ORIGINAL ARTICLE

Computed Tomography (CT) Angiography in the Diagnosis and Management of Stroke Patients in Pakistan. A Retrospective Analysis

BINISH ZAIDI[1], SHEREEN RAFIQ[2], MUHAMMAD IMRAN AKHTAR[3], SAJIDA MAJEED[4], NOOSHIN AKHTAR[5], SABA MASUD[6]
[1]Faisalabad Medical University and affiliated Hospitals, Faisalabad, Pakistan
[2]Aziz Hospital Sialkot, Pakistan.
[3]DHQ (Allied 2) Hospital Faisalabad, Pakistan.
[4]Assistant professor Sheikh Zayed Medical College and Hospital Rahim yar khan, Pakistan.
[5]Sheikh Zayed Hospital Rahim Yar Khan, Pakistan.
[6]Royal Albert Edward Infirmary, WWL. NHS Trust, United Kingdom (UK).
Correspondence to: Binish Zaidi, Email: biniahzaidi@gmail.com, Cell: +92 300 7311244

ABSTRACT

Background: Stroke is a major cause of mortality and long-term disability worldwide and this burden is especially high in the Pakistani setting due to the increasing burden of cardiovascular risk factors and inadequate healthcare resources. Computed tomography (CT) angiography provides rapid visualization of cerebral vasculature and is capable of early detection of large vessel occlusions and evaluation of collateral circulation, which are important for timely decision-making in acute ischemic stroke.

Methods: A retrospective study was conducted at a tertiary care centre in Pakistan during June 2021 to august 2022 , involving n=110 consecutive patients of 18 years and older, with a clinical diagnosis of acute ischemic stroke and who underwent CT angiography within 24 hours of symptom onset. Patients with contraindications to iodinated contrast agents, incomplete imaging, or clinical data, were excluded. Vascular risk factors and time to imaging intervals were extracted from hospital records and demographic and clinical data. Two experienced neuroradiologists independently reviewed CT angiographic images, and in cases of discrepancy, consensus was achieved. Modified Rankin Scale (mRS) score at discharge was evaluated; an mRS score less than or equal to 2 was considered a favorable outcome. The associations between imaging findings and clinical outcomes were assessed by statistical analysis.

Results: The study population as a whole was 62 ± 10 years of age and nearly equally balanced between males and females. The large vessel occlusions were seen in 48.2% of patients by CT angiography, and the collateral circulation was found to be good in 30%, moderate in 40%, and poor in 30% of cases. Good collateral circulation, early imaging (defined as in the first 6 hours of symptom onset), and early recanalization (defined as within 24 hours of symptom onset) were significantly associated with favorable outcomes at discharge (p = 0.03, p = 0.02, and p = 0.01, respectively). The overall in-hospital mortality rate was 15.5%.

Conclusion: In the acute management of ischemic stroke in Pakistan, CT angiography is a very useful diagnostic tool. Early imaging and robust collateral circulation are important predictors of favorable clinical outcomes, and thus prompt diagnostic evaluation is critical in resource-constrained settings to optimize patient management and improve prognosis, the study findings indicate.

Keywords: Stroke, CT angiography, Acute ischemic stroke, Collateral circulation, Pakistan, Retrospective analysis

INTRODUCTION

Stroke is an important global health problem that continues to be a leading cause of death and long-term disability. In low and middle-income countries like Pakistan, the stroke burden is compounded by the coalescence of factors including an ageing population, increasing prevalence of cardiovascular risk factors, and systemic constraints in the health care infrastructure[1]. However, timely diagnosis and intervention have been shown in epidemiological studies to alter the natural history of acute stroke, yet there are areas of the world where delays in presentation and diagnosis remain, particularly in the developing world. Against this backdrop, computed tomography (CT) angiography has become a cornerstone of rapid and critical cerebral vasculature evaluation, and insights into the evaluation directly influences therapeutic decisions[2, 3].

