



## ADDED UTILITY OF COMPUTED TOMOGRAPHY PERFUSION STUDY IN THE ASSESSMENT OF EARLY ISCHEMIC STROKE IN COMPARISON WITH NON-CONTRAST COMPUTED TOMOGRAPHY - A PROSPECTIVE OBSERVATIONAL STUDY

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### ABSTRACT

#### Objective:

1. To study the added utility of computed tomography perfusion study in the assessment of early ischemic stroke in comparison with non-contrast computed tomography.
2. To study the role of computed tomography perfusion study in deciding thrombolytic treatment/ therapeutic protocols aimed at reversing the cerebral ischemic insult.

**Conclusions and Results:** It was observed that 15 (46.68%) patients were in the 61-70 years of age group followed by 8 (25%) in the age group of 51-60 years. The mean age of the patients was  $58.87 \pm 12.14$  years.

- Females were affected more i.e. 18 (56.25%) compared to the male patients 14 (43.75%).
- Most observed co-morbid condition was hypertension in 9 (28.13%) patients followed by hypertension and diabetes in 7 (21.87%) patients and diabetes in 6 (18.75%) patients.
- Among the study participants 4 (12.50%) were smokers followed by 6 (18.75%) were alcoholic and smokers & alcoholic (15.62%) respectively.
- It was observed that the symptoms of palsy were present among 23 (71.88%) patients
- The most commonly observed time of onset of symptoms was 3-5 hours in 23 (71.88%) patients followed by 1-3 hours (21.87%) and >5 hours in 2 (6.25%) patients.
- NCCT findings observed was definite signs of stroke in 12 (37.5%) patients followed by suspected signs of stroke on NCCT (25%)
- It was observed that no sign of stroke was observed in 12 (37.5%) patients.
- CT perfusion findings observed was increased mean transient time (MTT) in all (100%) patients followed by decreased blood flow in all (100%) patients. It was observed that cerebral blood volume decreased in 12 (37.5%) patients, increased in 8 (25%) and normal in 12 (37.5%) patients.
- The correlation of NCCT and CT perfusion findings observed that out of total 32 patients NCCT study identifies 20 patients while all 32 patients were identified by CT perfusion study with sensitivity of 100%.
- CT perfusion provides early diagnosis of ischemic stroke thus helps in management of stroke patients.

**Inference :** The present study concludes that CT-perfusion had more sensitivity compared to NCCT in identifying early ischemic stroke. CT perfusion has additional utility in management of early ischemic stroke. CT Perfusion study provides important information to the neurologist and neuro-interventionalist when evaluating patients for endovascular reperfusion therapy by identifying the size of core infarction and penumbra.

**KEYWORDS :** NCCT, CT PERFUSION, MTT, CBV, CBF

### INTRODUCTION

Stroke is defined as sudden onset of focal neurological deficit of vascular origin.<sup>1</sup> Acute stroke is a common cause of morbidity and mortality. The incidence of stroke increases with age. The risk is higher in women due to factors related to pregnancy, such as preeclampsia, contraceptive use and hormonal therapy<sup>2</sup>

Stroke is a multifactorial disease and can be classified into two categories: ischemic and hemorrhagic. Age, sex, race/ethnicity are non-modifiable risk factors while hypertension, diabetes, smoking, alcohol consumption, substance abuse, diet, and physical inactivity are modifiable risk factors for stroke.

Ischemic stroke results from occlusion of a cerebral artery resulting in irreversible death of the cerebral tissue supplied by that occluded artery, referred to as the core. Surrounding this core there is a brain tissue that is ischemic but still viable, if timely restoration of blood flow is achieved which is the penumbra.<sup>3</sup> After clinical examination, non-contrast computed tomography of brain is the first-line imaging technique to differentiate ischemic from hemorrhagic stroke. Computed Tomography angiography further helps in identifying the occlusion site.

Computed Tomography perfusion assess the extent of salvageable tissue, produces perfusion maps, and predicts the benefit after thrombolysis.<sup>4</sup>

Computed Tomography Perfusion parameters that are commonly calculated include Cerebral blood flow, Cerebral blood volume, Mean Transit Time, and Time to peak.<sup>5</sup> The utility of Computed Tomography (CT) perfusion study in stroke diagnosis, as well as its logistical feasibility, makes it a diagnostic tool that can be potentially incorporated in stroke triage and treatment decisions.<sup>6</sup>

### MATERIALS AND METHODS

The study was conducted in a tertiary care hospital, in the Department of Radio-diagnosis.

