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Pediatric Blunt Cerebrovascular Injury: A Review of Literature and Case Study

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Introduction and Objectives

- Blunt cerebrovascular injury (BCVI) is a rare but serious non-penetrating injury to the carotid or vertebral arteries
- Primarily caused by high impact mechanism of injury with hyperextension and/or rotation of the neck
- Adults have higher incidence of BCVI, with 0.18-2.7% of all blunt trauma admissions¹, while children have an incidence of 0.03%²
 - Likely missed BCVI in children due to lower index of suspicion, lower rate of screening, and discrepant symptoms
- Computed tomography (CT) is the standard imaging modality for BCVI
 - Imaging often not obtained for pediatric patients due to concern for radiation sequelae³
- Objective:** Review relevant literature on pediatric BCVI as well as analyze specific case from LVHN pediatric trauma cohort

Methods

- Literature Review
 - Systematic review of articles through ClinicalKey journal database
 - Literature was relevant to pediatric BCVI
 - 19 articles reviewed, 3 key articles presented
- Database Query
 - Common BCVI ICD codes compiled from literature
 - Excluded penetrating trauma findings
 - Queried LVHN pediatric trauma database yielding 1,675 relevant patients; one was chosen for case study
- Analysis
 - Papers were analyzed for relevant findings
 - Case study was evaluated and compared to literature

Results

Figure 1: Considerable Pediatric BCVI Literature Findings

| Study Title | Unique BCVI Presentations | Imaging Decisions | Radiographic Findings | Treatment |
|--|---|--|---|---|
| 1. Blunt cerebrovascular injury in children: underreported or underrecognized? : A multicenter ATOMAC study ⁴ | - 13% of patients with BCVI did not meet any adult criteria - Clavicular fractures - Combined head & chest trauma | - Adult guidelines (Memphis Criteria) were used to decide who should receive imaging | - Clavicular fracture had highest association with BCVI - BCVI rate of 0.4% - 1 patient with frontal bone fracture near eye with frontal lobe contusion - 1 patient with pulmonary contusion | - Antithrombotic treatment is effective: 0 patients with BCVI developed stroke after antithrombotic therapy, all 6 BCVI patients with stroke were untreated |
| 2. Risk factors for blunt cerebrovascular injury in children: do they mimic those seen in adults? ⁵ | - Concerning neurological exam helped predict BCVI - 100% of patients with carotid artery injury had poor neurological exam - 3 patients did not become symptomatic until 18 hours after initial presentation | - Adult guidelines were used (Denver Criteria) | - 100% of patients with vertebral artery injuries had cervical spine fractures - BCVI rate of 0.9% - Majority of injuries were intimal flaps or dissections | - Stroke rate for patients treated with antithrombotic therapy was 0% versus 38% in those untreated |
| 3. Screening for Pediatric Blunt Cerebrovascular Injury: Review of Literature and a Cost-Effectiveness Analysis ³ | - Displaced midface or complex mandibular fracture with severe neck hyperextension - Closed head injury | - Selective CTA was found to be the most cost-effective, optimal imaging strategy | - CTA chosen over magnetic resonance angiography (MRA) because MRA has long scan times, need for sedation in children, lower sensitivity with MRA | - Selective anticoagulation is the most cost-effective treatment for high risk BCVI patients |

