Spring 5-30-2024

Blunt Cerebrovascular Injury (BCVI): Universal CTA Neck Screening at Level 2 Trauma Center

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Executive Summary

Introduction

This executive summary outlines an overview of the introduction of universal screening with computed tomography angiography (CTA) for Blunt Cerebrovascular Injury (BCVI) at a Level II American College of Surgeons (ACS) verified trauma center. Injuries to the carotid and vertebral arteries resulting from blunt trauma, known as BCVIs, may initially manifest without any clinical symptoms (Rutman et al., 2018). BCVI is associated with an increased risk of stroke if not promptly identified and appropriately managed. BCVI screening at the trauma center entailed the application of clinical screening tools, namely the extended Denver criteria (eDC) and the Memphis criteria (MC), to distinguish between high-risk and low-risk blunt trauma patients. Subsequently, upon identifying risk factors, the patient underwent CTA of the head and neck using a 16-slice or higher multidetector array. Owing to the limited sensitivity and specificity of the eDC and MC, the initial workup for blunt force trauma does not consistently include completion of CTA neck scans and, in some instances, may be omitted altogether. Some patients may not display obvious signs or symptoms of BCVI, making it even more important to rely on screening rather than solely on clinical presentation. If BCVI is left untreated, it can result in complications such as stroke, arterial dissection, or thrombosis (Alfanek et al., 2022). Failing to identify and manage these injuries expeditiously can substantially enhance the likelihood of morbidity and mortality (Black et al., 2020).

Literature Review

Thirty-seven articles were reviewed based on inclusion criteria: human studies in English, published between 2019 and onwards, patients aged ≥ 15 years with blunt force injuries, screening protocols with clinical algorithms and universal screening with CTA neck for BCVI, and current practices for BCVI screening. The Johns Hopkins Research Evidence Appraisal Tool was utilized to evaluate the methodological quality of every article included in the study.

BCVI injuries can occur due to cervical hyperflexion, extension, or rotation, which stretches the blood vessels (Rutman et al., (2018). Approximately 30% of patients with BCVI may develop a stroke, typically occurring 72 hours after the initial injury (Kim et al., 2020). Nevertheless, strokes associated with BCVI can also manifest themselves several days or even months after the initial incident (Kim et al., 2020). The Biffl scale demonstrated the various categories of BCVI on angiography. The occurrence of BCVI in trauma patients varies from 1% to 3%, according to different studies (Kim et al., 2020). If left untreated, traumatic carotid artery injuries (TCAI) can result in a morbidity rate of 32% to 67% and a mortality rate of 17% to 38% (So et al., 2022). Similarly, untreated traumatic vertebral artery injuries (TVAI) have a morbidity rate of 14% to 24% and a mortality rate of 8% to 18% (So et al., 2022).

Clinical screening tools, such as the DC and MC, are designed to help identify patients at risk for BCVI based on specific clinical signs and risk factors. While these tools can be helpful, they are not perfect, and there are several reasons why they may not be considered superior or sufficient for BCVI screening. The DC relied on mechanistic aspects, indicators, and symptoms, whereas the extended version of the DC (eDC), encompasses more than eleven components. Nevertheless, numerous studies have demonstrated inconsistencies in accurately categorizing patients as having BCVI when employing either the DC or eDC. Schmidt et al. (2023) conducted a study revealing that utilizing the DC criteria would have failed to identify 132 out of 433 BCVI

cases, while the eDC criteria would have missed 150 out of 433 cases. In another study by Vogt et al. (2021), a universal screening protocol was implemented, revealing that the eDC had limitations, with only 83% meeting screening criteria and a lower percentage when using another clinical screening criteria (CSC). The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of the eDC were reported as 83%, 50%, 5%, 99%, and 51%, respectively (Vogt et al. (2021). Notably, none of the CSCs identified a significant portion (23%) of individuals with BCVI grade 3 or above. Overall, the findings highlighted concerns regarding the accuracy and effectiveness of CSC, urging the need for improvements in BCVI detection methods.

Recent publications are encouraging more liberal screening with universal CTA of the neck to identify BCVI. Conventional CSC with DC, eDC, and MC have high sensitivity but low diagnostic capacity. A retrospective study by Black and colleagues (2020) found that 92.5% of patients with BCVI identified by CTA neck universal screening would not have received a neck CT scan if conventional CSC had been utilized. Another study by Harper et al. (2022) found that before universal screening with CTA neck for BCVI, only 1.5% of blunt trauma patients received CTA. The extensive list of possible injuries for the eDC can lead to delayed treatment and worse outcomes, as BCVI patients have the highest risk of stroke within the first 72 hours following injury (Ali et al., 2022).

The widespread availability of multi-slice CT scanners will make screening more accessible and efficient. Concerns for contrast-induced acute injury (AKI) have been evaluated, concluding that adding a CTA neck to standard blunt trauma CT scans does not increase the amount of contrast agent used and poses little danger to the patient (Leichtle et al., 2020).

