Evaluation and Management of Spinal Trauma in Children

MARK A. ERICKSON, MD
Rose Brown Chair in Pediatric Orthopedics
Chairman, Department of Orthopedics, The Children's Hospital
Medical Director, Spine Center, The Children's Hospital
Associate Professor, Department of Orthopedics,
University of Colorado at Denver and Health Sciences Center
Disclosures

• None
Objectives

- Evaluation of screening radiographs in children
- Safe cervical immobilization options in children
- Identify patterns of cervical and thoracolumbar trauma in children
- Identify management options for spinal trauma in children
Epidemiology

- Spinal trauma uncommon in children
  - 1-4% of children admitted for trauma
  - Incidence increases with age
- Cervical and thoraco-lumbar injuries ~equal
  - Cervical injuries in children associated with head trauma
- Neurologic injury rare
- Consider non-accidental trauma in very young children
### Epidemiology

<table>
<thead>
<tr>
<th>Age</th>
<th>Common Mechanisms</th>
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<tr>
<td>Birth – 2</td>
<td>Birth trauma</td>
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<td>Non-accidental trauma</td>
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<td>3 – 5</td>
<td>Falls</td>
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<td>Motor vehicle accidents</td>
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<td>Non-accidental trauma</td>
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<tr>
<td>6 – 18</td>
<td>Sports injuries</td>
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Cervical spine injury in young children: a National Trauma Data Bank review

Alison Polk-Williams\textsuperscript{a}, Brendan G. Carr\textsuperscript{d}, Thane A. Blinman\textsuperscript{a}, Peter T. Masiakos\textsuperscript{b}, Douglas J. Wiebe\textsuperscript{c}, Michael L. Nance\textsuperscript{a,*}

\textsuperscript{a}Children’s Hospital of Philadelphia, Philadelphia, PA 19104, USA
\textsuperscript{b}Massachusetts General Hospital, Boston, MA 02114, USA
\textsuperscript{c}Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania, Philadelphia, PA, USA
\textsuperscript{d}Department of Emergency Medicine, University of Pennsylvania School of Medicine, Philadelphia, PA 19104, USA

- Relatively uncommon
- Especially uncommon age < 2
- 50% upper cervical spine
- 50% lower cervical spine
- Approaches adult patterns of cervical spine injury after age 8

J Pediatr Surg 2008
Cervical Neurologic Exam

- C4 – Trapezius; shoulder shrug
- C5 – Deltoid; Shoulder abduction
- C6 – Biceps; Elbow flexion
- C7 – Triceps; Elbow extension
- C8 – Finger flexion
- T1 – Finger abduction
Thoracolumbar Neurologic Exam

- L1-L2 – Iliopsoas; Hip flexion
- L2-L3 – Hip adduction
- L2-L4 – Quadriceps; Knee extension
- L2-L4 – Hamstrings; Knee flexion
- L5 – Gluteus medius; Hip abduction
- L4 – Tibialis anterior; Ankle dorsiflexion
- L5 – EHL; Great toe dorsiflexion
- S1 – Gastrocsoleus; Ankle plantaflexion
Evaluation of Spinal Cord Injury (SCI)

- Complete vs incomplete
  - Spinal shock must be resolved
  - Return of bulbocavernosism reflex
Medical Management of SCI

• Hemodynamic support
  • Maintain blood pressure
• Foley catheter – decompress bladder
• Temperature – keep warm (high surface area)
• Steroid use controversial
  • Not studied well in children
  • Adult literature mixed results
  • Consult spine trauma consult service
• DVT prophylaxis
Radiographic Evaluation

The pediatric cervical spine instability study
A pilot study assessing the prognostic value of four imaging modalities in clearing the cervical spine for children with severe traumatic injuries

Douglas L. Brockmeyer • Brian T. Ragel • John R. W. Kestle

Childs Nervous System 2012

• CT had best detection of cervical spine injury
• MRI with good sensitivity, but high false positive rate
  • Consider in obtunded patients
• Flexion/Extension XR may be of utility in a delayed fashion to identify ligamentous injury
Radiographic Evaluation

- Standard AP and Lateral x-rays
- Consider CT scan for cervical spine if unable to obtain good quality radiographs
  - Especially upper cervical spine in young children
- Defer MRI until evaluation by spinal trauma consult service

1 – spinous processes
2 – spinolaminar line (Swischuk’s)
3 – posterior body line
4 – anterior body line
Cervical Spine: Differences in Children

- Increased range of motion
  - Ligamentous laxity, muscle weakness
  - Wedge shaped cervical vertebral bodies
  - More horizontal orientation of facet joints

4 mo  6 yrs  17 yrs
• Swischuk’s spinolaminar line
• Up to 4mm
• Horizontal facets
• 1/3 of children will have >1 level of injury
• 5-10% will have another injury >3 levels away from the initially diagnosed injury
• Complete clinical and radiographic examination of the entire spinal column recommended if any spine injury identified
• Need to optimize for children due to relatively larger head compared to adults
Backboard Options for Children
Cervical Immobilization

