# Impact of Clinical and Radiologic Factors on CTP Timing in Acute Ischemic Stroke

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## ABSTRACT

**BACKGROUND AND PURPOSE:** CT perfusion is widely used to assess infarct core and penumbra in acute stroke, but scan durations vary and may be affected by patient-specific delays in contrast arrival. Our purpose was assess the impact of radiologic and clinical variables on brain CTP curves in patients with acute ischemic stroke.

**MATERIALS AND METHODS:** We included 295 patients who underwent CTP for acute ischemic stroke in our institution (January 2020 to March 2024). Two radiologists evaluated arterial input function and reference vessel curves to assess bolus arrival delay and time to equilibrium; discrepancies were resolved by consensus. Additionally, they evaluated the unenhanced brain CTs acquired before CTP for the presence of microangiopathy (van Swieten scale) and intracranial arterial wall calcifications (yes/no). CTA was evaluated for the site of occlusion. Age, sex, arterial blood pressure, heart rate, presence of arrhythmias, and NIHSS were retrieved from an institutional database. A univariate analysis was performed to establish significant variables; variables with a $P$ value $< .1$ in the univariate analysis were subsequently included in a multivariate logistic regression model to adjust for potential confounding factors.

**RESULTS:** Logistic regression identified cardiac arrhythmias and increasing age as independent predictors of nondiagnostic perfusion CT examinations ($P < .001$). Other factors, including arterial calcifications, white matter lesions, NIHSS score, and large vessel occlusion, were not significantly associated with nondiagnostic outcomes. Logistic regression analysis revealed that the arterial time-to-peak value was significantly associated with the presence of cardiac arrhythmias ($P < .0001$), with higher time-to-peak values observed among patients with arrhythmias (24.0 seconds; interquartile range [IQR]: 20.2–27.1 seconds) compared with those without (18.6 seconds; IQR: 15.5–21.7 seconds). Similarly, the venous time-to-peak was found to be longer in patients with cardiac arrhythmias (median 30.2 seconds; IQR: 26.4–32.0 seconds) compared with those without (25.6 seconds; IQR: 22.5–28.7 seconds), $P < .0001$.

**CONCLUSIONS:** Our study showed that patients with cardiac arrhythmias need longer CTP acquisition times to avoid perfusion curve truncation and potentially nondiagnostic results. The knowledge of the impact of clinical variables on CTP may help better tailor the acquisition delays to improve diagnostic quality and avoid unnecessary radiation doses.

**ABBREVIATIONS:** AIF = arterial input function; AIS = acute ischemic stroke; IQR = interquartile range; LVO = large vessel occlusion; RefV = reference vessel

Addressing acute ischemic stroke (AIS) is a major challenge in emergency medicine due to the narrow time window available for diagnosis and timely treatment. In patients with acute neurologic symptoms suggestive of AIS, NCCT is typically performed to rule out intracranial hemorrhage and to assess the presence of early ischemic signs. CTA is used to detect large vessel occlusions (LVOs), accessible for mechanical thrombectomy. At the same time, advanced neuroimaging techniques may be advantageous in cases of diagnostic uncertainty.[1]

With the aim of establishing a wider time-to-treatment window, CTP has emerged as a valuable tool in the management of AIS, providing essential quantitative information on the extent of the irreversibly infarcted cerebral tissue ("core") and the hypoperfused, severely ischemic, but potentially salvageable tissue ("penumbra").[2] These act as essential indicators for identifying patients who are most likely to benefit from reperfusion therapy and to minimize the risk of hemorrhagic complications.[3-5] Besides its growing role in determining eligibility for clinical trials, CTP is currently incorporated into routine clinical practice to aid in selecting patients for intravascular thrombolysis and endovascular thrombectomy if the time from symptom onset is unknown or if it exceeds 6 hours. On the other hand,

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NCCT-based evaluation with the semiquantitative ASPECTS score falls short in terms of accuracy and reliability in estimating infarction volume.[6,7]

Although CTP is widely used in the management of acute stroke, recommendations for optimal scan acquisition parameters, such as scan duration, vary among studies.[8] As a result, CTP scan durations vary significantly between centers, ranging from 40–90 seconds.[2,9] The assessment of ischemic tissue by using CTP depends on the characteristics of the contrast bolus as it passes through, indicating that the optimal scan duration varies based on the bolus's arrival time and shape, and is thus case-specific. Too short scan durations may lead to truncation of the concentration measurements, resulting in inaccurate CTP results.[10] Conversely, long scan durations may subject patients to unnecessary radiation without improving the accuracy of CTP results. The ideal minimum scan duration, which would prevent truncation-related errors while minimizing radiation exposure, has yet to be determined.

