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Research Article

Evaluation of a Stroke Protocol Using Computed Tomography Angiography for the Evaluation of Acute Ischemic Stroke Patients

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Abstract

Objectives:

Computed tomography angiography (CTA) provides early assessment of cerebral vasculature in ED patients presenting with Acute Ischemic Stroke (AIS). Prior studies using 4 row detector CT scanners have suggested that results may be used to determine who receives thrombolytics (tPA). We sought to evaluate the rate of normal CTA and the use of tPA in AIS patients with and without blockages using modern CT technology.

Patients and Methods:

We conducted a retrospective cohort study of all code stroke patients presenting to our ED over a 3 year period. Inclusion criteria included an ED and neurology diagnosis of AIS with a CTA performed at presentation. All patients had an NIHSS score recorded at presentation and underwent imaging using a 64 row detector scanner with 50cc of non-ionic contrast. Demographic, imaging, and clinical data were collected. Modified Rankin Scores (mRS) were assigned at hospital discharge. Good clinical outcome was defined as an mRS of 0-2. Data are reported as frequencies and medians with interquartile ranges (IQR) as appropriate. Rates of tPA use were evaluated using χ^2 testing. Rates of good outcomes were evaluated using odds ratios.

Results:

A total of 205 subjects met inclusion for analysis of which 103 (50%) were male and 109 (54%) had no blockage on CTA. The median NIHSS score and mortality rates were 14 (IQR 8-19), 14 (14%) with CTA blockage, and 4 (IQR 2-7), 2 (2%) for those without. Of those with AIS and a blockage on CTA, 46 (48%) were treated with tPA including 29 who were treated with intra-arterial therapy as well while only 13 (13%) of patients without a blockage were treated with tPA. Post tPA bleeding occurred in 12 (13%) patients with blockage on CTA and in 0 patients without blockage. Use of tPA was significantly more frequent in patients with a blockage on CTA, P <0.001.

Conclusion:

More than half of our AIS patients presenting through our ED have no blockage on CTA. Inter-rater reliability among neuroradiologists evaluating for large vessel occlusion appears to be very good. Patients with AIS and no blockage on CTA have less severe strokes and are less likely to receive tPA. Given the new guidelines recommending endovascular treatment for AIS we expect more emergency departments to begin performing CTA.

Keywords:
Stroke; computed tomography; computed tomography angiography

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Introduction

Acute stroke is a common medical emergency with an incidence of 795,000 in the United States alone. [1] The majority of strokes are acute ischemic strokes (AIS) for which we have limited treatments. Currently the approved treatments for AIS in the United States include the use of tissue type plasminogen activator (t-PA), antiplatelets such as aspirin, and intra-arterial therapy including intra arterial t-PA and thrombus evacuation.

There are a variety of imaging modalities which can be used in patients presenting with AIS. These include non contrast computed tomography (CT), computed tomography angiography (CTA), computed tomography perfusion (CT-P), magnetic resonance imaging (MRI), magnetic resonance angiography (MRA) and magnetic resonance imaging perfusion (MRI-P). The need for rapid assessment and treatment of AIS is important as earlier treatment has been shown to provide better outcomes[2]. The American Heart Association recently recommended that all AIS patients eligible for t-PA begin treatment within 60 minutes from time of arrival [3]. This short time window makes the choice of imaging modalities important as the length of time to perform these studies can range from a few minutes with a non contrast CT to 60 minutes with a brain MRI.

The rate of occlusion on patients with AIS who undergo CTA has ranged from 27-85%. [4,5,6,7,8] Some have suggested that those AIS patients without visible occlusion on CTA receive little benefit from the use of tPA.[8,9] Other authors have suggested that tPA is beneficial for patients with AIS and no occlusion on CTA, but diagnoses other than stroke should be considered as well[6]. Limiting the use of tPA for AIS patients to only those who have occlusions on CT would leave out a sizeable population of patients with AIS.

We sought to evaluate the incidence of occlusion on CTA in our acute stroke population and evaluate if those who receive tPA have improved outcomes based on the presence or absence of arterial occlusion.

Methods

We performed a retrospective cohort study of all AIS patients over a three year period. Patients were evaluated as part of our hospital code stroke protocol which involves a rapid evaluation in the emergency department to determine if this is possible AIS and then imaging performing both non contrasted CT and also CTA of the brain. The images were evaluated by a board certified neuroradiologists at the time of presentation. All patients were rated using the National Institutes of Health Stroke Scale (NIHSS) upon arrival by certified physicians in the emergency department. Patients who were transferred to our facility and who did not have imaging performed at our institution were excluded. Patients who received a final diagnosis of something other than AIS were excluded. All diagnoses of AIS were made by one of our staff neurologists.

CT Protocol

All CT exams were performed on Philips Brilliance 256 or 64 channel machines. Initial noncontrast CT of the head was performed. The patients then underwent CTA of the head and neck. CTA was performed using bolus tracking with 50 cc injection at 4cc/sec utilizing Optiray 320 (Ioversol, Mallinckrodt Pharmaceuticals). Raw axial data was obtained at 0.6 mm. Data set was transferred as thin, and 3x3mm sets. Data set then used to generate sagittal and coronal multiplanar reconstruction images (2mm thick, 2mm spacing), and sagittal, coronal, and axial maximum intensity projection images (10mm thick, 2mm spacing). The CTA of the head and neck was performed down to the level of the aortic arch.

