Aerodigestive Traumatic Injuries in the Pediatric Population

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Disclosure

• No financial interests to disclose
Outline

- Oropharyngeal, Laryngeal and Esophageal
  - History
  - Evaluation
  - Management
Oropharyngeal Injuries

- Usually occur in 3-5 year olds
- Toddlers run with objects in mouth and fall
- Oropharyngeal trauma:
  - Frequently unrecognized + unreported
  - Palate injury with bleeding worries most parents enough to go to ER
  - Largest concern is always ICA injury and associated complications
• Braudo 1956:
  • 3 patients with hemiplegia and other deficits after soft palate injury
• Bickerstaff 1964: Coined term “pencil injury”
• 20-30 case reports since reporting injury and subsequent devastating complications
• Neurologic sequelae are rare, but potentially devastating:
  • High level of suspicion needed in assessing patients with innocuous oropharyngeal injuries
Case Reports

- All injuries involved lateral palate
- Range from:
  - Toothbrush without mucosal penetration
  - Large palate laceration with ICA exposure

- Most patients had “lucid period”
  - 3-60 hours with no neurologic deficits
  - Immediate neurologic symptoms rare
  - Many did not develop neurologic symptoms until ≥ 24 hours after injury
Toothbrush Injury
Carotid sheath is in close proximity to peritonsillar + palatal tissues

ICA compressed between penetrating object and transverse process of 2\textsuperscript{nd} or 3\textsuperscript{rd} cervical vertebrae, or skull base

Shearing action can lead to intimal tear without direct arterial puncture:
  • Mural thrombus formation:
    • Occlusion of lumen
    • Distal propagation
ICA thrombosis:

- Usually doesn’t cause neurologic symptoms
  - If it does, usually complete recovery with observation or anticoagulation
  - Majority of patients have adequate collateral circulation via circle of Willis to tolerate acute unilateral ICA occlusion
  - “Lucid interval” = represents the time required for development + propagation of intraluminal thrombus
  - Deficits Seen: Contralateral hemiplegia, hemianopsia, aphasia (if dominant side involved)
  - Rare: Expanding neck hematoma, cervical bruit, Horner’s Syndrome
Total of 251 cases of oropharyngeal trauma*  
No neurological sequelae identified  
No cases of ICA identified  
Mean age = 3.5 years (Newborn – 16 years)  
Male to female ratio: 1.5:1 to 5.5:1  
Most common mechanism = wooden stick/ pencil  

Location of injury:  
- Lateral oropharynx in 70% to 81%  
- Most common site:  
  - Left soft palate (up to 53%)  
  - May reflect predominant R-handedness

• **Length of hospital stay:**
  • 12 hours to 18 days
  • 54% stayed < 24 hours
  • 78% stayed < 48 hours
• Reasons for extended stay (>48 hours):
  • Poor po intake (n=3)
  • Buccal cellulitis (n=2)
  • Pneumomediastinum (n=3, resolved spontaneously)
  • Retropharyngeal free air (n=2, resolved spontaneously)
  • VPI/child abuse work-up (n=1)

• **Extended stay and monitoring did not significantly alter management**
Prophylactic antibiotics:
- Abx used in 87% to 88% cases
- 85% got IV Abx followed by po Abx
- PCN or 1st generation cephalosporin
• 107 cases total/ 52 CTA
• Examined severity & management
  • Graded 1-3 based on severity
• CTA utilization was influenced by:
  • Laterality
  • Severity
  • If ENT was consulted
• CTA identified 1 patient with hematoma adjacent to carotid that was managed conservatively
### Table 3. Wound Severity in 107 Cases of Oropharyngeal Trauma

<table>
<thead>
<tr>
<th>Grade</th>
<th>Frequency, No. (%)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 (7)</td>
<td>Abrasion or ecchymosis without mucosal disruption</td>
</tr>
<tr>
<td>2</td>
<td>68 (64)</td>
<td>Puncture wound or simple laceration $\leq 1$ cm</td>
</tr>
<tr>
<td>3</td>
<td>31 (29)</td>
<td>Laceration $&gt;1$ cm or any laceration with an oronasopharyngeal fistula or large mucosal flap</td>
</tr>
</tbody>
</table>
Management Protocol

- Hospitalization for all children with oropharyngeal trauma is **neither practical nor clinically warranted**
- Admission for 24 hours provides **false sense of security**, since there is often a delay in neurologic symptoms
- Admission for 3 days with frequent non-invasive studies **offers no advantage in outcome**
- Give similar instructions as for minor head trauma
- Emphasize close parental observation for 3 days
- Admit for: <1yo; Delayed; Unreliable parents; If repair performed
Management Protocols

- Abx use empirically advocated though data does not demonstrate for or against
- Most palate injuries heal without intervention:
  - Even gaping though-and-through lacerations
  - Extensive blood supply and healing capacity
- Reserve surgery for:
  - Rare case of large avulsion flap
  - Need to explore for retained F.B.
Management Protocols