Conditions such as reduced cardiac output, cardiac arrhythmias, stenosis or occlusion of the internal carotid artery, intracranial vessel occlusion, or a combination of these factors, which are frequently observed in patients with ischemic stroke, may result in delayed iodine saturation in cerebral tissues.[11,12] The extent to which these patient-specific factors influence the diagnostic quality of CTP has not yet been thoroughly evaluated.

The aim of our study was to determine how individual clinical factors might affect cerebral tissue iodine saturation and mean transit time/time-to-peak for CTP in the context of acute ischemic stroke.

## MATERIALS AND METHODS

### Patient Population

This institutional review board–approved retrospective observational cohort study was conducted in accordance with the Declaration of Helsinki; the need for informed consent was waived. This study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

We considered for inclusion 316 consecutive patients who underwent NCCT and CTP at our institution between January 2020 and April 2024 with the clinical suspicion of anterior circulation AIS. Exclusion criteria were the presence of severe movement artifacts compromising the diagnostic value of CTP (8/316), a diagnosis of acute epileptic seizure upon admission (4/308), intra- or extra-axial intracranial neoplasm at the time of admission (2/304), intracranial hemorrhage (1/302), other diagnoses at the time of CTP ruling out acute ischemic stroke, or lack of appropriate clinical documentation (6/301).

### Imaging Protocol

All CT scans were performed on a 128-slice single-source scanner.

CTA from the ascending aorta to the vertex was acquired after administration of 50 mL of nonionic contrast agent (350 mg/mL of iodine) at a flow rate of 4.0 mL/s, followed by a saline "chaser" of 30 mL at the same injection rate. A bolus tracking technique was used, with an ROI in the ascending aorta and a trigger of 100 Hounsfield units (HU) of attenuation.

CTP was acquired after administration of 40 mL of nonionic contrast agent (350 mg/mL of iodine) injected at a flow rate of 6 mL/s, followed by a saline chaser of 50 mL at the same injection rate. Four seconds after the start of the injection, a series of 30 consecutive scans, 1 every 1.5 seconds, is initiated.

### Image Analysis

Two radiologists, with 2 and 9 years, respectively, of experience in emergency neuroradiology, evaluated arterial input function (AIF) and reference vessel (RefV) curves to assess bolus arrival delay and time to equilibrium; CTPs were considered of diagnostic quality if at least 3 time points were measured before AIF rise and 1 after RefV return to equilibrium, as per vendor guidelines. In case of disagreement, a consensus was reached. An example of early truncation of AIF and RefV curves is shown in Fig 1, while Fig 2 shows an example of a technically adequate examination. The unenhanced brain CTs acquired before CTP were evaluated for the presence of microangiopathy (score 0–4) according to the van Swieten CT scoring system[13] (Fig 3), intracranial arterial wall calcifications (yes/no), and endotracheal tube at the time of examination (yes/no).

CTA images were assessed to determine the site of any detectable occlusion, and LVOs, defined as occlusions involving the internal carotid artery or the proximal segments of the middle and anterior cerebral arteries, were distinguished from more distal vessel occlusions.

The selection of these variables was guided by those most commonly reported in the literature as potential confounders of CTP diagnostic quality, although in many cases their inclusion appears to rely more on clinical intuition than on robust empirical evidence.

### Clinical Data Collection

Biometrical and clinical parameters, such as date of birth and sex of the patients, date of examination, arterial blood pressure, heart rate, cardiologic consults with ECG, and NIHSS at the time of admission, as well as documentation regarding previous diagnoses of cardiac arrhythmias, were retrieved from institutional databases. Particular attention was given to documentation of preexisting cardiac arrhythmias, including atrial fibrillation, atrial flutter, bundle branch block, and other clinically relevant rhythm disturbances. The age of the patients at the time of examination was calculated.