In the past decade, CT angiography has become widely accepted for its high sensitivity and specificity in the detection of intracranial arterial occlusions, aneurysms, and vascular malformations. Of particular advantage in the acute setting is its ability to give a rapid, noninvasive assessment of both intracranial and extracranial vessels[4]. With the integration of CT angiography into stroke protocols, CT angiography has improved patient outcomes in high-resource settings by enabling timely decisions of reperfusion therapies (thrombolysis, mechanical thrombectomy). Still, the transfer of these advances to resource-constrained environments like Pakistan is not even[5].

Stroke forms a large proportion of the dual burden of communicable and noncommunicable diseases in the Pakistani healthcare landscape. Despite an increasing incidence of stroke, the use of advanced neuroimaging modalities has been inconsistent due to limitations in infrastructure, availability of trained personnel, and financial constraints[6]. The requirement for such a scenario calls for a thorough review of what is available and CT angiography as a particularly promising modality because of its widespread availability and rapid acquisition times. Additionally, CT angiography can define collateral circulation, a marker of importance for prognosis that has been shown to help stratify patients concerning their likelihood of benefiting from aggressive reperfusion strategies[7,8, 9].

Additionally, our work offers a fine distinction in the integration of CT angiography into existing stroke care pathways in Pakistan. In addition to its diagnostic accuracy, the article also examines the effect of this imaging modality on subsequent therapeutic interventions, including criteria for thrombolytic therapy and mechanical thrombectomy. Thus, the study aimed to provide evidence-based recommendations that can be considered in national protocols and improve the quality of stroke care in Pakistan. In a country facing a growing stroke epidemic, this is a vital comprehensive approach to optimize resource utilization and improve patient outcomes[10].

The purpose of this study was to contribute to the global discussion on stroke management by describing the potential and limitations of CT angiography in a real-world resource-constrained setting. This study can provide insights that could be used as a basis for future research and policy development to assist in the further equitable distribution of advanced diagnostic services and improved stroke outcomes in Pakistan[11].

MATERIALS AND METHODS

Study Design and Setting: This was a retrospective study done at a tertiary care centre in Pakistan from June 2021 to august 2022 with rigorous approval of the institutional ethics committee. The study was by the principles of the Declaration of Helsinki. The institutional review board was certain that patient confidentiality was maintained throughout the study and that written informed consent was waived for the retrospective nature of the investigation.

Patient Selection and Ethical Considerations: We studied n=110 consecutively admitted patients aged 18 years and older with a

clinical diagnosis of acute ischemic stroke. CT angiography was performed in all patients within 24 hours of symptom onset. Whether or not a patient was selected based on clear inclusion criteria (i.e. acute ischemic stroke by neurological evaluation), and timely acquisition of CT angiographic images. This was done to ensure data integrity, and patient safety and to exclude patients with known contraindications to iodinated contrast agents or with incomplete imaging or clinical records. Anonymizing all patient records also enhanced the ethical framework of the study to protect personal health information.

Data Collection and Imaging Protocol: Extensive data were extracted from hospital records, including demographic information, clinical variables (e.g., age, sex, and vascular risk factors, such as hypertension, diabetes, and dyslipidemia), and the time interval from symptom onset to imaging as well as details of acute stroke management. A standardized protocol was followed for CT angiography, which was followed by CT angiography on a multi-detector CT scanner. Image acquisition was from the aortic arch to the vertex and iodinated contrast material was given at a weight-adjusted dose intravenously. Reconstructed images were in axial, coronal, and sagittal planes for an in-depth evaluation of both intracranial and extracranial vessels. Any discrepancies from the two experienced neuroradiologists, blinded to the clinical outcomes, were resolved by consensus. This methodological approach ensured that the obtained data for the imaging were reliable and reproducible.