• Return to ED immediately if:
  • Drowsiness/listlessness
  • Irritability
  • Confused speech
  • N/V
  • Arm or leg weakness
  • Headache
  • Fits or seizures
  • Blurred vision
  • Neck swelling
  • Mouth bleeding

• F/U office exam to R/O subtle neurologic changes
  • If present, get angiogram
When does oropharyngeal laceration usually heal without intervention?
- Within a few days
- Over 90% require no surgery

When are prophylactic Abx warranted?
- Most of the time
- Mucosal laceration
• Are there any presenting signs + symptoms that may predict presence of ICA injury?
  • No

• What are appropriate screening radiology tests?
  • None (Radkowski et al, Hellmann et al)
  • Lateral neck X-ray (Schoem et al)
  • Ultrasound (Hengerer et al)
  • CT with contrast (Radcliff et al, Brietzke and Jones)
  • CT angiogram (CTA) (Soose et al)
  • MR angiogram (MRA)
Pediatric Laryngeal Injuries

- 1:30,000 ED Visits in general population
- Even more rare in pediatrics and most often seen in teens
- Mostly blunt
- Often severity is underestimated because lack of obvious fractures
- Most data is limited to adult research
Incidence of Laryngeal Trauma
Anatomical Considerations

• Pediatric Considerations
  • Larynx more superior (C4 vs C7) = more mandible protection
  • Generally more soft tissue and less cartilage damage
    • Looser Soft Tissue
    • Less Fibrous Support
    • More elastic cartilage
• Most important aspect is early recognition & treatment prior to obstruction
• Penetrating trauma management is much more obvious than blunt
• In the pediatric population trauma is almost always blunt
• Age plays a role in etiology but still blunt
  • Pre-puberty – falls and bike handlebars
  • Post-puberty – MVA, sports and clothesline
Initial Evaluation

- Proper evaluation should be performed while maintaining a safe and stable airway
- Wide variety of signs with blunt trauma
- Rapid respiratory compromise can occur
- Only proven symptom to correlate with severity of injury is respiratory distress
External Physical Findings

- Dysphonia to respiratory distress
- Anterior neck ecchymosis
- Loss of laryngeal landmarks
- Palpable laryngeal fractures
- Subcutaneous emphysema – large amount can correlate with laryngotracheal separation
<table>
<thead>
<tr>
<th>Symptom/Sign</th>
<th>Number (percent*) of patients</th>
<th>Association with Airway Intervention (P value)</th>
<th>Association with Surgical Intervention (P value)</th>
<th>Association with Adverse Outcome (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>13 (14.6)</td>
<td>0.130</td>
<td>0.442</td>
<td>0.512</td>
</tr>
<tr>
<td>Symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aphonie</td>
<td>1 (1.1)</td>
<td>1.00</td>
<td>0.483</td>
<td>0.397</td>
</tr>
<tr>
<td>Hoarseness/dysphonia</td>
<td>35 (3.9)</td>
<td>0.02</td>
<td><strong>0.090</strong></td>
<td>0.954</td>
</tr>
<tr>
<td>Odynophagia</td>
<td>23 (2.6)</td>
<td><strong>&lt;0.001</strong></td>
<td><strong>0.001</strong></td>
<td><strong>0.004</strong></td>
</tr>
<tr>
<td>Dysphagia</td>
<td>13 (14.6)</td>
<td>0.009</td>
<td>0.071</td>
<td>0.176</td>
</tr>
<tr>
<td>Pain</td>
<td>10 (11.2)</td>
<td>0.003</td>
<td>0.091</td>
<td>0.073</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>11 (12.4)</td>
<td>0.317</td>
<td>0.659</td>
<td>0.467</td>
</tr>
<tr>
<td>Snoring</td>
<td>1 (1.1)</td>
<td>0.348</td>
<td>1.00</td>
<td>N/A</td>
</tr>
<tr>
<td>Signs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>6 (6.7)</td>
<td>0.416</td>
<td>0.447</td>
<td>1.00</td>
</tr>
<tr>
<td>Stridor</td>
<td>15 (16.9)</td>
<td><strong>0.075</strong></td>
<td>0.321</td>
<td>0.130</td>
</tr>
<tr>
<td>Tracheal deviation</td>
<td>1 (1.1)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Subcutaneous emphysema</td>
<td>19 (21.3)</td>
<td>0.184</td>
<td>0.048</td>
<td>0.467</td>
</tr>
<tr>
<td>Pneumomediastinum</td>
<td>4 (4.5)</td>
<td>1.00</td>
<td>0.274</td>
<td>1.00</td>
</tr>
<tr>
<td>Respiratory distress/airway</td>
<td>24 (27.0)</td>
<td><strong>&lt;0.001</strong></td>
<td><strong>&lt;0.001</strong></td>
<td>0.103</td>
</tr>
</tbody>
</table>

*Percentages do not add up to 100 due to multiple injuries.

