

The Use of High-risk Criteria in Screening Patients for BCVI: A Survey

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Rationale and Objectives: Blunt cerebrovascular injury (BCVI) is uncommon, but delayed detection can have disastrous consequences. The Denver criteria are the most commonly used screening criteria. We aim to examine the utilization of screening criteria in the emergency department (ED) of our institution and assess whether patients with risk factors were imaged.

Materials and Methods: A survey questionnaire was sent out to radiologists in a large academic institution. A search was performed in the database on the use of CT angiography (CTA) and MR angiography (MRA) among patients with risk factors in the last 11 years.

Results: The survey was sent to 173 radiologists, with 41 responses (35 complete). Most of the physicians (30 out of 35) surveyed selected CTA as their preferred modality to screen for BCVI, whereas the remaining physicians selected MRA. None of the respondents reported routine use of Denver screening criteria or grading scale in their readouts. Only five respondents selected risk factors in the Denver criteria correctly. In the institution search, among the 1331 patients with blunt trauma and risk factors for BCVI, 537 underwent at least one angiographic study (40.3%). There was an increase in the screening rate after February 2010 in all risk factors, but only statistically significant among patients with foramen transversarium fractures and C1–C3 fractures.

Conclusions: Both the Denver screening criteria and grading scale of vascular injury have been underutilized in the ED for patients with risk factors. Greater awareness and utilization of imaging can potentially result in decreased incidence of subsequent stroke in patients with blunt injury.

Key Words: Denver criteria; blunt cerebrovascular injury; trauma; angiography; utilization analysis.

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INTRODUCTION

Blunt cerebrovascular injury (BCVI) refers to injuries to the carotid or vertebral arteries from nonpenetrating trauma, which may result in cerebrovascular ischemia. Mortality rates of up to 33% and morbidity rates of up to 58% have been reported (1–3). Timely detection of BCVI is critical in the emergency setting as patients may have a 10–72 hours latent, asymptomatic period, and early treatment during this time has been shown to reduce patients' risk of stroke and to improve patient outcomes (4–7).

The annual incidence of BCVI has been reported to be 0.18%–2.7% among all trauma admissions (8,9). Increasing incidence of BCVI has been reported, at least partially attributed to its increased awareness, implementation of aggressive screening protocols, and improvements in imaging technology.

However, there is significant controversy regarding the criteria for patient selection to undergo imaging, as well as the optimal imaging strategy to detect BCVI (10,11). In the current medical literature, there is lack of level I evidence for the risk factors associated with BCVI and the suitable screening modality for blunt trauma patients (8). Multiple screening criteria have been proposed, among which the modified Denver criteria is the most commonly used (12,13). Digital subtraction angiography (DSA) has been regarded as the reference standard diagnostic test, but CT angiography (CTA) is being increasingly used in emergency departments (ED) due to speed, easy availability, and reduced invasiveness as compared to DSA. However, there is significant controversy regarding the sensitivity and specificity of CTA, even with current generation scanners, and indications for subsequent DSA (14,15).

Wide variability has also been reported in physician perception of the utility of different modalities and indications for imaging (16). Studies reporting poor performance of CTA relative to DSA have not elaborated on the reasons, and both

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high false-negative and false-positive rates have been reported with CTA (14,15). Previous studies have shown a learning curve, resulting in the improvement in reported sensitivity of CTA (17). Our hypothesis was that lack of knowledge of current literature might play a role in the effectiveness of CTA as a screening modality. In this study, we examined the use of screening and grading criteria in the emergency setting and assessed radiologists' preferred imaging modality for BCVI detection. We also assessed the utilization of imaging over time, especially in reference to the guidelines published by the Eastern Association for the Surgery of Trauma (EAST), and whether patients with risk factors for BCVI were imaged more frequently over time.

METHODS

A survey questionnaire was created and sent out to radiologists in a single, large, academic, tertiary care institution in July 2015. The survey was sent to 87 faculty members, 32 fellows, and 54 residents. It was explained clearly that the purpose of the survey was not to test the respondents' ability but to assess the frequency of screening and grading criteria being used. The complete modified Denver screening criteria is presented in Table 1, and the survey questions and choices are presented in Table 2 (18).

Upon the approval of our Institutional Review Board, we also performed a search in the imaging database for CTA, MR angiography (MRA) reports, and reports with search strategy ("skull base fracture," "foramen transversarium fracture," "LeFort" fracture, and "C1 fracture" OR "C2 fracture" OR "C3 fracture"). Patients from the last 11 years were included, from January 2004 to December 2014. The search results were reviewed to eliminate duplications and then compiled for analysis. The lists were compared to assess the percentage of patients with risk factors who ultimately underwent a CTA or an MRA. We also divided

all patients into two groups, before and after February 2010, when the EAST Guidelines were first published (8). The screening rates of patients with at least one of the four risk factors in the two groups were compared.

RESULTS

Survey

The survey was sent to a total of 173 radiologists and 41 responses were received (23.7% response rate), out of which 35 were complete. Among all the respondents, 32 (91.4%) were radiologists working in the ED. Only 43 out of the 173 radiologists actually worked in the ED and routinely read trauma scans. The response rate among radiologists working in the ED was approximately 75% (32 out of 43). Twenty-seven (77.1%) physicians were fellowship-trained and 8 (22.9%) were still in training. The subspecialties of fellowships included neuroradiology, body or musculoskeletal radiology, pediatric radiology, emergency radiology, magnetic resonance imaging, interventional radiology, breast imaging, and nuclear radiology. The most common subspecialties were neuroradiology (15 out of 35, 42.9%) and body and musculoskeletal radiology (11 out of 35, 31.4%).

Most of the physicians (30 out of 35, 85.7%) surveyed selected CTA as their preferred modality to screen for BCVI, whereas the remaining physicians selected MRA. DSA was not preferred by any of the respondents. When asked about their confidence in the sensitivity of CTA as compared to DSA, 21 (60.0%) estimated the sensitivity to be in the 75%–100% range, whereas 10 (28.6%) indicated it was between 50% and 75%, 3 (8.6%) estimated it to be 25%–50%, and only one (2.8%) respondent considered the sensitivity was in the range of 0%–25%.

When asked about the Denver criteria, none of the 35 respondents reported routine use of the criteria in their practice.

TABLE 1. Modified Denver Screening Criteria (18)	
Signs and symptoms of BCVI	– Arterial hemorrhage – Cervical bruit – Expanding cervical hematoma – Focal neurologic deficit – Findings from neurologic examination incongruous with head CT scan findings – Stroke on secondary CT or MRI scan
Risk factors for BCVI	High energy transfer mechanism associated with: – Displaced mid-face fracture (LeFort II or III) – Mandible fracture – Complex skull fracture/basilar skull fracture/occipital condyle fracture – CHI consistent with DAI and GCS <6 – Cervical subluxation or ligamentous injury, transverse foramen fracture, any body fracture, any fracture C1–C3 – Near hanging with anoxic brain injury – Clothesline type injury or seat belt abrasion with significant swelling, pain, or altered MS – TBI with thoracic injuries – Scalp degloving – Thoracic vascular injuries – Blunt cardiac rupture

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