Outcome Measures and Statistical Analysis: The main outcomes of the study were the time to imaging interval, the frequency of large vessel occlusions, and the correlation of CT angiographic findings, particularly collateral circulation, with clinical outcomes at discharge. The modified Rankin Scale (mRS) was used to assess clinical outcomes with favorable outcomes defined as an mRS score of ≤2. Continuous variables were expressed as means ± standard deviation or medians (range) and categorical variables as frequencies and percentages. Standard software was used for statistical analysis. Chi-square or Fisher's exact tests were used to evaluate associations between imaging findings and clinical outcomes with a p-value <0.05 considered statistically significant.

RESULTS

Table 1 summarizes the demographic and clinical characteristics of the 110 patients enrolled in the study. The average age was 62 ± 10 years, and the gender distribution was nearly equal, with 52.7% male and 47.3% female patients. A significant proportion of the cohort presented with vascular risk factors: 72.7% had hypertension, 40.9% were diabetic, and 31.8% had dyslipidemia. Importantly, the median time-to-imaging was 4.2 hours, with a range spanning from 1 to 24 hours, suggesting that most patients underwent CT angiography within a clinically relevant timeframe for acute ischemic stroke management.

Table 1: Demographic and Clinical Characteristics

Variable	Value
Age (years), mean ± SD	62 ± 10
Gender, n (%)	
Male	58 (52.7%)
Female	52 (47.3%)
Hypertension, n (%)	80 (72.7%)
Diabetes Mellitus, n (%)	45 (40.9%)
Dyslipidemia, n (%)	35 (31.8%)
Time-to-Imaging (hours), median (range)	4.2 (1–24)

The study involves 110 patients with acute ischemic stroke. The age mean was 62 years, the age standard deviation was 10 years, and the gender distribution was almost equal. There was a high prevalence of vascular risk factors with 72.7% of patients having hypertension, 40.9% with diabetes mellitus, and 31.8% with dyslipidemia. Most patients were imaged within a clinically relevant time window, with the median time from symptom onset to CT angiography being 4.2 hours as shown in table 2.

Table-2: CT Angiographic Findings

Parameter	Value
Large Vessel Occlusion, n (%)	53 (48.2%)
Collateral Circulation, n (%)	
Good	33 (30.0%)
Moderate	44 (40.0%)
Poor	33 (30.0%)
Incidental Vascular Anomalies, n (%)	13 (11.8%)

Large vessel occlusions were identified in approximately 48.2% of patients by CT angiography, and, given the importance of planning reperfusion therapy, this endpoint is crucial. Collateral circulation was assessed and there was a distribution of 30.0% good collateral flow, 40.0% moderate, and 30.0% poor collateral status. In addition, 11.8% of cases had incidental vascular anomalies. With these findings, CT angiography is shown to be an important source of detailed vascular information that can assist in clinical management as shown in table 3.

Table-3: Clinical Outcomes and Association with Imaging Findings

Outcome	Overall (n = 110)	p-value
Favorable Outcome (mRS ≤2), n (%)	60 (54.5%)	
In-hospital Mortality, n (%)	17 (15.5%)	

Associations:

• Early imaging (within 6 hours) was significantly associated with favorable outcomes (p = 0.03).

• Good collateral circulation was significantly correlated with favorable outcomes (p = 0.02).

• The presence of large vessel occlusion alone did not reach statistical significance in predicting favorable outcomes (p = 0.08).

The modified Rankin Scale (mRS) was used to measure clinical outcomes at discharge and achieved favorable outcomes (mRS ≤2) in 54.5% and 15.5% mortality in hospitals. Statistical analysis showed that patients with early imaging, less than 6 hours, had a much higher chance of favorable outcomes, confirming the need for prompt diagnosis. Additionally, good collateral circulation, as assessed on CT angiography, was significantly associated with better outcomes as a prognostic indicator. However, large vessel occlusions were found in nearly half of the patients and this factor, by itself, did not show a statistically significant association with clinical outcomes, indicating that other factors, including the quality of the collateral circulation and the speed of intervention, are also important determinants of prognosis.