*P* values of factors selected for multivariate regression following correlational analysis and clinical evaluation are in bold text.
Figure 1: Anterior aspect of the patient's neck with ecchymosis and cervicofacial swelling are present.
Major changes in management after WWII
Lynch classified “lacerating”, “penetrating”, “contusions” & “crushing”
Nahum examined sites and types of injuries
  Treatment based on outcome “reversible, intermediate or irreversible”
Holinger and Harris further refined to develop an algorithm of management
<table>
<thead>
<tr>
<th>Group</th>
<th>Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Minor endolaryngeal hematoma without detectable fracture</td>
</tr>
<tr>
<td>II</td>
<td>Edema, hematoma, minor mucosal disruption without exposed cartilage, nondisplaced fractures</td>
</tr>
<tr>
<td>III</td>
<td>Massive edema, mucosa disruption, exposed cartilage, vocal fold immobility, displaced fracture</td>
</tr>
<tr>
<td>IV</td>
<td>Group III with 2 fracture lines or massive trauma to laryngeal mucosa</td>
</tr>
<tr>
<td>V</td>
<td>Complete laryngotraheal separation</td>
</tr>
</tbody>
</table>
How does this translate into Pediatrics

- Anatomy is higher
- Cooperation is less
- Airway is smaller
- Performance pressure is high

**Goal:** To act conservatively but not to the point where it is harmful to the patient and vice versa
Flexible Fiberoptic Laryngoscopy

- Recommended for stable adults but controversial in pediatrics
- Utilize in stable cooperative pediatric patients prior to any further testing or intervention (laying down)
- Useful for examining mucosal tears, hematomas, and surgical preparation
- Should be performed by someone experienced in FFL
CT - Scan

- Useful in stable patients after FFL if shows concern
- Gives subglottic information
- Good for Surgical planning and to clear cervical spine
- Laying flat is a risk
- Surgeon capable of securing airway should be present at time of CT-Scan
- Info may be limited in young children because of lack of mineralization of larynx
CT-Scan Pre and Post Repair
Intubation

- Controversial and debated in both pediatric & adult patients
- Sometimes will present intubated from field
- In children if done:
  - In OR
  - Tracheostomy set open
  - Most experienced (surgeon & anesthesia)
  - Can be done with bronchoscope or seldinger
  - Smaller endotracheal tube should be used
- Risk – Laryngotracheal separation group
Awake tracheostomy is gold standard in adults & most reliable & conservative way of securing the airway under local

- **BUT...** Children don’t read the books or care
- May need to induce general anesthesia
- Have rigid bronchoscope and ET tube ready
- Should be a tracheotomy not a cricothyroidototomy
- Often needed to gain access for repair
When to repair?

- Studies are limited on timing of surgical repair
- Endoscopic vs open is largely dependent on experience and injury
  - Endoscopic – mucosal tears
  - Open – true fractures, anterior commissure work
- Observation – minor edema, hematoma, minor tears
Indications for Open Surgical Repair

- Laryngeal Cartilage Fracture
- Exposed Cartilage
- Significant Mucosal Laceration
- Laceration Involving Free Edge of VF or Anterior Commissure
- Vocal Fold Avulsion
- Cricoarytenoid Dislocation
- Vocal Fold Paralysis
- Cricotracheal or Laryngotracheal Separation
Early (<48 hours) vs Late Surgery

Bent et al.
• 25% incidence of poor voice in late vs 2% in early
• Voice results decline within 1 day of delay

Leopold et al.
• 87% patients treated in 24 hours had good outcome
• 69% patients after 2-7 days had good outcome
• 27% after 7 days had good outcome
Blunt Airway Injury Points

- Can have rapid decline
- Flexible scope if stable
- If laying flat for any testing have a surgeon present
- CT good for surgical repair planning
- Awake tracheotomy is NOT a must in children
- Sooner the repair the better the outcome
Esophageal Trauma

- Primarily seen in penetrating not blunt events and both are infrequent
- 4-6% incidence in penetrating trauma
- Often self limiting but can be deadly
- Large case series review in penetrating determined:
  - Barium/ Gastrograffin Swallow and CT esophagography with IV are equivalent
  - Rigid esophagoscopy demonstrated highest sensitivity
108 patients with blunt trauma evaluated

Patients presented primarily with swallowing complaints, pneumomediastinum or subcutaneous air

Gastrograffin or barium swallow demonstrated similar information to that of rigid esophagoscopy

1 patient identified with significant esophageal tear requiring surgical intervention and patient was unstable at arrival

Conclusion: In stable patients with blunt trauma swallow evaluation is reasonable. If patient required airway evaluation can perform esophagoscopy at same time
• Pharyngeal injuries should be managed conservatively
• Laryngeal injuries should be evaluated and secured early
• Laryngeal injuries should be repaired early
• Esophageal injuries in patients with demonstrated blunt laryngeal trauma can be ruled out with esophagoscopy in OR
• If no significant laryngeal trauma and patient stable esophagus can be evaluated by swallow evaluation if concern exists
* Hwang, S. Y. Management dilemmas in laryngeal trauma