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What Are the Expected Findings on Follow-up Computed Tomography Angiogram in Post-traumatic Patients With Blunt Cerebrovascular Injury?

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Abstract

Purpose: Blunt cerebrovascular injury (BCVI) is a rare but potentially devastating diagnosis. Our study establishes the temporal changes and findings on follow-up imaging.
Methods: For this retrospective, institutional review board−approved study, the hospital trauma registry was queried for all severely injured polytrauma patients who underwent computed tomography angiogram (CTA) scans in the emergency department between January 1, 2010, and December 31, 2016, with injury severity score ≥16, yielding 3747 patients. A total of 128 patients had a follow-up CTA for BCVI. The grade, location, and outcomes of injuries on follow-up imaging were studied.
Results: A vehicular collision was the most common mechanism of injury (75%). The majority of patients (61%) had a Glasgow Coma Scale of 10-15. Vertebral fractures were the most common associated injury (57%). The overall incidence of BCVI in our study population was 4.8%. On the initial CTA, 50% of injuries were grade 1, 25.4% were grade 2, 7% were grade 3, 17% were grade 4, and 0.6% were grade 5. For the different grades of injuries, improvement has been documented in 44% with complete healing in 34%, while 51% of injuries remained unchanged from the initial scan. Only 5% progressed to a higher-grade injury. Twelve patients developed strokes with an incidence of 9.4% in patients with a follow-up CTA.
Conclusions: This study can help increase the awareness of radiologists about the evolution patterns of different grades of BCVIs on follow-up CTA for severely injured posttraumatic patients.

Résumé

Objet : Les diagnostics de traumatisme vasculaire cérébral fermé sont rares, mais potentiellement dévastateurs. Notre étude examine l'évolution de ces traumatismes dans le temps et les résultats de l'imagerie de suivi.
Méthodes : Aux fins de cette étude rétrospective approuvée par le comité d'examen de l'établissement, le registre des traumatismes de l'hôpital a été utilisé pour identifier tous les patients victimes de polytraumatismes graves qui ont subi une angiographie par tomodensitométrie (ATDM) au service d'urgence entre le 1er janvier 2010 et le 31 décembre 2016 et dont la blessure avait un indice de gravité médian égal ou supérieur à 16; 3 747 patients répondaient à ces critères. Au total, 128 patients ont subi une ADTM de suivi après un traumatisme vasculaire cérébral fermé. À l'aide des images, nous avons pu étudier le grade, l'emplacement et les conséquences des blessures.
Résultats : La collision de véhicules était le mécanisme de blessure le plus courant (75 %). La majorité des patients (61 %) avaient un score de 10 à 15 sur l'échelle de Glasgow. La fracture cérébrale était la blessure connexe la plus courante (57 %). L'incidence globale des traumatismes vasculaires cérébraux fermés chez les sujets de notre étude était de 4,8 %. Sur l'ADTM initiale, 50 % des blessures étaient de grade 1, 25,4 % de grade 2, 7 % de grade 3, 17 % de grade 4 et 0,6 % de grade 5. Tous grades confondus, des améliorations ont été observées dans 44 % des cas (dont 34 % de guérison complète), et les traumatismes sont restés les mêmes dans 51 % des cas. Seuls 5 % des traumatismes ont progressé à un grade supérieur. Douze patients ont fait les accidents vasculaires cérébraux, soit 9,4 % des patients chez qui une ADTM de suivi a été effectuée.

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Conclusion : L'étude peut davantage sensibiliser les radiologistes aux types d'évolution des traumatismes vasculaires cérébraux fermés de grades différents observés au moyen d'une ADTM de suivi chez les patients gravement blessés.

Key Words: Trauma; Blunt cerebrovascular injuries; Vertebral artery injury; Carotid artery injury

Blunt cerebrovascular injuries (BCVIs) are defined as injuries to the extracranial carotid arteries and vertebral arteries as a sequela of blunt trauma. BCVIs are diagnosed in approximately 1%−2% of trauma patients and can result in devastating outcomes [1,2]. Stroke rates in untreated vascular injuries can approach 40%−60%, with a stroke-related mortality rate of 50% [3,4]. With treatment, the stroke rate can be as low as 4% [3]. In a recent study conducted by Esnault et al [5], the stroke rate in patients with severe traumatic brain injury was 9.2%. Patients may remain clinically silent for hours to months before experiencing a cerebrovascular event [6]. Only 10% of patients present with focal neurological signs upon presentation and approximately 67% develop clinical symptoms within 24 hours [7].