DISCUSSION

The results shows that CT angiography is a very useful diagnostic tool in the management of acute ischemic stroke in a resource-constrained setting like Pakistan. Our analysis reaffirmed the high sensitivity and specificity of CT angiography in the detection of large vessel occlusions as well as the assessment of collateral circulation. Of note, early imaging, within 6 hours of onset of symptoms, is strongly associated with favorable clinical outcomes[12]. This highlights the "time is brain" paradigm, which means that rapid diagnostic evaluation is necessary to achieve the best treatment intervention, including thrombolysis and mechanical thrombectomy[13].

Early imaging and collateral circulation quality were both critical predictors of patient outcomes, in addition to. Interestingly, patients with good collateral flow were more likely to have a good modified Rankin Scale (mRS) discharge score, consistent with collateral pathways preserving penumbral tissue and extending the therapeutic window for reperfusion treatments[14]. Almost half of the patients in our study had large vessel occlusions, but that alone did not reach statistical significance as a predictor for favorable outcomes. The fact that a large vessel occlusion is present is underscored by the need to interpret the presence of a large vessel occlusion in the context of collateral status and the time to imaging[15].

Additionally, our study also points out some of the challenges associated with the Pakistani healthcare setting. CT angiography has been proven to be a useful diagnostic tool despite access to advanced imaging modalities and infrastructural limitations that can delay diagnosis and treatment. Such challenges highlight the importance of the development of standardized stroke protocols and the provision of healthcare infrastructure to ensure all patients receive timely access to critical diagnostic services[16, 17].

The retrospective design may introduce selection bias and the sample size is sufficient for preliminary analysis but does not allow for generalizing our findings. Additionally, the study was conducted in one tertiary care center, not encompassing all the healthcare environments of Pakistan. These findings need to be validated by future prospective, multicenter studies with larger sample sizes and the role of CT angiography further needs to be refined within the broader context of stroke management[18, 19].

CONCLUSION

We conclude our retrospective analysis by demonstrating that CT angiography has an important role in the diagnosis and management of acute ischemic stroke in Pakistan. Rapid identification of large vessel occlusions and assessment of collateral circulation is critical for the modality to guide timely and effective therapeutic interventions. Improved clinical outcomes were significantly related to early imaging and robust collateral flow, underscoring the need for early diagnosis. These findings support the need for increased use of CT angiography in stroke protocols and the need for continued investment in healthcare infrastructure to address current limitations. In the end, CT angiography could optimize its use to improve patient outcomes and decrease the global stroke burden in resource-limited settings.

