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Brief Report

Acute ischemic stroke in a trauma cohort: Incidence and diagnostic challenges

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ABSTRACT

Introduction: Diagnosis of acute ischemic stroke is critical for acute intervention. Its diagnosis may be obscured in trauma patients due to confounding injuries. We report its incidence in trauma patients following their presentation at our institution.
Methods: Electronic charts of all acute trauma patients presenting to a designated level 1 trauma center emergency department between September 2012–November 2015 were screened and included in the study if they had a discharge diagnosis of acute ischemic stroke. Patient data were reviewed to identify the presence of neurologic deficit on initial triage, imaging type obtained (intracranial or extracranial) and time to diagnosis of stroke.
Results: Of 192 trauma patients screened, 11 were found to have acute ischemic stroke (5.7%). Patients were generally young (median age, 49 years) and predominantly males (n = 8). Presentation after vehicular crash was most frequent (n = 8 or 73%). Patients had predominantly skeletal injuries (n = 8 or 73%). Initial workup involved vascular imaging below the neck (n = 9), while only one had intracranial vascular imaging. When patients underwent cervicocranial vascular imaging, 64% (n = 7) had findings explaining the etiology of their stroke. None of the patients was diagnosed with acute ischemic stroke on admission. Its diagnosis was delayed by an average 1.8 days following presentation.
Conclusions: Acute ischemic stroke in trauma patients was a frequent diagnosis albeit with delay. Routine craniocervical vascular imaging at the time of presentation could potentially facilitate early diagnosis. A prospective study with routine craniocervical vascular imaging in trauma patients will be needed to further explore this hypothesis.

1. Introduction

Acute ischemic stroke is often diagnosed in patients presenting to the emergency department (ED) with acute onset of focal symptoms. The initial workup of acute ischemic stroke involves imaging of brain as well as blood vessels supplying the brain. The recognition of clinical findings suggesting acute ischemic stroke may be challenging in patients who have concurrently suffered from trauma due to confounding factors such as patient injuries, intoxication and intubation. Patients who have sustained trauma typically receive non-contrasted head CT (HCT) in addition to chest, mediastinal and abdominal imaging (including of aortic arch), although craniocervical vascular imaging (CT angiogram of head and neck) is not routinely done, which could potentially aid in diagnosis of acute ischemic stroke.

We conducted a retrospective observational study in our trauma cohort to characterize patients who were diagnosed with acute ischemic stroke with some delay after hospitalization. We also evaluated whether routine neurovascular imaging in these trauma patients on presentation would have facilitated an early diagnosis of acute ischemic stroke.

2. Methods

This was a single center retrospective study done after approved by the Institutional Review Board at St. Louis University Hospital. Electronic charts of patients with trauma alerts from September 2012–November 2015 were provided by the medical records department for review. After de-identification of personal health information, patient charts were screened for inclusion. Inclusion criteria were trauma as reason for presentation to the ED in patients ≥18 years old. We included all trauma alerts regardless of their trauma severity at presentation. This was intended to capture the full spectrum of trauma patients who had a concurrent acute ischemic stroke, unlike a previous study where patients were not included on account of mild trauma [1]. Data was collected on patients diagnosed with acute ischemic stroke during the course of their hospitalization as indicated by International Classification

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of Diseases 9 and10 discharge diagnoses. Patients were excluded if their stroke type was intracranial hemorrhage (ICH).

Information regarding patient demographics, comorbid conditions, and other traumatic injuries were collected. Also collected was information regarding any documented neurologic deficit on initial triage, Glasgow Coma Score (GCS) upon arrival, mechanism of trauma, type of injury, airway status (whether intubated or not), time to diagnosis of stroke from initial presentation, type of imaging obtained on initial presentation, presence of head and neck imaging or extra cranial vascular imaging and vascular injury. For patients without no obvious focal neurologic impairment on presentation, the time from admission to physical exam findings suggestive of neuropathology was recorded. We also collected exam findings from the neurology consultant's note when patient was first seen and the neuroimaging findings (based on MR brain or HCT) for data regarding stroke location, laterality and possible etiology (whether stroke possibly due to atherothrombosis, embolism, dissection or other based on vascular imaging).

3. Results

Records of 192 patients presenting with trauma to the ED during the study period were screened, following which 11 patients with a diagnosis of acute ischemic stroke (5.7%) were included in the study. Diagnosis of acute ischemic stroke was identified by CT findings consistent with ischemia on presentation to the ED or during the admission for evaluation of their traumatic event. Patients included were male and female age >18. Table 1 provides characteristics of these patients.

None of the patients were diagnosed with stroke on initial presentation to the ED, although 36% (n = 4) were noted to have neurological deficits on presentation. Only 1/3rd of patients had stroke risk factors. A neurologic consultation was not obtained on any of the patients on initial triage. The median time to acute ischemic stroke diagnosis was 2 days (range, 0–5 days).