### Statistical Analysis

Demographic and clinical data were summarized by using descriptive statistics, measures of variability, and precision. Initially, a univariate analysis was performed to evaluate the impact of various variables, such as arrhythmia, arterial calcifications, heart rate, presence of white matter lesions (reported according to the Van Swieten scale), NIHSS, LVO, and endotracheal tube, on the diagnostic value of perfusion. ORs for a nondiagnostic examination were calculated for each variable. Variables with a $P$ value $<.1$ in the univariate analysis were subsequently included in a multivariate logistic regression model to adjust for potential confounding

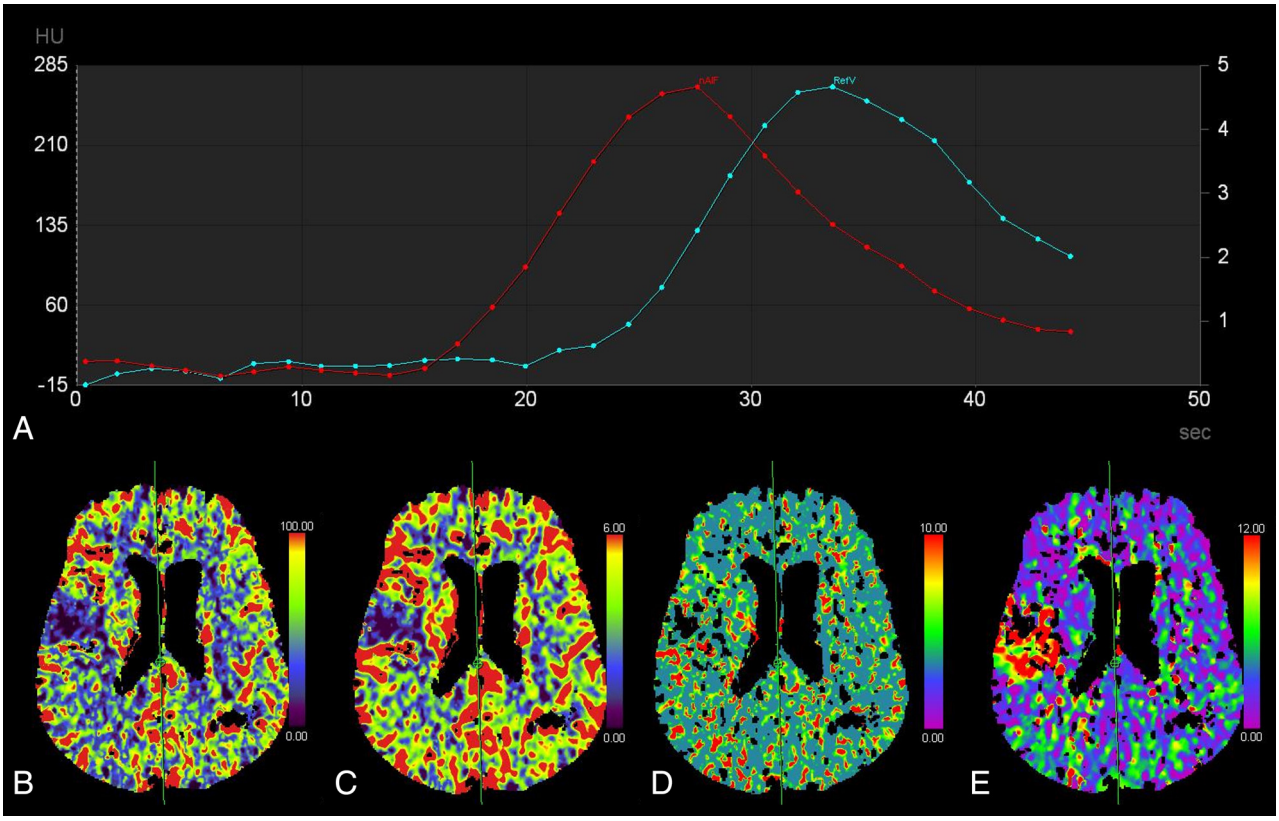


**FIG 1.** *A*, Example of AIF and RefV curve truncation in 67-year-old male patient with documented cardiac arrhythmia. *B–E*, Example of CBF, CBV, MTT, Tmax maps in the same patient. HU indicates Hounsfield units.

factors. In the multivariate model as well, ORs for a nondiagnostic examination were estimated. The validity of the logistic regression model was confirmed by using the Hosmer-Lemeshow test.

To investigate the effect of cardiac arrhythmias on perfusion timing parameters, arterial and venous time-to-peak values were measured in all patients. Median values and interquartile ranges (IQRs) were calculated for both groups: patients with cardiac arrhythmias and those without documented cardiac abnormalities. Comparisons between groups were performed by using the Mann-Whitney U test, due to non-normal distribution of the data.

*P* values $< .05$ were considered statistically significant.