**Data Source:** Study of 32 patients who are referred to the Department of Radio-diagnosis with symptoms of acute ischemic stroke and fulfilling the patient selection criteria as per the inclusion and exclusion criteria were included in the study.

**Study Design:** Prospective observational study

#### Inclusion Criteria

1. People with symptoms of acute neurodeficit.
2. Clinically diagnosed cases of early ischemic stroke.

3. Cases who had given consent.

**Exclusion Criteria:**

1. Cases with chronic infarct, lacunar infarcts on NCCT.
2. Cases with iodine sensitivity
3. Pregnancy
4. Diagnosed chronic kidney disease.

**Ethical Justification for Study:** The study was carried out only after approval by Institutional Ethical Committee of this tertiary care institute.

**DISCUSSION**

Stroke is a global health problem and is one of the leading causes of mortality and morbidity in adult. Perfusion computed tomography (CT) is a relatively new technique that allows rapid qualitative and quantitative evaluation of cerebral perfusion by generating maps of cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT).

Age is the most common non modifiable risk factors for the development of stroke. The mean age of the patients was 58.87 ± 12.14 years which correlates with Vivek Jain et al<sup>7</sup> study.

In the present study, it was observed that females were affected more i.e 18 (56.25%) compared to the male patients 14 (43.75%).

In the present study, most commonly observed co-morbid condition was hypertension in 9 (28.13%) patients followed by hypertension and diabetes in 7(21.87%) patients and diabetes in 6 (18.75%) patients. Among the study participants 4 (12.50%) were smokers followed by 6 (18.75%) were alcoholic and smokers & alcoholic (15.62%) respectively.

Vaishali Patel et al<sup>8</sup> in a study on early ischemic stroke observed 55% patients were hypertensive, 35% had DM and among 46 patients, 26 (56.53%) male patients were smokers and amongst total male 18 (39.13%) were alcoholic. So Hypertension, cigarette smoking and Diabetes mellitus were found to be important risk factor for stroke in our study.

In the present study, it was observed that the symptoms of palsy were present among 23 (71.88%) patients.

Ahmed Deif et al<sup>9</sup> in a study observed most frequent presenting symptom was limb weakness that was encountered in 75% of cases. Other symptoms included slurred speech in 12.5% of cases and facial drop in 12.5% of cases.

In the present study, the most commonly observed time of onset of symptoms was 3-5 hours in 23 (71.88%) patients followed by 1-3 hours (21.87%) and >5 hours in 2 (6.25%) patients.

Ahmed Deif et al<sup>9</sup> in a study on CT perfusion and CT angiography in detection of early ischemic stroke observed time intervals between the onset of symptoms and the initial CT scan ranged from 2 to 6 h, and the median time was 3 hours. This finding was similar to present study.

In the present study, the NCCT findings observed was definite signs of stroke in 12 (37.5%) patients followed by suspected signs of stroke on NCCT (25%) It was observed that no sign of stroke was observed in 12 (37.5%) patients.

Ahmed Deif et al<sup>9</sup> in a study observed among 64 patients, the non-contrast CT, 24 (37.5%) cases were negative for acute ischemic stroke. Among the positive 40 (62.5%) cases, 23 cases showed definite signs of ischemic stroke and 17 cases showed suspected signs of early ischemic stroke. This finding was similar to present study.

In the present study, the CT perfusion findings observed was increased mean transient time (MTT) in all (100%) patients followed by decreased blood flow in all (100%) patients. It was observed that cerebral blood volume decreased in 12 (37.5%) patients, increased in 8 (25%) and normal in 12 (37.5%) patients.

Ahmed Deif et al<sup>9</sup> in a study observed among 64 patients, CT perfusion showed evidence of cerebral hypo-perfusion in the form of prolonged MTT and decreased CBF in all stroke cases giving 100% sensitivity. The CBV was decreased in only 24 cases and was normal in 24 cases and increased in 16 cases.

In the present study, the correlation of NCCT and CT perfusion findings observed that out of total 32 patients, NCCT positive findings were seen in only 20 patients while CT perfusion study identified all 32 patients with sensitivity of 100%.

Shen J et al<sup>10</sup> in a systemic review of comparative accuracy of CT perfusion in diagnosing acute ischemic stroke observed sensitivity of CTP for acute ischemic stroke was 82% (95% CI 75±88%), and the specificity was 96% (95% CI 89±99%). CTP was more sensitive than NCCT and had a similar accuracy with CTA.