Patients were predominately males (n = 8 or 74%), median age being 49 years (range, 26–79 years). Vehicular collisions were more common (n = 8) while fall (n = 2) and assault (n = 1) were less frequent. Patients had predominantly skeletal injuries (n = 7 or 64%), while others had soft tissue injuries. Majority of patients (n = 9 or 82%) had vascular imaging to evaluate aortic injury on presentation, only one received intracranial vascular imaging while one did not receive any vascular imaging at the time of presentation. No extra cranial vascular injuries were reported during the investigations, while amongst patients that underwent cervical and cranial vascular imaging, 70% (or n = 7), were noted to have findings that explained their stroke etiology, mainly in form of dissection (n = 6; carotid = 2, vertebral = 4) or severe carotid stenosis (n = 1).

4. Discussion

Our study describes the trauma patient population presenting at a level 1 trauma center that were diagnosed with acute ischemic stroke soon after hospitalization. Nearly one in every six patients presenting after trauma was noted to have acute ischemic stroke. Patients were typically young and involved in a single-vehicle co or had a fall leading to their presentation. Clinical findings suggestive of acute ischemic stroke were present in only few at the time of presentation and patients were diagnosed typically after a delay. These findings were likely masked in the setting of musculoskeletal injuries, intubation/sedation.

Blunt cerebrovascular injuries (BCVI) due to carotid or vertebral vessels are known to result in cerebrovascular ischemia putting patients at increased risk for morbidity and mortality [2]. Patients in our cohort had twice as much vertebral artery involvement than the cervical carotid artery involvement. A possible explanation for greater incidence of vertebral artery injury when compared to the carotid artery may be the fact that vertebral artery is in closer proximity to the cervical spine making it more vulnerable to mechanical trauma unlike the carotid artery which has greater mobility and is more protected with adipose tissue and muscular layers [3]. A previous study reported acute ischemic stroke in 13 patients (3.7%) from a cohort of 355 polytrauma patients who were diagnosed with acute ischemic stroke within few hours of presentation up to >3 weeks [1]. Fifty-four percent patients (n = 7) were diagnosed with craniocervical dissection and their stroke diagnosis was made within the first day itself. Patients with mild injury, or those who had stroke prior to trauma were excluded. The incidence of acute ischemic stroke is in our patient cohort is higher (5.7% vs 3.7%) likely since we did not exclude patients on basis of severity of injury unlike in study by Blacker and Wijdicks where patients with mild trauma causing a single injury were excluded [1]. This may still not have captured those minor trauma patients that did not meet the trauma alert criteria. We also decided not to exclude patients who did not have obvious symptoms of stroke immediately prior to trauma. We reason that the proximity of one event (dissection/trauma) to another (diagnosis of acute ischemic stroke) makes it difficult to differentiate whether patients had dissection resulting in acute ischemic stroke (subsequently leading to traumatic events) or whether trauma led to craniocervical dissection/stenosis resulting in acute ischemic stroke.

Trauma patients at our institution do not routinely receive CT imaging of craniocervical vessels. Current guidelines suggest trauma patients should be considered for craniocervical imaging if there is concern for BCVI based on presentation- initial neurologic abnormality, epistaxis (level II recommendation) or if Glasgow Coma Scale is ≤8, diffuse axonal injury, injury to petrous bone or cervical spine, Lefort II/III facial fractures (level III recommendation) [2]. Based on these recommendations, very few of our patients would have fulfilled the screening criteria as only one patient received CT angiogram of cervical vessels while in emergency department. A study involving 418 trauma patients diagnosed with BCVI showed that 20% patients (n = 83) did not fulfill the screening criteria although nearly 34% of these patients (n = 28) suffered from a stroke within 2 days of presentation [4]. A recent study evaluated incidence of cervical artery dissections in trauma patients with Injury Severity Score (ISS) of ≥16 using routine head-and-neck computed tomography angiogram (CTA) and found 6.5% patients (16 of 230) to have cervical artery dissection [5]. These findings suggest that routinely including carotid and vertebral CT angiograms while screening for other injuries would be useful in detecting BCVI thereby allowing optimization of treatment and advanced imaging where needed in trauma patients at risk of acute ischemic stroke. It has been noted in a previous study that appropriate preventive therapy may be considered if dissection is found [6].

Our study has multiple limitations. It is a small, retrospective study of trauma patients over three years where only those patients that had a diagnosis of acute ischemic stroke in the setting of a concurrent trauma were reviewed. It Records of other patients were not reviewed to screen for incidence of CT angiograms in such patients. We did not include the ISS of patients to categorize the severity of their injury. The small sample size of acute ischemic stroke patients does not allow any further statistical analysis either.

5. Conclusion

Although delayed, acute ischemic stroke was diagnosed in 5.7% of our trauma cohort; presentation infrequently suggestive of at risk for BCVI. While an earlier diagnosis of at risk stroke patients could be made by routinely using non-invasive neurovascular imaging such as CT angiogram, a prospective study requiring routine neurovascular imaging in trauma patients is needed to further explore its utility.

Declaration of interest

The authors have no financial conflicts of interest to disclose.

Table 1
Characteristics of trauma patients diagnosed with acute ischemic stroke.