## RESULTS

### *Study Population*

The final patient population included 295 patients, 161 women and 134 men, with a median age of 79 years (IQR: 66–85). Median NIHSS was 8 (IQR: 4–15). Median systolic pressure was 150 mm Hg (IQR: 136–165), while median diastolic pressure was 80 mm Hg (IQR: 70–90) and median heart rate was 80 bpm (IQR: 70–92). No cardiac arrhythmia had been recorded in the patient's history or was diagnosed upon admission in 202 (68.5%) patients, while 93 (31.5%) patients had a positive history of cardiac arrhythmia or were newly diagnosed at admission. Namely, 89 (30.2%) patients had an established diagnosis of atrial fibrillation or were diagnosed with atrial fibrillation upon admission; specifically, 79 (26.8%) patients were actively fibrillating upon admission as demonstrated by routine ECG, and 10 (3.4%) patients had an established diagnosis while showing no signs of active atrial fibrillation at routine admission ECG. Four (1,4%) patients had a known history of bundle branch block. On NCCT of the brain, 87 (29.5%) patients showed no white matter lesions or only a single white matter lesion (Van Swieten 0), whereas 208 (70.5%) patients showed multiple white matter lesions, with 30 (10.2%) patients showing multiple unilateral focal white matter lesions (Van Swieten 1), 79 (26.8%) patients showing multiple bilateral focal white matter lesions or multiple unilateral confluent white matter lesions (Van Swieten 2), 37 (12.5%) patients showing multiple unilateral focal white matter lesions and contralateral multiple confluent white matter lesions (Van Swieten 3), and 62 (21.0%) patients demonstrating multiple bilateral confluent white matter lesions (Van Swieten 4); upon evaluation of the carotid siphons on NCCT 60 (20.3%) patients showed no signs of calcification, while 235 (79.7%) patients demonstrated calcifications of the carotid siphons. An endotracheal tube was positioned before imaging in only 5 (1.7%) patients, while 290 (98.3%) patients underwent diagnostic imaging without requiring intubation.

On CTA assessment, 64 (21.7%) patients presented with a large vessel occlusion, while the remaining 231 (78.3%) patients showed occlusions of more distal medium- and small-caliber vessels.

CTP was of diagnostic quality, ie, without truncation of AIF and RefV curves, in 192 examinations (65.1%), while CTP resulted in truncation of AIF and RefV curves in 103 examinations (34.9%). In all cases where CTP was deemed nondiagnostic, this was attributable to early truncation of the AIF and RefV curves.

