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Selective computed tomographic angiography in traumatic subarachnoid hemorrhage: a pilot study

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ABSTRACT

Background: Computed tomographic angiography (CTA) tends to be overused in patients with traumatic subarachnoid hemorrhage (tSAH) to rule out intracranial aneurysmal disease. We hypothesized that there are two exclusive subsets of patients with tSAH that maybe at increased risk for aneurysm and thus should undergo CTA, those "found down" with an unknown mechanism of injury and those with "central subarachnoid hemorrhage" (CSH, in the subarachnoid cisterns and Sylvian fissures). This pilot study was performed to provide more information on the validity of our hypothesis.

Methods: A retrospective analysis was performed on trauma patients with tSAH who underwent CTA of the brain. Patients presented to a level I trauma center from January 2008–December 2012. Our principal outcome was the diagnosis of an intracranial aneurysm. Student *t*-test, chi-squared test, Mann–Whitney *U* test, and binary logistic regression were used for statistical analysis, with significance set at alpha = 0.05.

Results: Of 617 total patients with tSAH, 186 patients underwent CTA. Majority of patients were male (64%), with median age of 56 y. Median Glasgow coma scale on presentation was 15, and the median injury severity score was 16. Thirteen patients (6.99%) had an aneurysm on the follow-up CTA. Of those, 8 of 13 (61.5%) were felt to have presented with a ruptured aneurysm. Among those, 5 of 8 (62.5%) sustained a fall and 3 of 8 (37.5%) resulted from a motor vehicle crash. Among the 14 patients (7.5%) "found down", none had an aneurysm. All eight patients with a ruptured aneurysm (100%) had CSH, whereas none of the five patients with unruptured aneurysm had CSH. On multivariate analysis, suprasellar cistern hemorrhage was the most predictive noncontrast computed tomographic finding with regard to aneurysm presence (odds ratio, 4.78; 95% confidence interval, 1.33–17.1). Patients with an aneurysmal disease had a significantly higher mean arterial pressure on presentation (median, 115 mm Hg) than those without an aneurysm (median, 96 mm Hg, $P < 0.05$). Of the eight ruptured aneurysms, six underwent neurosurgical clipping or coiling, one underwent a ventriculostomy, and one underwent a craniotomy for evacuation of hemorrhage.

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Conclusions: These preliminary data support a more selective approach to screening CTAs in patients with tSAH. CTA should be used in those patients with CSH regardless of mechanism of injury. A more restrictive approach should be used in patients with only peripheral subarachnoid hemorrhage.

1. Introduction

Significant percentage of patients with traumatic brain injury (TBI) will present with traumatic subarachnoid hemorrhage (tSAH) [1]. Because tSAH is the most common finding in cerebral aneurysm rupture [2,3], a controversy may arise regarding the need for diagnostic screening for aneurysmal disease and/or rupture in patients with tSAH identified on initial trauma computed tomographic (CT) scans, many of which are a by-product of the habit of "pan-CT scanning" [2–5]. In the past, the "aneurysm screening" was performed with conventional cerebral angiography, but with the advent of CT angiography (CTA), and because of its less invasive nature and equal ability to detect cerebral aneurysms, there has been a shift toward the latter imaging method [6–9]. Up to 6.8% of the general population has an unruptured saccular cerebral aneurysm [10], with a risk of rupture of 1.2% if the aneurysm is untreated. In one study, there was an approximate 8% incidence of saccular aneurysmal disease in a large number of patients with tSAH, prompting some to recommend that a high level of suspicion must be maintained when tSAH is encountered in the basal cisterns or the Sylvian fissure [11]. Shigemori *et al.* [12] reported that in patients with tSAH and overall "mild TBI" (e.g., Glasgow coma scale [GCS] $\geq$13), intracranial blood was mainly located in the Sylvian fissures or suprasellar cistern. On the other hand, patients with "severe TBI" (e.g., GCS <7) tended to have tSAH localized to the pontine-interpeduncular and ambient-quadrigeminal cisterns [1,12].

Given the paucity of data on the incidence of aneurysmal disease in the TBI patient population, the lack of consensus on which patients should undergo CTA, and the observed near-doubling in "screening CTA" use at our institution (27 studies in 2008, 49 studies in 2012 with comparable trauma/TBI volumes during both periods), the authors became concerned about the potential overuse of this modality. Consequently, it was hypothesized that there are two main subsets of trauma patients with tSAH who would benefit from a follow-up CTA: (a) those "found down" with an unknown mechanism of injury and (b) those with central subarachnoid hemorrhage (e.g., blood in the subarachnoid cisterns or Sylvian fissures). The study's aim was to demonstrate that more judicious and selective use of "screening CTA" in the setting of tSAH should be considered.

2. Materials and methods

This was a 5-y retrospective study of all trauma patients with blunt TBI and tSAH who underwent CTA of the head at our level 1 trauma center between January 1, 2008 and December 31, 2012. The study was approved by the Institutional Review Board. All initial brain CT studies were interpreted by a board-certified radiology attending, with the subsequent CTA follow-up studies being interpreted by a neuroradiology specialist.

Abstracted data included patient demographics (age and gender); mechanism and severity (e.g., injury severity score) of injury; GCS on admission; admission vital signs (systolic blood pressure and mean arterial pressure [MAP]); abbreviated injury score for "head"; as well as the anatomic pattern of tSAH on the initial CT brain. Subsequent CTA studies of the intracranial vasculature were reviewed for the presence or absence of intracranial aneurysmal disease. Criteria for study inclusion included the presence of CTA brain performed within 72 h of the initial CT brain and patient age within the range $\geq$18 and $\leq$90 y. Excluded were pregnant patients, patients aged <18 or >90 y, and prisoners.

The study's primary end point was the identification of "aneurysmal disease" on the follow-up CTA brain. Correlations were then performed between the anatomic location(s) of tSAH on the initial CT brain with the presence of an intracranial aneurysm (including aneurysmal rupture) on the follow-up CTA. Additional analyses were performed to examine correlations between admission MAP and observed patterns of tSAH and aneurysm presence. Finally, we examined the clinical accuracy of the recommendation to perform "screening CTA" originating from either an "attending radiologist" or an "attending nonradiologist" (i.e., a neurosurgeon or a trauma surgeon), with an aim of determining if there was a difference in overall predictive accuracy between these two groups.

Sample size analysis was performed before formal data collection and processing, indicating that at least 12 patients in the "aneurysm" group and at least 60 in the "nonaneurysm" group would be required to demonstrate a 40% difference between the two groups at significance level of alpha = 0.05 and power of 0.80. Subsequent analyses included descriptive statistics, Mann–Whitney *U* test for continuous variables, and Fisher exact testing for categorical data. Variables with statistical significance of $P < 0.20$ on univariate analyses were included in binary logistic regression to determine study parameters that were independently associated with the presence of intracranial aneurysm, with significance set at alpha = 0.05. Analyses were performed using SPSS 18 Statistics (IBM Corp, Armonk, NY), and descriptive graphs were designed using Microsoft Excel (Microsoft Corp, Redmond, Washington).

3. Results

A total of 617 patients with tSAH were identified during the study period. Of those, 186 (30.1%) underwent a CTA brain within 72 h of the initial CT brain and thus met study inclusion criteria. Majority of patients were male (64%), with median age of 56 y (range, 18–95, interquartile range [IQR], 40–78). The