Patient No	Age (y)	Sex	Trauma mechanism	GCS	Neuro deficits on presentation	Imaging on presentation		Injuries	Neuro deficits when diagnosed with stroke	Days to stroke diagnosis	Stroke territory	Dx modality	Stroke etiology
						CC	Other						
1	66	M	MVC-R	15	N	N	N	Rt anterior chest hematoma with rib #	Intubated, following simple commands, nystagmus on R lateral gaze, no motor response in all 4 extremities including to noxious stimuli	1	Rt cerebellum	HCT/CTA H&N, MRI brain	VA dissection/occlusion
2	31	F	SV-U	14	N	N	Y	Orbital medial wall #, L2-L4 TP#, T11 #, RP hematoma	Intubated, PERRL, vertical eye bobbing, no movement of LUE/LLE to noxious stimuli	5	Splenium/Lt frontal lobe	MRI/MRA H&N	Hypoperfusion
3	50	M	SV-U	6	Weakness, aphasia	N	Y	B/L hemothorax, b/l lung/cardiac contusions, Rib #	Intubated, opens eyes to noxious stimuli, no command following, Lt gaze deviation, Rt facial palsy, no movement RUE, trace movement RLE, spontaneous movement of LUE/LLE	3	Lt frontal/parietal, temporal/insular cortex	HCT/CTA H&N	Lt ICA dissection
4	53	M	Assault	11	Weakness, Intubated	N	N	Rt 5th digit nail avulsion	Rt gaze deviation, Lt facial weakness, LUE/LLE antigravity	1	Rt BG	HCT/MRA	UNK
5	26	F	MVC-U	12	Intubated	N	Y	Facial/skull #	Intubated, no eye opening to noxious stimuli, no movement of LUE, flexion of LLE to noxious stimuli	2	Rt frontal lobe	HCT/CTA H&N	Rt ICA dissection
6	45	M	Bicycle vs car	15	N	N	Y	L3-L5 TP #, T9 SP #, Rib/manubrium #, femoral/pelvic bone #, renal contusion	Expressive aphasia, no movement of LUE, flexion of LLE to noxious stimuli	1	Lt frontal	MRI brain/CTA	UNK
7	75	M	ATV	15	N	N	Y	Rib#, Lt pneumothorax/lung contusion, scapular #, L 6-L7 TP #	LUE no movement, LLE antigravity,	3	Rt parietal/centrum semiovale	HCT/CTA H&N, MRI	Paroxysmal A-fib, LAA thrombus
8	30	M	SV	15	Weakness	Y	Y	C4-C7 AP #	Intubated, opens eyes to voice, follows commands, LUE antigravity, RUE withdrawal to noxious stimuli, paraplegic in lower extremities (baseline)	0	Lt Cerebellar, Rt occipital lobe	CTA neck, MRI brain and MRA	Traumatic lt VA occlusion
9	49	M	Fall	15	N	N	Y	Pancreatic injury, T4-L1 #	Drowsy, intermittently follows commands, no aphasia, no motor weakness, exam limited due to lack of cooperation	2	Rt PCA and Lt cerebellar	CTA H&N; MRI	Traumatic lt VA occlusion
10	35	F	SV	13	N	N	Y	T4-T11 SP #, L4 TP #	Intubated, LUE/LLE reduced to resistance	2	B/l occipital lobes/cerebellar	HCT/CTA H&N, MRI brain	Lt VA dissection
11	79	M	Fall	3	Weakness, intubated	N	Y	Nasal bone/maxillary sinus/sphenoid sinus/left greater sphenoid wing #	Intubated, opens eyes to voice, does not follow commands, Lt gaze preference, purposeful movements of LUE, no movement of RUE, non purposeful movement of bilateral lower extremities	1	Lt frontal/temporal/parietal/cortex, deep grey structures	HCT/CTA H&N, MRI brain	Rt ICA stenosis
Median	49			14						1.8			

Abbreviations- GCS: Glasgow Coma Score on presentation, CC: Craniocervical, Dx: Diagnosis, Rt: Right, Lt: Left.
M: Male, F: Female, N: No, Y: Yes, UNK: Unknown, B/L or b/l: Bilateral, #: Fracture, TP: Transverse Process, SP: Spinous Process, RP: Retroperitoneal.
HCT: Head Computed Tomography scan without contrast, CTA: Computed Tomography Angiogram, MRI: Magnetic Resonance Imaging, MRA: Magnetic Resonance Angiogram, MVC-R: Multiple Vehicle Collision- Restrained, MVC- U: Multiple Vehicle Collision- Unrestrained, SV-U: Single vehicle- Unrestrained, ATV: All Terrain Vehicle, H & N: Head and neck, SP: Spinous Process, AP: Articular Process, VA: Vertebral Artery, ICA: Internal Carotid Artery, BG: Basal Ganglia, A-fib: Atrial Fibrillation, LAA: Left Atrial Appendage, PCA: Posterior Cerebral ArteryRUE: Right Upper Extremity, RLE: Right Lower Extremity, LUE: Left Upper Extremity, LLE: Left Lower Extremity.

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