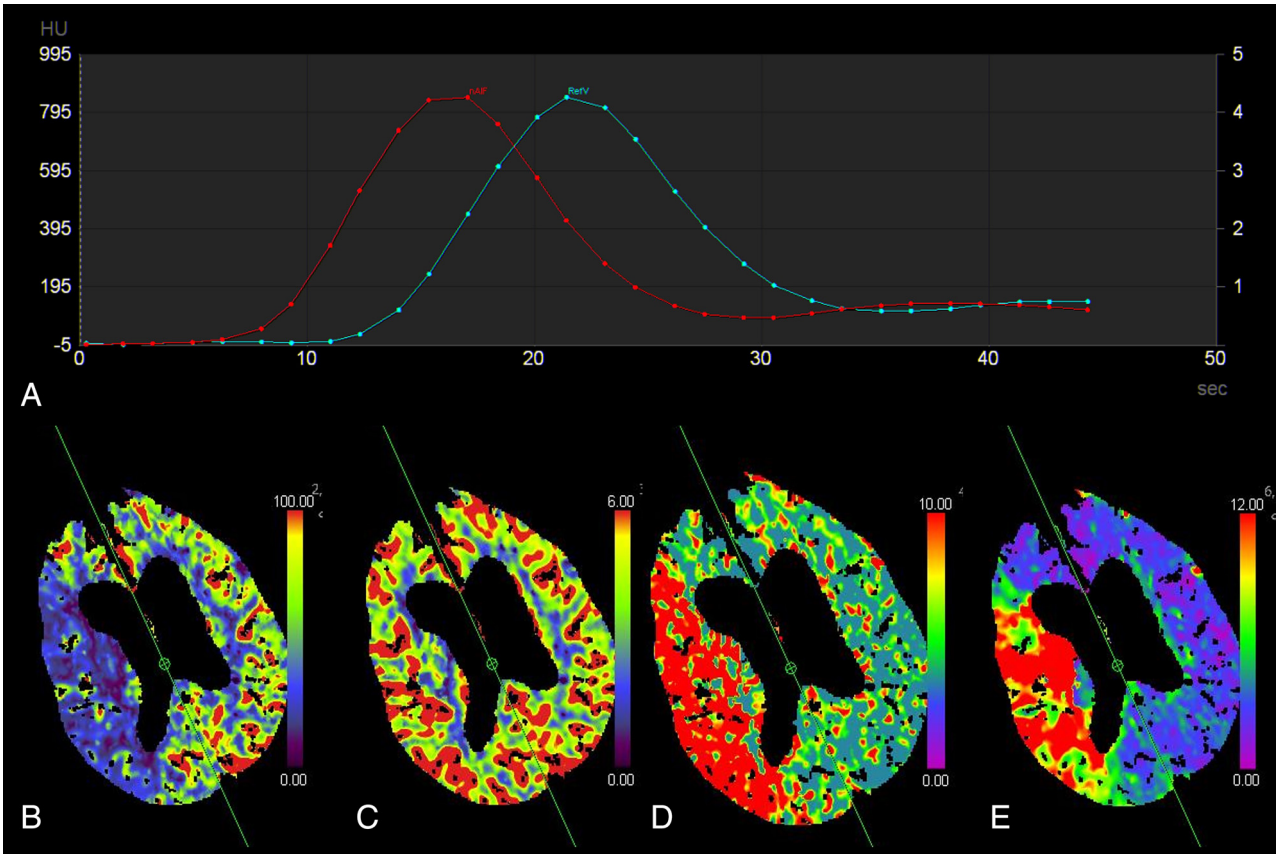


**FIG 2.** *A*, Example of adequate AIF and RefV curves without truncation in 74-year-old female patient without evidence of cardiac arrhythmias. *B–E*, Example of CBF, CBV, MTT, Tmax maps in the same patient. HU indicates Hounsfield units.

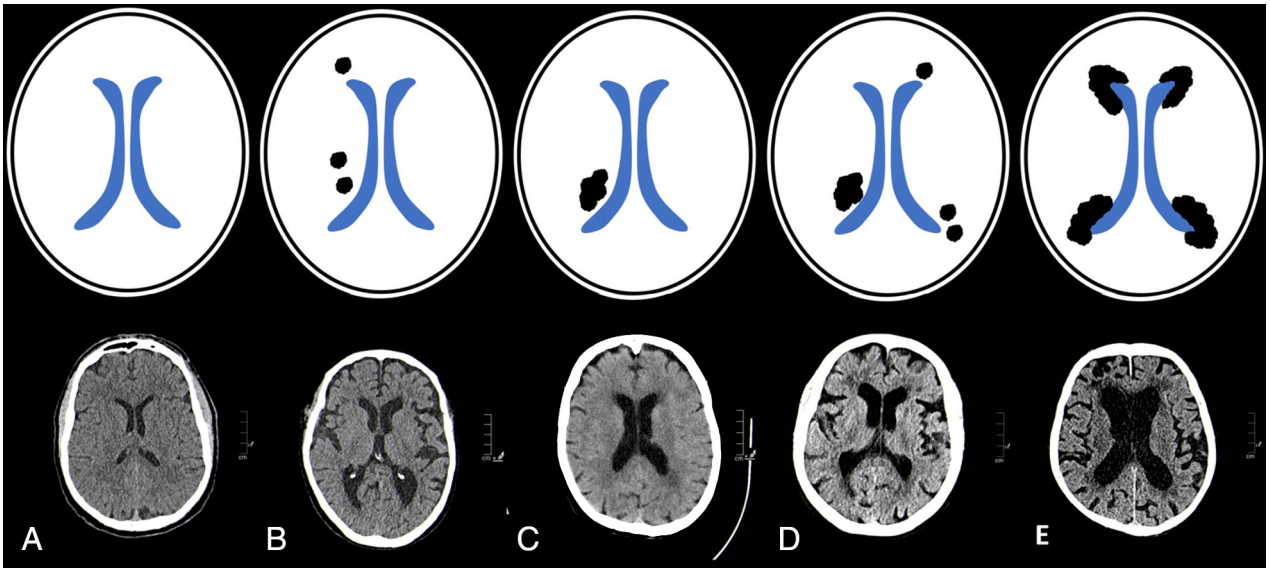


**FIG 3.** Graphic summary and clinical examples of different scores of white matter lesions according to Van Swieten scale. *A*, No evidence of white matter lesions (Van Swieten scale 0). *B*, Multiple unilateral focal white matter lesions (Van Swieten 1). *C*, Multiple unilateral confluent white matter lesions (Van Swieten 2). *D*, Multiple unilateral focal white matter lesions and contralateral multiple confluent white matter lesions (Van Swieten 3). *E*, Multiple bilateral confluent white matter lesions (Van Swieten 4).

### *Association*

The results of the univariable analysis of the various factors considered in relation to CTP diagnostic quality are reported in Table 1, along with the ORs and CIs.