- Sandbags/Foam
- Cervical collar
- Halo Vest
Pediatric Halo

- 6-10 pins (vs 4 in teenagers/adults)
- Lower insertional torque in children

Rule of thumb:
Age/2=torque
Ex: 8yo/2=4 inch-lbs
Limit: adult=16yo=8 inch-lbs
Cervical Spine Injuries

- Upper cervical spine (Occiput, C1, C2)
  - Atlanto Occipital Dislocation
  - Atlanto Axial Instability
  - Odontoid fractures
- Lower cervical spine (C3-C7)
  - Flexion distraction
  - Flexion compression
  - Acute traumatic disc herniation
- SCIWORA
Atlanto Occipital Dislocation

- High mortality, >50%
- Occasional patients survive
  - High rate of SCI
- XR: increased interspinous distance
  - Powers ratio (BC/OA) > 1
- Initial Treatment: Reduction and halo
  - Fusion from occiput to C1 or C2
Atlanto Occipital Dislocation
Atlanto Axial Instability

- More commonly non-traumatic
  - Down’s syndrome
  - Skeletal dysplasia
  - JRA
- Traumatic uncommon
- Flexion-Extension xrays
- Treatment: Halo + C1- C2 fusion
Odontoid Fractures

- 10% of cervical fractures in children
- Neurologic injury uncommon
- “Physeal injuries” occur
Odontoid Fractures: Treatment

- **Non-operative**
  - Closed reduction
  - Halo

- **Operative**
  - Some type II fractures
  - Unable to reduce
**Os Odontodium**

- Tip of dens not fused to body
  - Smooth margins
- Congenital variant vs old trauma
- Can lead to acute on chronic injury as well with trauma
3+11 yo, neck pain after falling

PSF with Halo
Lower Cervical Spine Trauma

- More common age >8
  - Similar patterns to adults
- Flexion distraction
- Flexion compression
- Unilateral vs bilateral facet subluxation
- “double bat wing” sign
- Treatment: Closed awake reduction with tong traction followed by cervical fusion
Flexion Compression Injury

• Can result in compression or burst type fractures
• Usually unstable
• MRI to evaluate posterior injury
• Surgical treatment recommended
  • ASF vs ASF/PSF
14yo snowboarding injury

Neck pain x 2 weeks prior to presentation

“feels funny” in my arms if I turn my head the wrong way
• MRI – minimal posterior ligamentous injury
• Treated with C4 corpectomy and ASF C3-C5
Tolerance to Stretch

• SCIWORA
  • Spinal cord injury without radiographic abnormality (XR)
    • Somewhat obsolete in era of MRI
• Immature c-spine can stretch 5cm prior to failure
• Spinal cord fails with less than 1cm stretch
SCIWORA: 10 yo MVC

Hemodynamic instability despite resuscitation - MRI
Thoracolumbar Spine Injuries

- Compression fractures
- Burst fractures
- Flexion distraction injury (Chance fracture)
Compression Fractures

- Anterior vertebral body failure
- Posterior vertebral body height intact
- Generally from flexion-compression
Compression Fractures

- Stable injuries
- Brace for comfort
- Return to activities as tolerated

- If after minor trauma consider pathologic processes
  - Tumor
  - OI
  - Infection
Burst Fracture

- Anterior and middle column involved
- Higher risk of neurologic injury vs compression fractures
- CT scan helpful to evaluate spinal canal compromise
- Non-operative treatment with brace/cast generally effective
Burst Fracture: Operative Treatment

- >50% spinal canal intrusion
- Kyphosis >20-30 degrees
- Neurologic compromise
- Anterior vs posterior approach
  - Anterior – easier decompression
  - Posterior – more familiar approach, stronger instrumentation
Flexion Distraction Injuries: Chance Fractures

- Increased incidence
  - Increased reporting
  - Seatbelt legislation

- Susceptibility in children
  - Increased head to body ratio
  - Poorly developed iliac crest
  - Submarining
  - 2-point restraint in rear-seat
Mechanism of Injury

- Fulcrum of rotation anterior to PLL or vertebral body
  - Anterior compression
  - Simultaneous posterior distraction
Flexion – Distraction “Chance” Fractures

• Seat belt sign

• Associated injuries:
  • Abdominal
  • Pelvic

• Bony vs soft tissue
Chance Fractures

• Better healing with bony fractures
  • Generally non-operative (cast/brace)
• Operative treatment recommended for primarily soft tissue fractures

Bony Chance

Soft Tissue Chance

Tachdjian’s Pediatric Orthopaedics Vol 3
• Pure bony injury: Extension cast
Soft tissue injury
Fracture Dislocation Injuries

- High energy
- High rate of neurologic injury
- Associated visceral injury
- Early surgical treatment recommended to stabilize injury
• Marked instability
• Paralysis common
• Associated thoraco-abdominal injuries
• Extreme instability
• Spinal cord at risk!!
FRACTURE-DISLOCATION

ORIF
Thank You!