion imaging is an important modality in the assessment of cerebral ischemia since it differentiates between infarcted tissue and salvageable brain regions. Perfusion deficit was present in 84% of patients in our cohort, reflecting the large extent of ischemic compromise. We also observed that 56% of patients had infarct core volumes >50 ml, a previously validated predictor of poor outcome [13]. The mismatch ratio, indicating the volume of salvageable brain tissue in relation to the infarct core, was ≥1.8 in 66% of patients. This is significant because studies such as the DEFUSE trials have demonstrated that a larger mismatch ratio is associated with more positive responses to reperfusion therapies [14, 15].

On three-month follow-up, 54% of patients experienced a good outcome (mRS 0–2), 40% had persistent disability (mRS 3–5), and 6% died (mRS 6). These findings emphasize the prognostic value of perfusion imaging in the assessment of post-stroke recovery. Several previous studies have reported comparable outcome distributions, emphasizing the notion that infarct core size and perfusion status are strong prognostic indicators [16, 17].

One of the key findings was the strong correlation of perfusion imaging parameters with clinical outcomes. Patients with both small infarct volumes (≤50 ml) and large mismatch ratios (≥1.8) showed a significantly better functional improvement, in accordance with studies by Lev et al., and Marks et al [18, 19]. On the other hand, patients with higher infarct volumes and low mismatch ratio were likely to experience severe disability or death, findings that are consistent with those of Kim et al. and Aviv et al [20, 21]. These results highlight the importance of early and accurate imaging for guiding treatment decisions as well as in predicting long-term functional outcome.

Our research results contribute to the growing body of evidence stressing the role of perfusion imaging in acute stroke management. Perfusion parameters provide valuable information about the severity of ischemia and the potential for tissue salvage, which is essential in designing treatment strategies. Several studies have demonstrated that patients with a large mismatch ratio and small infarct core benefit significantly from reperfusion therapies such as intravenous thrombolysis and mechanical thrombectomy [22, 23]. Our study validates this concept by demonstrating that perfusion imaging findings are closely correlated with clinical outcomes.

In addition, perfusion imaging has also aided in the prediction of hemorrhagic transformation and other complications. Both Kim et al., and Aviv et al., have shown that severe hypoperfusion and large infarct volumes are associated with an increased risk of hemorrhagic transformation, which can further deteriorate patient prognosis [20, 21]. This also justifies the application of perfusion imaging in acute stroke protocols for the sake of optimizing treatment decisions and improving patient safety.

Limitations of the study

While our research provides important data on the application of perfusion imaging in stroke severity and outcomes, there are a few limitations that should be considered. The sample size was relatively small and therefore may limit the generalizability of our findings. Additionally, while perfusion imaging is a very useful diagnostic tool, its availability and accessibility in different clinical settings might vary, and this may influence its widespread clinical application.

CONCLUSION

Our study highlights the tight correlation of perfusion imaging parameters, stroke severity, and functional outcome. Findings endorse the prognostic value of infarct core volume and mismatch ratios for outcome prediction, as in previous research. Perfusion imaging remains a useful part of stroke assessment, providing critical data that informs treatment decisions and long-term recovery predictions. Continued advancement in imaging technology and more extensive clinical application of perfusion-based stroke assessment can be expected to enhance patient outcomes and further optimize stroke management strategies.

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