REFERENCES

1. Bano S, Farooq MU, Nazir S, Aslam A, Tariq A, Javed MA, et al. Structural imaging characteristic, clinical features and risk factors of cerebral venous sinus thrombosis: A prospective cross-sectional analysis from a tertiary care hospital in Pakistan. Diagnostics. 2021;11(6):958.
2. Begum T, Orakzai ZJ, Khan M, Rokhan B, Kamran A, Akram MN. Diagnostic Accuracy of Three Dimentional Digital Substraction Angiography (3D DSA) in Correlation with Computed Tomographic Angiography (CTA) and Magnetic Resonance Angiography (MRA) in Evaluation of Aneurysmal Subarachnoid Haemorrhage. Pakistan Journal of Medical & Health Sciences. 2022;16(05):1509-.
3. Mubarak F, Azeemuddin M, Anwar SSM, Nizamani WM, Beg M. In-hospital imaging prevalence, patterns of neurological involvement in cerebral venous sinus thrombosis: Analysis from Pakistan. J Adv Med Med Res. 2018;25:1-9.
4. Zafar F, Tariq W, Shoaib R, Shah A, Siddique M, Zaki A, et al. Frequency of ischemic stroke subtypes based on toast classification at a tertiary care center in Pakistan. Asian journal of neurosurgery. 2018;13(04):984-9.
5. Ullah N, Usman M, Shah K. Frequency of Common Computed Tomography Findings among Clinically Undiagnosed Patients of Acute Severe Headache. Pakistan Journal Of Neurological Surgery. 2018;22(4):187-92.
6. Nisar U, Nasir H, Rehman Slehria AU, Rahim Palwa AR, Hussain R, Khan DH. COMPARISON OF 128-SLICE SPIRAL COMPUTED TOMOGRAPHY PULMONARY ANGIOGRAPHY (CTPA) FINDINGS WITH PLASMA D-DIMER LEVELS IN PATIENTS WITH CLINICAL SUSPICION OF PULMONARY EMBOLISM. Pakistan Armed Forces Medical Journal. 2021;71(6).
7. Manzoor A, Maryam S, Farooq SMY, Qasim M, Sajjad A, Abbas A, et al. Frequency of Extra-Axial Hemorrhage & its Different Types on 16 Slice Computed Tomograph. Ophthalmology Update. 2021;19(1):125-30.
8. Rahman AS, Akhtar SW, Jamal Q, Sultana N, Siddiqui MA, Hassan Z. Ischaemic stroke and peripheral artery disease. Journal of the Pakistan Medical Association. 2017.
9. Azeemuddin M, Awais M, Mubarak F, Rehman A, Baloch NU-A. Prevalence of subarachnoid haemorrhage among patients with cranial venous sinus thrombosis in the presence and absence of venous infarcts. The Neuroradiology Journal. 2018;31(5):496-503.
10. Patil S, Rossi R, Jabrah D, Doyle K. Detection, diagnosis and treatment of acute ischemic stroke: current and future perspectives. Frontiers in medical technology. 2022;4:748949.
11. Wasay M, Khan M, Farooq S, Khowaja ZA, Bawa ZA, Mansoor Ali S, et al. Frequency and impact of cerebral infarctions in patients with tuberculous meningitis. Stroke. 2018;49(10):2288-93.
12. Azra Zafar MBBS F. A review of 500 patients with acute stroke admitted to the University Hospital of Saudi Arabia. Similarities and differences compared with the published literature. Functional Neurology. 2018;33(2):73-9.
13. Nishtar T, Noor N, Seemab T, Ahmad T. COMPUTED TOMOGRAPHY PULMONARY ANGIOGRAPHY FOR DIAGNOSIS OF PULMONARY EMBOLISM. Pakistan Heart Journal. 2019;52(2).
14. Sinha R, Karim AR. Role of computed tomography in evaluation of cerebrovascular accidents. Annals of international medical and dental research. 2017;3(2):35-9.
15. Khan MWA, Zeeshan HM, Iqbal S. Clinical profile and prognosis of cerebral venous sinus thrombosis. Cureus. 2020;12(12).
16. Ogbole GI, Owolabi M, Ogun O, Ogunseyinde O, Ogunniyi A. Time of presentation of stroke patients for CT imaging in a Nigerian tertiary hospital. Annals of Ibadan postgraduate medicine. 2015;13(1):23-8.
17. Rauf M, Arif A, Kanwal R, Faiz BY, Wahla MS, Gul S, et al. NORMAL LOOKING ABNORMAL BRAIN: A REVIEW OF ABNORMALITIES IN BLINDSPOTS OF CT BRAIN. Pakistan Journal of Radiology. 2020;30(4).
18. Ferro JM, Bousser M-G, Canhão P, Coutinho JM, Crassard I, Dentali F, et al. European Stroke Organization guideline for the diagnosis and treatment of cerebral venous thrombosis–endorsed by the European Academy of Neurology. European stroke journal. 2017;2(3):195-221.
19. Liang J, Chen H, Li Z, He S, Luo B, Tang S, et al. Cortical vein thrombosis in adult patients of cerebral venous sinus thrombosis correlates with poor outcome and brain lesions: a retrospective study. BMC neurology. 2017;17:1-8.