Outcomes were measured using a Modified Rankin scale (mRS) at time of discharge. We defined good clinical outcome as an mRS score of <2. We compared mRS using logistic regression. Demographic data was collected and findings of the CTA were recorded using a structured form. Rates of tPA usage were evaluated using Chi2 analysis. All statistics were performed using STATA (version 11.2 College Park, Texas, USA).

Kappa substudy.

We performed a substudy to evaluate the agreement among the neuro-radiologists reading the CTA of the brain. The original interpretations were performed by one of 4 board certified neuro radiologists. The studies were then evaluated by a blinded neuro radiologist who provided his own interpretations. The interpretations were considered different for any new occlusions found, even if they were in the same vascular territory as an identified occlusion, or for those studies in which an occlusion was named which is not felt to be present on the blinded neuro-radiologist's interpretation. These interpretations were compared using an unweighted Cohen's kappa for the two interpretations.

Results

A total of 365 subjects were evaluated of which 205 met inclusion criteria and were involved in the analysis. Males comprised 103 (50%) of all subjects and 109(55%) of subjects had no occlusion seen on CTA. There was a high prevalence of hypertension and moderate prevalence of diabetes and hyperlipidemia. The median age was 67 (IQR 57-80). The population with occlusion on CTA tended to be older and have a high proportion of African Americans. Demographic data can be seen in Table 1. The median NIHSS score for patients with a blockage was higher when compared to those without, 14 (IQR 8-19) to 4 (IQR 2-7) respectively. Of the patients with a blockage on CTA, 46 (50%) received tPA including 29 (31%) who underwent an intra-arterial procedure. Among the patients without a blockage

Table 1. Demographics

	No Blockage (%)	Blockage on CTA (%)
	N=109	N=93
Male	60 (55)	41 (44)
Female	49 (45)	52 (56)
Age (IQR)	64 (56-76)	72 (57-82)
African American	18 (16)	30 (32)
Hispanic	3 (3)	6 (6)
Caucasian	71 (61)	71 (76)
Hypertension	82 (75)	70 (75)
Hyperlipidemia	46 (42)	33 (35)
Smoker *	44 (40)	36 (39)
Diabetes	47 (43)	32 (34)

only 13 (13%) received tPA which was significantly lower compared to the CTA positive patients, $p < 0.001$.

Of the patients treated with tPA who had no blockage 65% had a good outcome defined by an mRS of 2 or less. Of the patients treated with tPA and who did have a blockage 24% had a good outcome. The odds ratio for a good outcome for the entire group with blockage on CTA was 0.17 (95% CI 0.093-0.31) however the odds ratio for the group with a blockage who received tPA was 1.3 (95% CI 0.5-3.41). The odds of a good outcome in those patients with no occlusion was 5.8 (95% CI 3.14-10.74). There were 14 (15%) deaths in the group with blockages on CTA compared with 2 deaths in the AIS group without blockages.

The Kappa score for agreement for interpretations by the neuro-radiologists was 0.85 (CI 0.77-0.95) with an overall agreement of 92.5%. The majority of changes were for an additional occlusion in a similar arterial territory.

Discussion

The use of CTA to guide therapy decisions is controversial. In this study, over half of patients with AIS had no occlusion on their CTA. Some authors have advocated using imaging decision making for stroke arriving in the 3-6 hour range from time of onset.[9] We did not attempt to perform an analysis for this population as we had few who were treated beyond 3 hours.

The findings of greater stroke severity in patients with visible vascular occlusions should not be surprising as we would expect a greater vascular territory to be at risk. This has already been shown in other studies[7,10].

Our rate of brain CTA without occlusions was higher than previously reported studies[6,10]. Reasons for this may include higher rates of diseases associated with microvascular disease including hypertension and diabetes in our population. Also we use a code stroke process that encourages activation even for strokes that might be considered too minor for thrombolytic therapy.

The creation of new guidelines utilizing endovascular treatments for acute stroke will likely increase the number of emergency departments performing CTA for their suspected AIS patients. We expect emergency medical service agencies to transport those patients with a high likelihood of a proximal arterial occlusion to a center who can perform endovascular therapy[11,12].

Some limitations of this study included use of a single site for data collection. We used a 64 row detector CT scanner but as technology improves this may become dated technology making our results less relevant. We did not collect data on long term outcomes so we cannot be sure any improvements were maintained. We relied on neurologist final diagnosis of stroke as the gold standard. It is possible that some patients may have been misdiagnosed, increasing our rates of AIS without occlusion.

In conclusion we found that over half of our AIS patients presenting in the acute setting have no vascular occlusions on CTA. We feel CTA will likely be the imaging of choice for AIS patients arriving in emergency departments. Since the induction of our protocol we currently treat > 90% of our AIS patients with tPA in less than 45 minutes. Our protocol for the assessment of possible AIS patients with possible LVO works with streamlined efficiency. We found the agreement of neuro radiologists to accurately read CTA to be excellent.

Competing Interests

The authors have declared that no competing interests exist.

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