



Cervical angiograms in cervical spine trauma patients 5 years after the data: has practice changed?

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Background: We sought to retrospectively evaluate changes in practice of use of computed tomography angiography (CTA) in the cervical spine trauma population at the authors' institution following intervention to increase the clinical utility of this study. Prior studies have shown screening asymptomatic trauma patients demonstrate a rate of vertebral artery injury (VAI) near 1%. While CTA can readily provide a diagnosis, the high number of concomitant injuries limit which patients are candidates for treatment. At our institution, this had been described in a previous 5-year study.

Methods: After IRB approval, 1,201 charts from 2011 to 2016 were reviewed at our Level 1 trauma hospital. Data collected included cervical injury type, neurologic examination, diagnostic testing, and treatments or complications of VAI. This time frame begins after the prior study was completed and results of the study had been disseminated among the trauma faculty.

Results: A total of 1,142 subjects were eligible for inclusion. Six hundred forty patients had cervical spine fractures, and of these 158 patients had CTA/MRA. Twenty-four were diagnosed with VAI, and 12 were treated. None of the subjects had complications from angiography, one patient with VAI had blood loss after initiation of therapeutic anticoagulation requiring transfusion. There has been a significant increase in CTA/MRA testing ($P < 0.001$), but no significant increase in patients treated or in percent of positive tests ($P = 0.15$, $P = 0.77$).

Conclusions: Despite discussion at our institution of the clinical utility of CTA in the trauma population, there are more CTA studies being done and without a corresponding change in rate of diagnosis or treatment for VAI. The presence of symptoms and risk of therapeutic anticoagulation in this population are important factors to consider. We recommend the use of a treatment algorithm in the electronic ordering system to help aid practitioners in targeting the use of this test.

Keywords: Spinal trauma; quality improvement; resource utilization

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Introduction

Evaluation of cervical spine trauma has been revolutionized by use of computed tomography (CT), which allows greater specificity and sensitivity in detection of cervical spine trauma (1). With improved quality and access to advanced

diagnostic imaging, there has also come the ability to detect vertebral artery injury (VAI) on a wider scale than previously available. Prior data has shown that in a trauma patient population, when screening patients who present with high clinical suspicion of VAI or with neurologic symptoms suggestive of central nervous system pathology,

rates of VAI that are diagnosed in the trauma population are approximately 0.1% (2). In populations where asymptomatic trauma patients are also screened, rates of VAI among the trauma patient population approaches 1% (2-4). However, prior studies have shown that often the clinical significance of diagnosing VAI in poly-trauma patients is minimal, as many of the patient who are diagnosed with an injury are not candidates for treatment, and no changes are made to patient management after diagnosis (2,3). Previous studies at the author's institution discussed the limited indications for a CTA of the cervical spine, and recommended limiting the use of this diagnostic test to symptomatic patients and those who can have a change in course of treatment if they are diagnosed with an injury (2). This initial study was done over 5 years at a level 1 trauma center, and the recommendations outlined in that paper were disseminated among the staff at the in trauma and orthopedic departments.

CT angiograms of the cervical spine provide an interesting lens into possible applications of a treatment algorithm designed to better guide a health care system focused on reducing excess. CT angiograms are not risk-free; the test requires an additional contrast dye load, as well as radiation dose to patients who already are subject to significant physiologic stressors and a multitude of imaging studies during a trauma evaluation (4-7). The purpose of this study will be to provide evaluation of a level 1 trauma system's response to data demonstrating the range of patients most appropriate for cervical CTA, and will allow for evaluation of any changes in practice made in the trauma system in response to published evidence. It will also evaluate for the possible role of a treatment algorithm in trauma patients to guide decisions for angiography in the cervical spine trauma patient in a trauma facility.

Previous studies have showed that cervical CTA is often performed in the evaluation of cervical spine trauma patients, but a positive finding rarely results in either treatment or correlation with clinical symptoms (2,3). With the availability of data demonstrating the limited utility of cervical spine CTA in all but a small subset of patients, our study plans to examine results over a subsequent 5-year period to see if treatment patterns have changed in a level 1 academic trauma center.

Methods

After IRB approval, a chart review was conducted at our

level 1 trauma hospital. At our institution, a trauma registry is recorded which includes all patients who arrive in the emergency department for evaluation of trauma related complaints. The trauma registry from 2011 to 2016 was used to identify all patients from 18–89 with a diagnosis of cervical spine injury or pain, using both ICD 9 and 10 codes to ensure all patients with relevant injuries were included. This time frame begins after the prior referenced study by Dreger *et al.* was completed.

These 1,201 eligible charts were reviewed for age, gender, mechanism of injury, cervical injury sustained and injury location, cervical injury treatment, neurologic examination, presence of head injury, and the use of further diagnostic testing to evaluate the cervical injury. All records were assessed for the completion of a CTA or magnetic resonance imaging angiography (MRA), diagnosis of VAI, treatment of any vascular injury, any complications from the CTA, presence of a radiology report recommending CTA before CTA imaging performed, and any complications noted as a result of the VAI. Inclusion criteria were ages 18–89, and imaging of the cervical spine performed. Exclusion criteria were ballistic or penetrating trauma to the neck, death on arrival to the emergency department without imaging performed, and imaging performed at outside institution only. Statistical analysis was performed using SPSS.

Results

Review of the institutional trauma registry showed 1,201 patients who met initial inclusion criteria. From these, exclusions due to death in the trauma bay or on arrival and penetrating/ballistic mechanisms resulted in 1,142 eligible patients for review. A total of 186 CTA/MRA studies were done in this patient population. Six hundred forty patients in this included population had a cervical spine fracture, and of these patients 158 had a CTA/MRA. There has not been a formal protocol for CTA study use implemented in our facility in the past 5 years, so clinical judgment of the ordering provider was the main ordering criteria. Additionally, radiologist recommendations were also present on initial CT cervical spine studies, which may also play a role in ordering provider decision making.