Figure 2: BCVI Patient Case Study

| Mechanism of Injury and Initial Presentation | |
|---|--|
| - Healthy 4-year-old male - Two seat utility vehicle roll-over, patient in passenger seat with older sibling driving - Vehicle pinned patient's left chest and neck, crush injury | - No loss of consciousness - Hoarse voice - Abrasion on right neck and across chest (shoulder to shoulder) - Neurologically intact Right shoulder swelling and pain |
| Hospital Course and Imaging Results | |
| - Scans obtained due to mechanism of injury and exam: CTA neck, CT chest, CT head, X-ray (XR) chest, XR right humerus, XR abdomen - Upper mediastinal hematoma with tracheal deviation; otolaryngology (ENT) performed laryngoscopy with no significant findings | - Questionable left common carotid artery (L CCA) intimal flap on CTA, MRA neck was recommended for following day due to poor CTA visualization - Sedated for MRA, found with L CCA intramural hematoma, 50% luminal narrowing, 3 cm extending superiorly from aortic arch - Small infarction in left occipital cortex (11 mm), causing impaired strength, impaired balance, decreased activity tolerance, impaired gait |
| Outcome | |
| - Sent to outside facility for pediatric cardiothoracic (CT) surgery consult - Immediately started on acetylsalicylic acid (ASA) antiplatelet therapy, to continue for 1 month | - CT team did not recommend surgery - Proceed to follow up with neurology and further imaging in 3 months to check for any vascular changes - Seen by physical therapy for rehabilitation |

Conclusions

- Adjunctive MRA proved valuable in case presented, but feasibility is still not widely accepted as standard of care in the literature
- Case highlights importance of pediatric-specific guidelines due to:
 - Smaller body size and different anatomy
 - Impact sustained from mechanism of injury
 - Implications for medical treatment and intervention
- Head and chest trauma correlated with pediatric BCVI in both literature and case study
 - No neurological deficits in patient upon first examination, contrasting with some literature findings that suggest carotid artery injuries are paired with poor initial neurological exams
- Anticoagulation therapy was indicated in literature, and used for patient without complication

Future Directions

- We plan to use available literature and LVHN pediatric trauma cohort to create a quality improvement initiative
 - Find common pediatric presentations of BCVI in our own patients
 - Create guidelines at LVHN for screening blunt cerebrovascular injury in children

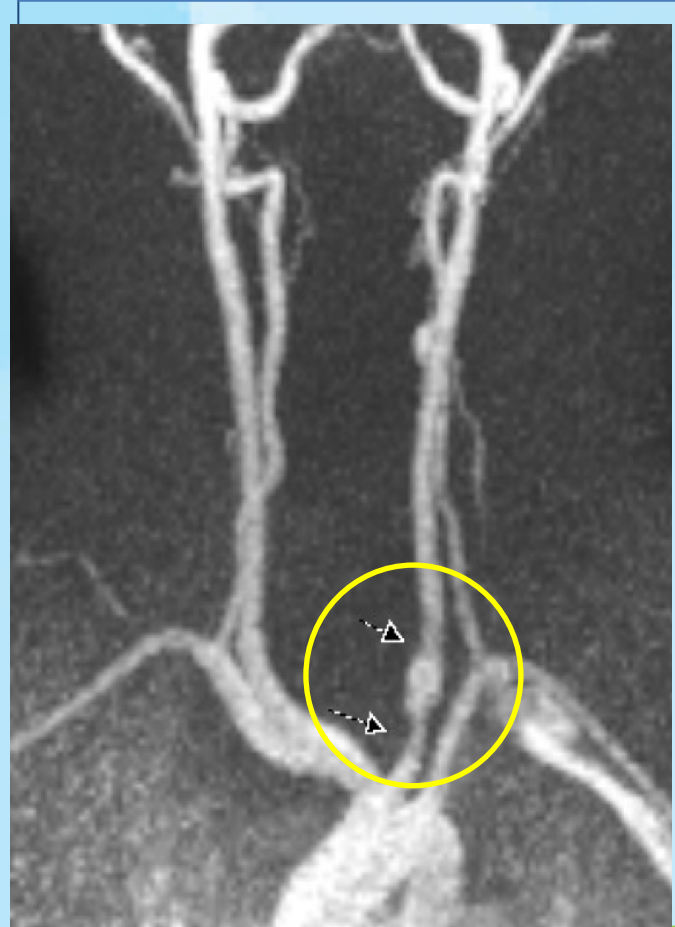


Figure 3: Patient's MRA Neck Showing L CCA Injury

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