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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 admissions<sup>1</sup>, while children have an incidence of 0.03%<sup>2</sup>
  - 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 sequelae<sup>3</sup>
- 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 <sup>4</sup>	- 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? <sup>5</sup>	- 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 <sup>3</sup>	- 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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