Identifying BCVI and initiating treatment early have been found to reduce the chances of stroke, stroke-related complications, and mortality rates.

Project Methods

The level II trauma center screened for BCVI based on CSC. The goal of this DNP project was to create an evidence-based universal screening protocol with CTA neck to screen for BCVI screening in all major blunt trauma patients. The trauma registry was reviewed retrospectively after CTA neck completion at the initial radiographic evaluation for all major blunt trauma activations. Prior to the retrospective review, inter-rater reliability (IRR) was conducted, and the data points had an IRR greater than 98%. The project focused on quality improvement and is exempt from IRB review. Key stakeholders were involved in the project, and quality improvement objectives were discussed in detail. A 16-slice multidetector array CT scanner was used to detect BCVI. Optimization on the order of the radiographic exams and timing of contrast injections was discussed with the lead radiologist to reduce radiation exposure and contrast burden on patients. The universal protocol outlined the order for the CT scans of the head, neck, chest, abdomen, and pelvis for trauma patients. A "Trauma CT Order" form was used by attending trauma surgeons for quick reference.

Evaluation

CTA is renowned for its remarkable ability to identify vascular damage sensitively and specifically. It captures intricate details of the blood vessels, facilitating the detection of abnormalities like dissections, pseudoaneurysms, or thrombosis. At the trauma center, universal screening with CTA neck during the initial blunt trauma workup was performed for the early identification of BCVI so that early intervention can be done to minimize the chances of stroke, stroke-related complications, and overall mortality. Data was collected on all patients who had

major trauma activations after blunt force injuries, specifically, those categorized as level I and level II according to the institution's trauma activation criteria.

Result

This doctoral project spanned from March 2023 to January 2024. The total number of patients observed during the given period was 395. Out of the total patients, 210 were eligible for BCVI. The number of patients who received the BCVI screening was 156. Positive cases for BCVI varied each month, totaling 11 positive cases. The percentage of positive BCVI ranged from 0.00% to 14.29% over the entire study period, with a 7.05% overall score. The screening protocol was not administered to 54 patients as the surgeons overlooked completing it during the initial evaluation. Policy adherence for BCVI increased over the months, ranging from 0.0% in March 2023 to 100.0% in January 2024. The overall policy adherence for the entire period was 74.3%. Furthermore, Pearson correlation statistical analysis demonstrated a significantly strong positive correlation between the variables "BCVI Followed" and "Positive BCVI" (r=0.97, p<0.001). The significantly high r value supported the hypothesis that as use of CTA neck for BCVI screenings increased, detection of positive BCVI cases also increased, leading to early identification of BCVI that could have potentially been delayed or undiagnosed.

Limitation

This doctoral project encountered various limitations that are important to acknowledge, primarily attributed to the short duration of the project and the initial lack of adherence to policies. The data review, initially planned for assessments at 3, 6, 9, and 12 months, was carried out daily instead due to low compliance. This led to the development of bi-weekly scorecards to monitor trauma surgeons' adherence to the protocol. The study revealed that screening with CTA neck had a 53.16% rate for level I and II trauma activations, which was influenced by factors like

patients transferred from other facilities and cases of hemodynamic instability that were unable to undergo CTA neck during the initial workup. The adherence to protocols was affected by human memory constraints to remember to implement the new protocol, particularly during the initial phase of the project. This highlighted the necessity for future projects to explore more dependable methods, such as real-time tracking systems or standardized checklists, to monitor protocol adherence.

Impact on Practice

Early screening for BCVI is crucial for timely detection and treatment. This doctoral project achieved 74.29% policy adherence rate over 11 months, emphasizing dedication to the BCVI universal screening protocol. The 7.05% BCVI detection rate, higher than previous studies, suggests a greater prevalence than anticipated. These results support the efficacy of CTA neck in universal screening for blunt force traumas. Relying solely on CSC may lead to undiagnosed BCVI cases which could lead to associated high healthcare costs, and potential long-term disabilities. Prioritizing prevention and risk mitigation in blunt trauma patients is crucial due to the substantial consequences of BCVI-related strokes.

Conclusion

Universal screening with CTA of the neck is the most effective method for detecting BCVI in injured patients during the initial trauma workup. Early detection is crucial in managing BCVI; reliance on the CSC for BCVI screening will result in missed injuries. It is advisable to include a CTA of the neck in cases where a patient sustained a severe injury necessitating CT scans of the head, cervical spine, and chest, abdomen, pelvis. This approach allowed for a comprehensive evaluation of the neck region, ensuring that any potential injuries or abnormalities are detected early. Outcomes from this DNP project supported universal screening

for BCVI as both a reliable and applicable resource in the initial trauma workup. Further research should concentrate on defining the incidence of BCVI through universal screening and assessing the long-term morbidity and mortality following early identification of BCVI.

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