The logistic regression analysis identified a statistically significant association between the presence of cardiac arrhythmias and the likelihood of a nondiagnostic perfusion CT examination. Specifically, patients with arrhythmias had more than 3 times the

**Table 1: Summary of examined variables**

| | Diagnostic CTP | Nondiagnostic CTP | *P* Value | OR | 95% CI |
|---|---|---|---|---|---|
| Age | 74 (IQR: 61–83) | 83 (IQR: 77–88) | <.001 | 1.06 | 1.04–1.09 |
| Sex | | | | | |
| Man | 84 (43.7%) | 49 (47.6%) | .53 | | OR (1.17) |
| Woman | 108 (56.3%) | 54 (52.4%) | | | |
| NIHSS | 7 (IQR: 4–13) | 11 (IQR: 6–18) | <.001 | 1.05 | 1.02–1.08 |
| Systolic BP (mm Hg) | 150 (IQR: 135–166) | 150 (IQR: 139–164) | .99 | 0.99 | 0.98–1.01 |
| Diastolic BP (mm Hg) | 81 (IQR: 72–90) | 80 (IQR: 70–92) | .98 | 1.00 | 0.99–1.02 |
| HR (bpm) | 80 (IQR: 70–89) | 80 (IQR: 66–97) | .58 | 1.01 | 0.99–1.02 |
| Arrhythmia | 39 (20.3%) | 54 (52.4%) | <.001 | 4.30 | 1.48–7.54 |
| Van Swieten scale | | | | | |
| 0 | 67 (34.9%) | 20 (19.4%) | .005 | | |
| 1 | 19 (9.9%) | 11 (10.7%) | .16 | 1.94 | 0.79–4.75 |
| 2 | 50 (26.0%) | 29 (28.2%) | .06 | 1.94 | 0.99–3.82 |
| 3 | 21 (10.9%) | 16 (15.5%) | .03 | 2.55 | 1.12–5.25 |
| 4 | 35 (18.2%) | 27 (26.2%) | .009 | 2.58 | 1.27–5.25 |
| Arterial wall calcifications | 146 (76%) | 89 (86.4%) | .04 | 0.50 | 0.24–0.99 |
| ETT | 3 (60%) | 2 (40%) | .81 | 1.25 | 0.10–11.06 |
| LVO | 32 (16.7%) | 32 (31.1%) | .004 | 2.25 | 1.28–3.96 |

**Note:**—BP indicates blood pressure; ETT, endotracheal tube; HR, heart rate.

**Table 2: Summary of multivariate regression analysis**

| | OR | 95% CI | *P* Value |
|---|---|---|---|
| Arrhythmia | 3.02 | 1.72–5.30 | <.001 |
| Arterial wall calcifications | 1.02 | 0.44–2.35 | .96 |
| Age | 1.05 | 1.02–1.09 | <.001 |
| Van Swieten scale | 0.96 | 0.77–1.21 | .75 |
| NIHSS | 1.03 | 0.99–1.07 | .18 |
| LVO | 1.74 | 0.85–3.55 | .13 |

odds of undergoing a nondiagnostic examination compared with those without arrhythmias (OR = 3.02; 95% CI, 1.72–5.30; $P$ = .0001). Age was also found to be an independent predictor, with a modest but statistically significant increase in risk per year of age (OR = 1.05; 95% CI, 1.02–1.09; $P$ = .0004). Hosmer-Lemeshow test confirmed good calibration of the model ($\chi^2 = 8.98$, $df = 8$; $P = .3437$). Other variables included in the model, arterial calcifications, presence of white matter lesions (Van Swieten scale), NIHSS score, and presence of LVO, did not show statistically significant associations with nondiagnostic outcomes (all $P > .05$). These results are summarized in Table 2.

Further analysis revealed that the arterial time-to-peak was significantly higher in patients with cardiac arrhythmias compared with those without cardiac abnormalities. Specifically, the median time-to-peak for patients with cardiac arrhythmias was 24.0 seconds, with an IQR of 20.2–27.1 seconds, whereas for those without cardiac abnormalities, the median time to peak was 18.6 seconds, with an IQR of 15.5–21.7 seconds. This difference was statistically significant, with a $P$ value <.0001. Similarly, the venous time to peak was also found to be higher in patients with cardiac arrhythmias compared with those without cardiac abnormalities. The median venous time to peak was 30.2 seconds, with an IQR of 26.4–32.0 seconds for patients with cardiac arrhythmias, compared with a median of 25.6 seconds and an IQR of 22.5–28.7 seconds for those without cardiac abnormalities, with a $P$ value < .0001.