High-risk groups for BCVI include LeFort II and III fractures, basilar skull fracture with carotid canal involvement, closed head injury, cervical vertebral body or transverse foramen fracture, near-hanging anoxia, or patients with a seatbelt or clothesline-type injury [8]. However, the absence of these risk factors does not entirely preclude screening of BCVI [9,10].

Duplex ultrasonography and magnetic resonance angiography are not considered as standard BCVI screening tools because of their poor sensitivities and specificities in clinical trials [11−13]. Four-vessel cerebral invasive angiography was the traditional gold-standard for BCVI screening. However, computed tomography angiography (CTA) of the neck vessels has replaced invasive angiography because CTA is a faster, noninvasive tool to diagnose vascular injuries, allowing for prompt initiation of treatment and effective prevention of stroke [14−16]. Whole-body CT (WBCT) is a single-acquisition WBCT scan to obtain accurate, quick imaging in the trauma setting and CTA of the neck and head arteries can be performed as a part of WBCT protocol for high-risk patients [17]. Management of BCVI with an antiplatelet or antithrombotic therapy is considered as a prophylactic measure against ischemia or stroke; however, grade 5 injuries may require endovascular treatment [8].

The purpose of this study is to examine the temporal changes and spectrum of radiological findings on follow-up CTA for patients with suspected BCVIs. The management and outcomes of these patients, including stroke patients, are discussed in our study. As a result, the study can help explore the use of follow-up CTA in monitoring the outcomes of BCVIs.

Materials and Methods

For this retrospective, institutional review board−approved study, the hospital trauma registry was queried for all polytrauma patients who underwent CTA scans in the emergency department between January 1, 2010, to December 31, 2016, with injury severity score ≥16, yielding 3747 patients.

Patient Population

The trauma registry database was queried for trauma patients with age ≥18 years who received CTA of the neck vessels after sustaining blunt trauma. Only patients with injury severity score ≥16 were included because BCVI screening with CTA was performed for patients with severe polytrauma. Our institution's BCVIs screening algorithm is illustrated in Figure 1 [1].

The included patients had to have a documented BCVIs on initial CTA and at least 1 follow-up CTA within 6 months from the initial CTA. Exclusion criteria included patients who had a normal initial scan or did not receive or had no record of a follow-up CTA within the study time frame. Demographic information, mechanism of trauma, associated injuries, and management of patients were recorded.

Imaging Protocol

All trauma studies were performed on 128-slice dual-energy CT scanners (SOMATOM Definition Flash CT Scanners; Siemens Healthcare, Erlangen, Germany). All trauma patients were positioned supine, feet first, with their arms down at their sides. CT scans of the head and face were performed first without intravenous contrast. Then, patients underwent CTA of the neck and CT of the cervical spine, acquired during a single run, followed by CTA of the chest, abdomen, and pelvis (arterial phase) and then CT of the abdomen and pelvis during the venous phase. For the CTA of the neck, contrast injection was performed using 80 mL of iohexol 350 at 3.2 mL/s, followed by 20 mL of 0.9% sodium chloride. Once contrast was seen entering the aortic arch, scanning was initiated. Images were acquired at 1 mm slice thickness and at 1-mm intervals (1 mm × 1 mm). Sagittal images were reformatted at 4 mm × 4 mm, and both coronal and sagittal reformats were done in maximum intensity projection mode at 10 mm × 2.5 mm. Images for the CT of the cervical spine were obtained during scanning for the CTA of the neck at 2 mm × 2 mm. Reformats were then done manually with coronal and sagittal images in bone window at 2 mm × 2 mm, sagittal images in standard window at 2 mm × 2 mm, and angled axial reformats in bone and standard window at 2 mm × 2 mm. For the CTA of the chest, abdomen, and pelvis, 90 mL of iohexol 350 was used, at an injection rate of 4 mL/s, followed by 20 mL of 0.9% sodium chloride. Arterial phase