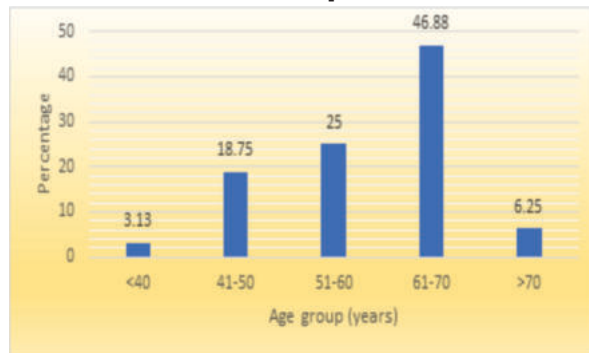
Ahmed Deif et al<sup>9</sup> in a study observed analysis of CTP, the sensitivity significantly increased to 100%. This was in agreement with previous studies by Lin k et al<sup>11</sup> Wintermark M et al<sup>12</sup> and Pepper EM et al<sup>13</sup> which demonstrated increased diagnostic sensitivity using CTP compared with non-contrast CT (NCCT).

Kloska et al.<sup>14</sup> found a sensitivity for CTP of 76%, whereas Mayer et al.<sup>15</sup> found a sensitivity of 93% in 61 patients with a follow-up study. From a theoretic point of view, a completed infarct and tissue at risk can be defined by reduced CBF, and quantitative assessment of CBF by CTP should provide exact maps of the infarct.

Out of total 32, 12 patients with clinically diagnosed stroke had their NCCT findings normal, especially those that were within 3-4 hours of presentation. CT perfusion study helped to identify those patients in whom NCCT study was normal. As these patients were in therapeutic window i.e. within 3-4 hours, they could be taken for thrombolytic therapy. Hence CT perfusion also helps in deciding the thrombolytic/ therapeutic protocols for management of these patients.

Mehmat et al.<sup>16</sup> in his report found that early diagnosis of acute cerebral infarction is critical due to the time limit of thrombolytic treatment and CT perfusion provides early diagnosis of major vessel occlusions in the brain thus helping in management of stroke patients.

Cases with chronic occlusion should be interpreted with caution and should prompt DWI imaging to exclude underlying infarct not discernable at CT perfusion. There is increased sensitivity to detect acute ischemic infarction from 40% to 100% after additional analysis of CTP



**Chart 1: Age-wise Distribution Of Study Participants**

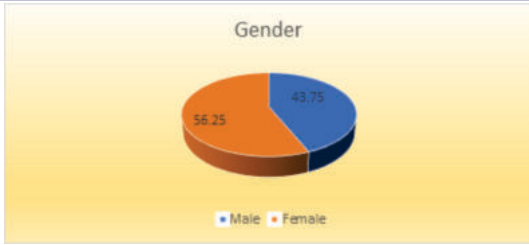


Chart 2: Gender-wise Distribution Of Study Participants

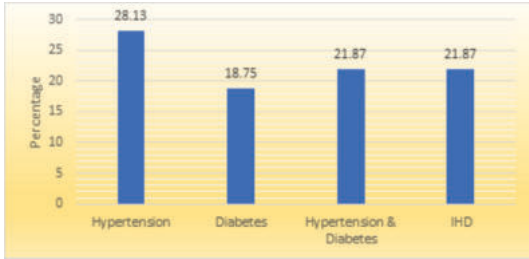


Chart 3: Study Participants With Associated Comorbidity



Chart 4: Social Habits Of The Study Participants

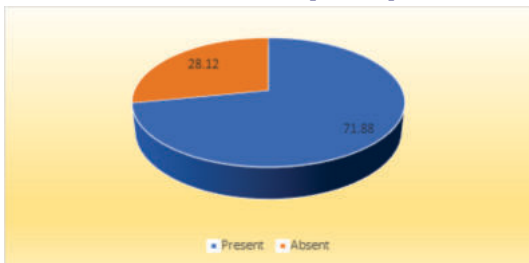


Chart 5: Distribution Of Study Participants As Per Symptoms Of Palsy

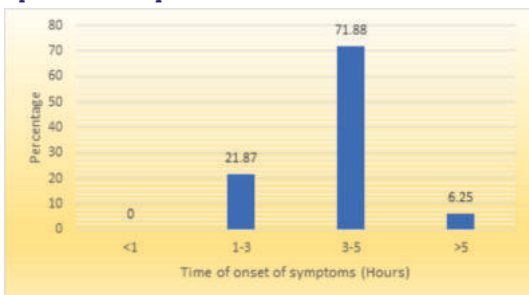


Chart 6: Distribution Of Participants As Per Time Of Onset Of Symptoms:

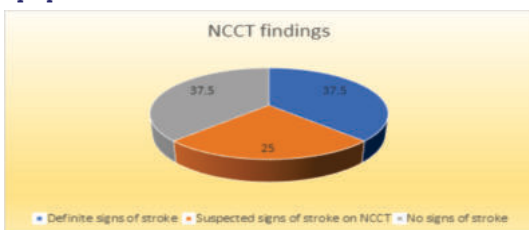


Chart 7: Distribution Of Study Participants As Ncct Findings:

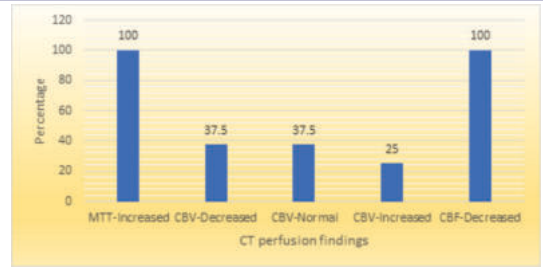


Chart 8: Distribution Of Study Participants As Ct Perfusion Findings:

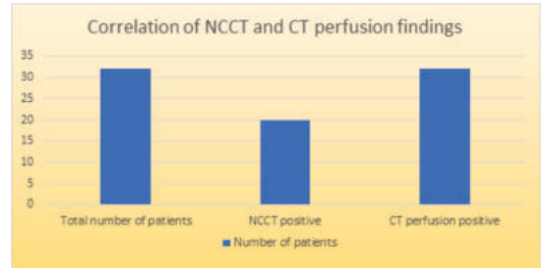
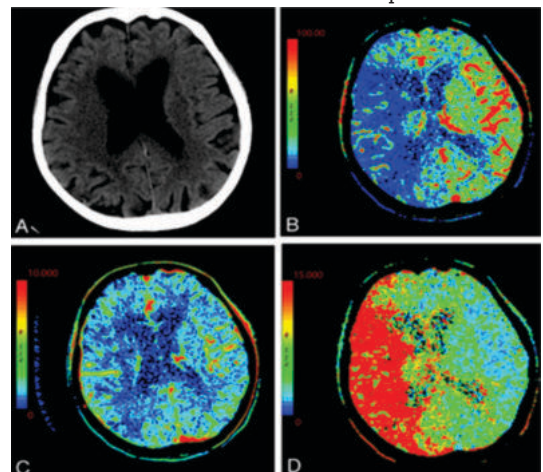


Chart 9: Correlation Of Ncct And Ct Perfusion Findings:

**CASE-1**

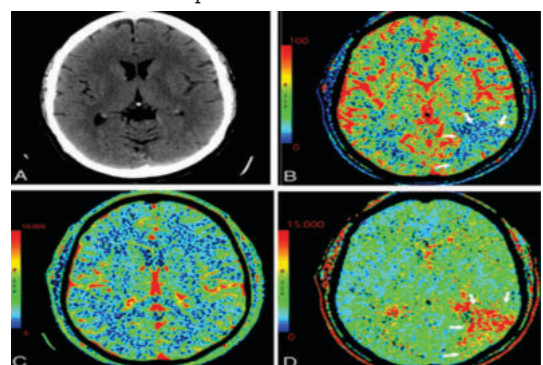
75 years old woman presenting with left sided weakness since 3 hours. On admission NCCT and CTP was performed.



A- NCCT done shows subtle hypodensity in right corona radiata with maintained grey white differentiation.  
 B- CBF perfusion maps shows decreased CBF  
 C- CBV perfusion maps shows decreased CBV  
 D- MTT perfusion maps shows increased MTT  
**These Patterns Suggest Large Core Infarct.**

**CASE-2**

60 years old male patient presented with complaints of headache and acute aphasia since 4 hours



A- NCCT done shows no evidence of acute infarction

B- CBF perfusion maps shows decreased CBF

E- CBV perfusion maps shows no abnormality

F- MTT perfusion maps shows increased MTT

**This pattern suggests ischemic penumbra.**

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