## DISCUSSION

The present study explored the influence of various patient-specific factors on the diagnostic quality of CTP in evaluating AIS. Our findings emphasize that cardiac arrhythmias significantly affect the accuracy of CTP-derived perfusion parameters. While the influence of cardiac output has long been known as a possible cause of delayed brain perfusion during CTP, this concept has never been quantified systematically, thus failing to quantify the impact of altered cardiac function on perfusion studies.[11,14] This insight has important implications for tailoring CTP acquisition protocols and interpreting perfusion results in the context of acute stroke management. The most striking finding of our analysis was the strong association between cardiac arrhythmias and delayed arterial and venous time-to-peak values. Specifically, patients with cardiac arrhythmias exhibited a median arterial time-to-peak of 24.0 seconds, compared with 18.6 seconds in patients without cardiac abnormalities. Similarly, the median venous time-to-peak was 30.2 seconds in patients with cardiac arrhythmias, compared with 25.6 seconds in those with normal cardiac function. These differences were highly statistically significant ($P < .0001$). These delays can be attributed to the irregular cardiac output characteristic of cardiac arrhythmias, which disrupts consistent cerebral blood flow. Delayed bolus arrival and slower transit through cerebral vessels reduce the reliability of perfusion maps, particularly in detecting the ischemic penumbra. This finding supports prior studies that have linked impaired cardiac function with longer CTP acquisition times and showed that AIF correlates with ejection fraction and worse outcomes in acute stroke.[15] This represents a relevant issue in current practice, because most criteria regulating access to life-saving treatments, such as systemic thrombolysis with alteplase and mechanical thrombectomy, rely heavily on quantitative, CTP-assessed measurements of the extent of infarcted core tissue volume and ischemic penumbra.[1] The findings of this study are consistent with previous literature highlighting the complex interaction between acquisition parameters, patient-specific cardiovascular factors, and the diagnostic quality of CTP. Optimal CTP thresholds for defining infarct core and ischemic penumbra have been shown to depend on the time elapsed between imaging and reperfusion, suggesting that static acquisition protocols may fail to adequately account for patient-dependent hemodynamic variability.[16] This

time sensitivity is particularly relevant in patients with cardiac rhythm disturbances or altered contrast bolus dynamics, as observed in our cohort. Moreover, ischemic core overestimation on CTP was more frequent in patients with larger baseline ischemic core volumes and higher degrees of recanalization, yet paradoxically associated with better functional outcomes, highlighting the potential for tissue salvage even in cases with large cores and emphasizing the need for cautious interpretation of CTP-based thresholds in endovascular treatment decision-making.[17] Similarly, previous research has underscored the limitations of fixed CTP acquisition protocols and advocated for the implementation of adaptive imaging strategies that can accommodate physiologic variations in cardiac output and contrast arrival time.[18] Our data support this perspective, showing that cardiac rhythm abnormalities are associated with reduced diagnostic quality, primarily due to delayed AIF and RefV curves.

This has led to the widespread adoption of CTP protocols with longer scan times, often exceeding 90 seconds.[8] While this, in most cases, guarantees the accuracy of the calculated ischemic core and penumbra volumes, it also results in a higher radiation exposure.[19,20] This study effectively shows how most patients do not benefit from longer scan times, most often requiring a continuous scan shorter than 45 seconds for optimal AIF and RefV curves, guaranteeing optimal volumetric evaluation of infarcted brain parenchyma while minimizing radiation exposure. Future imaging protocols might incorporate prescan cardiac assessments to predict the need for prolonged scan durations in affected patients.

Another factor that showed a significant correlation with CTP diagnostic quality was the patient's age at the time of the examination. Older patients were more likely to have nondiagnostic CTP scans. This association may be explained by the higher prevalence of cardiac dysfunction in the elderly population, including a greater incidence of impaired left ventricular ejection fraction, which can affect cerebral blood flow and delay contrast arrival times. Additionally, age-related changes in cerebral microcirculation, such as widespread microperfusion abnormalities, may further compromise the quality and interpretability of CTP imaging. These physiologic changes may collectively reduce the reliability of perfusion parameters in older patients, thereby impacting diagnostic accuracy.[18]

Interestingly, factors such as intracranial arterial calcifications, higher NIHSS scores, the presence of a large vessel occlusion, white matter lesions (as assessed by the Van Swieten scale), and the presence of endotracheal tubes did not show statistically significant associations with CTP diagnostic quality. Moreover, the statistical analysis did not reveal any association between heart rate or arterial blood pressure at admission and the diagnostic quality of CTP. While these findings may seem counterintuitive, it is possible that their effects are overshadowed by more dynamic factors like arrhythmias and initial stroke severity. Alternatively, the study's sample size and retrospective design might have limited the ability to detect subtler effects from these variables.