Of the 158 CTA/MRA studies performed in patients with cervical spine fracture, a total of 24 studies were positive for VAI injury, and ten showed pertinent findings in other vessels. Of these patients, 12 were treated with either aspirin (ASA), heparin drip, Coumadin, or therapeutic Lovenox

for VAI. One patient treated with a heparin drip developed increasing blood loss requiring cessation of the drip and multiple unit transfusion. No additional complications for VAI treatment were noted.

Previously, 15 of 108 patients with cervical spine fracture who received a CT angiogram had a VAI, and four were treated. Rates of CTA performed for patient with a cervical spine fracture increased in our study, with 108 (16.95%) of patients receiving a CTA in our prior study and 158 (24.69%) in our current study with a P value <0.001. Despite increased test utilization, and rates of positive CTA remained relatively stagnant at 15 (13.89%) and 24 (15.19%) respectively with a P value of 0.77. Though by absolute numbers more of the diagnosed injuries were treated in our study group with a treatment rate of 12 out of 24 VAI (50.00%) versus our prior study which showed a treatment rate of 4 out of 15 diagnosed VAI (26.67%), this did not reach statistical significance, with P=0.15. Of note, of all the trauma patients with or without cervical spine fracture who received CTA testing, 8.06% of patients ever received any treatment for an injury diagnosed from testing.

Addition information of interest is in the origin of recommendations for CTA, and the prognostic significance of these recommendations. Some patients in the data set did not have the initial CT scan done at the study center or had the CTA done at the same time as the CT scan, and these scans are not included in the sub-analysis. At our institution, either on the final or preliminary radiographic report from the Radiology department, there may be a recommendation from the reading radiologist for a CTA for further study depending on the injury type. In addition, a consulting service may ask based on initial CT for a CTA and document that request in a consult note. In our study, 125 CTA studies were performed in trauma patients after an initial CT scan at the study institution. Of these scans, 72 were recommended by the reading radiologist in either the preliminary or final reads. Among radiology recommended CTA studies, 56 (77.8%) had negative findings, 12 (16.7%) had positive findings for VAI, and 4 (5.6%) had findings indicating injuries other than VAI. Studies performed in patients without recommendations from radiology or subservices for CTA showed 18 (78.3%) with no evidence of VAI, 3 (13.0%) with positive findings for VAI, and 2 (8.7%) with findings indicating injuries other than VAI. Of the 13 CTA studies performed for concern of other injuries, no VAI injuries were diagnosed. In the case

of the 17 CTA studies performed for investigation of VAI at the request of the consulting spine service, all 17 scans showed no VAI or other injuries were diagnosed.

Discussion

Prior studies have discussed the specific role of CTA in the trauma population, and there has been considerable discussion and education about the results of these studies in our institution. In an increasingly cost conscious health care environment, there is continued discussion on how to best maximize health care expenditures. Our study has demonstrated that there is still a significant portion of patient's tested for VAI that do not receive any treatment for the findings due to other injuries. Despite this, the rate of CTA performed in the cervical spine trauma patient population has increased significantly at our institution. The rate of positive testing has remained stagnant, and half of positive testing still goes untreated. Despite attempts at provider education, there has not been improved diagnostic accuracy of CTA. While the cost of treatment can be minimal in the case of injuries to the vertebral arteries treated with aspirin, the cost of the testing for each patient treated still remains high (6).

We propose the consideration of an institutional algorithm for ordering a CT cervical spine angiography study. When ordering imaging through the electronic medical system, we propose two additional prompts, similar to the existing prompts for imaging studies that asked the clinician if the patient has renal disease or a pacemaker/defibrillator device. The two suggested prompts are "*Is the patient eligible for treatment of vascular injury?*" and "*Is the patient symptomatic or was the test recommended by a consulting service?*". With these prompts, the provider is asked to consider if the patient has risk of bleeding or other contraindication for initiation of therapeutic anticoagulation, as well as assess if the patient has any of the associated symptoms of a VAI or had the study required in a specialist workup would work to limit the reflexive ordering of this test in the trauma population. If the answer to both prompts is "No", the provider would receive a second prompt asking if the test is still needed.

Consideration for this institutional intervention may help to decrease the number of CT angiograms that are ordered and do not result in treatment or are unlikely to diagnose an injury. In an era where efficiency in healthcare expenditure is increasingly coming to the forefront of patient management, trying to ensure tests are only employed in situations they

effect clinical management remains an important goal for all practitioners. When computer physician order entry was introduced in specific clinical settings, an associated decrease in cost, medical errors, and failure of guideline compliance was noted (8-10). The current use of electronic ordering systems could be utilized to guide and target the appropriate ordering of this study. As more hospital systems move towards utilizing an electronic medical ordering and records system, this system should not be overlooked for its possible role in helping to aid clinicians improve their quality of care and treatment choices. Consideration of systems based changes to help provide a more targeted, high clinical yield use of this test could help targeted the use of this imaging study and reduce unnecessary testing.

Conclusions

In the acute poly-trauma setting, cervical spine CTA is a useful tool for at risk patients, but in daily practice it is often utilized in a fashion that does not result in a change to treatment. We propose that given the statistically significant rise in tests ordered without an associated increase in positive test results or patients treated, an institutional algorithm for test utilization may be considered to guide the use of this diagnostic tool.

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Footnote

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/jhmhp.2019.06.04>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was approved by institutional ethics committee/ethics board of St. Louis University Hospital (No. 27424). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Informed consent was taken from all patients.

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