From a clinical perspective, our findings suggest the need for a more personalized approach to CTP imaging. Current standard protocols often apply fixed scan durations, potentially leading to inaccurate perfusion measurements in patients with delayed bolus arrival due to cardiac arrhythmias. Adaptive imaging protocols that adjust scan duration based on real-time bolus arrival detection could enhance diagnostic reliability while minimizing unnecessary radiation exposure.

Additionally, integrating automated algorithms that incorporate patient-specific variables such as heart rate variability and arrhythmia history into CTP processing software could improve workflow efficiency. Such algorithms could notify radiologists of potential perfusion map inaccuracies, prompting manual adjustments or additional imaging.

An essential consideration in CTP imaging is the potential for reducing radiation exposure, particularly in younger patients more susceptible to long-term radiation risks. Shorter acquisition times could significantly minimize radiation dose while maintaining diagnostic accuracy, provided that bolus arrival and peak measurements are adequately captured. This approach is especially relevant in younger patients with stroke, where balancing diagnostic yield with radiation safety is critical. Future research should explore optimized acquisition protocols that ensure precise perfusion assessment while adhering to the principles of radiation dose reduction, ultimately promoting safer imaging practices.

While this study provides valuable insights, it also has several limitations. The retrospective design limits the ability to establish causality, and the study was conducted at a single-center, potentially affecting generalizability. Future prospective multicenter studies with larger patient cohorts could validate these findings and explore additional variables that may influence CTP results. A further limitation of our study is that the evaluation of CTP diagnostic quality was based on technical criteria provided by the software vendor, rather than on direct assessment of clinical impact, such as whether perfusion and Tmax maps would influence therapeutic decisions, as outlined in frameworks like Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke 3 (DEFUSE 3). Ideally, diagnostic quality should be assessed with reference to such decision-making end points. However, in our cohort, standardized clinical outcome data and treatment eligibility assessments were not consistently available, and follow-up imaging was heterogeneous. As a result, we adopted vendor-recommended thresholds as surrogates for acceptable temporal sampling and deconvolution accuracy. Although these criteria are supported by internal validation studies from the software manufacturer, we acknowledge they may not fully reflect clinical interpretability.

It is also important to note that the median NIHSS score in our study population was relatively low (median NIHSS 8), suggesting that many patients presented with less severe clinical symptoms. Less severe strokes are often associated with smaller infarct cores or more distal vessel occlusions, which may produce subtler perfusion abnormalities that are more difficult to detect. Although motion artifacts were excluded from our study, such subtle deficits may still be underrepresented or misclassified in CTP analyses, particularly in cases of delayed contrast arrival due to impaired cardiac function.

Future studies incorporating treatment decision data or structured clinical adjudication would provide a more robust validation framework. Moreover, technical advances in CTP acquisition and processing hold promise for overcoming some of the challenges identified in this study. Developing

artificial intelligence–powered tools that adjust scan protocols in real-time based on incoming imaging data could revolutionize acute stroke imaging.

## CONCLUSIONS

Our study highlights the critical impact of patient-specific factors, particularly cardiac arrhythmias and age, on the diagnostic accuracy of CTP imaging in AIS. We demonstrate that patients with arrhythmias are significantly more likely to experience delayed bolus arrival and curve truncation, leading to nondiagnostic perfusion maps. This finding underscores the importance of adapting scan duration to individual hemodynamic profiles rather than relying on fixed acquisition protocols.

These insights support the implementation of tailored imaging strategies, such as real-time bolus monitoring or prescan cardiac assessments, to optimize CTP quality while minimizing unnecessary radiation exposure. Importantly, our results suggest that most patients may not require prolonged acquisitions beyond 45 seconds, and that unnecessarily long scan times should be avoided unless specific clinical or physiologic indicators (eg, arrhythmias) suggest otherwise.

This personalized approach could enhance the reliability of perfusion-based treatment decisions, particularly in emergency settings where rapid and accurate assessment of infarct core and penumbra is essential for guiding thrombolysis or thrombectomy.

Future research should validate these findings in larger, multicenter prospective cohorts, and explore the development of artificial intelligence–driven CTP acquisition systems capable of adjusting scan parameters in real time. Overall, optimizing CTP protocols based on patient-specific parameters may lead to more accurate stroke diagnostics, more equitable access to reperfusion therapies, and improved clinical outcomes.

Disclosure forms provided by the authors are available with the full text and PDF of this article at www.ajnr.org.

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