Cervical Spinal Injury and Airway Management: Debunking the Myths

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Editor, Anaesthesia
http://sthjournalclub.wordpress.com/
Objectives

1. Epidemiology

2. Protection of the spinal cord
   a. Cervical collars
   b. Manual in-line stabilisation
   c. Tracheal intubation
      a. Videolaryngoscopy
      b. FOI

3. Resuscitation principles
Winning hearts and minds...

Semmelweiss Reflex
“The reflex-like tendency to reject new evidence of knowledge because it contradicts established norms, beliefs or paradigms”

Pseudoaxioms
“False principles or rules handed down through generations of medical providers and accepted without serious challenge or investigation”
Epidemiology of SCI

- Median age 47.2 years

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Number</th>
<th>Median age</th>
<th>% aged &gt; 50 years</th>
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<tbody>
<tr>
<td>Traumatic Coma Data Bank</td>
<td>1984-1987</td>
<td>746</td>
<td>25</td>
<td>15</td>
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<tr>
<td>UK Four Centre Study</td>
<td>1986-1988</td>
<td>988</td>
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<td>EBIC Core Data Survey</td>
<td>1995</td>
<td>1005</td>
<td>38</td>
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<td>Rotterdam Cohort Study</td>
<td>1999-2003</td>
<td>774</td>
<td>42</td>
<td>39</td>
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<td>Austrian Severe TBI Study</td>
<td>1999-2004</td>
<td>492</td>
<td>48 (mean)</td>
<td>45</td>
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<tr>
<td>TARN Review</td>
<td>2003-2009</td>
<td>15173</td>
<td>39 (mean)</td>
<td>Not reported</td>
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<tr>
<td>Italian TBI Study</td>
<td>2012</td>
<td>1366</td>
<td>45</td>
<td>44</td>
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<tr>
<td>RAIN Study (UK)</td>
<td>2008-2009</td>
<td>2975</td>
<td>44</td>
<td>Not reported</td>
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</tbody>
</table>
Epidemiology of SCI

• 813 patients in Canada
• 13 year increase in mean age from 2002-2010
• > 60% patients aged > 55 years
  – 80% tetraplegia
  – Increase in central cord syndrome
Asymptomatic cervical spine disease

<table>
<thead>
<tr>
<th>Imaging Finding</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
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</thead>
<tbody>
<tr>
<td>Disk degeneration</td>
<td>37%</td>
<td>52%</td>
<td>68%</td>
<td>80%</td>
<td>88%</td>
<td>93%</td>
<td>96%</td>
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<tr>
<td>Disk signal loss</td>
<td>17%</td>
<td>33%</td>
<td>54%</td>
<td>73%</td>
<td>86%</td>
<td>94%</td>
<td>97%</td>
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<tr>
<td>Disk height loss</td>
<td>24%</td>
<td>34%</td>
<td>45%</td>
<td>56%</td>
<td>67%</td>
<td>76%</td>
<td>84%</td>
</tr>
<tr>
<td>Disk bulge</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
<td>69%</td>
<td>77%</td>
<td>84%</td>
</tr>
<tr>
<td>Disk protrusion</td>
<td>29%</td>
<td>31%</td>
<td>33%</td>
<td>36%</td>
<td>38%</td>
<td>40%</td>
<td>43%</td>
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<tr>
<td>Annular fissure</td>
<td>19%</td>
<td>20%</td>
<td>22%</td>
<td>23%</td>
<td>25%</td>
<td>27%</td>
<td>29%</td>
</tr>
<tr>
<td>Facet degeneration</td>
<td>4%</td>
<td>9%</td>
<td>18%</td>
<td>32%</td>
<td>50%</td>
<td>69%</td>
<td>83%</td>
</tr>
<tr>
<td>Spondylolisthesis</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
<td>14%</td>
<td>23%</td>
<td>35%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Epidemiology of SCI

Hasler et al. J Trauma 2011; 72: 975-981

- RTC
- Fall > 2m
- Fall < 2m
- Sports
- Other

- All Injuries
- Cord Injuries
Epidemiology of SCI
Hasler et al. J Trauma 2011; 72: 975-981

• Median age 47.2 years
• 66% male
• 3.5% had cervical spine injuries
  – 10.3% in those with GCS 3 to 8
  – only 23% had neurological symptoms [0.8% of total]
Epidemiology of SCI
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• Median age 47.2 years
• 66% male
• 3.5% had cervical spine injuries
  – 10.3% in those with GCS 3 to 8
  – only 23% had neurological symptoms [0.8% of total]
  – 25% had injuries to other regions
    • 16% head
    • 16% extremities
    • 14% chest
SCIWORA
Hendrey et al. J Trauma Acute Care Surg 2002; 53: 1-4

• NEXUS data
• n=34,069; 2.4% cervical spine injury
• 27 patients SCIWORA [0.08% of total]
SCIWORA
Hendrey et al. J Trauma Acute Care Surg 2002; 53: 1-4

• NEXUS data
• n=34,069; 2.4% cervical spine injury
• 27 patients SCIWORA [0.08% of total]

• Included > 3000 children
  – None had SCIWORA
Distribution of Bony Injuries

• 1496 cervical spine injuries (2.4%)
• 30% clinically insignificant
• Fractures:

<table>
<thead>
<tr>
<th>Spinal Level</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>8.8</td>
</tr>
<tr>
<td>C2</td>
<td>23.9</td>
</tr>
<tr>
<td>C3</td>
<td>4.3</td>
</tr>
<tr>
<td>C4</td>
<td>7.0</td>
</tr>
<tr>
<td>C5</td>
<td>15.0</td>
</tr>
<tr>
<td>C6</td>
<td>20.3</td>
</tr>
<tr>
<td>C7</td>
<td>19.1</td>
</tr>
</tbody>
</table>

\{ C1-2=33\% \\
\{ C5-7=54\% \}
Distribution of Bony Injuries

- 1496 cervical spine injuries (2.4%)
- 30% clinically insignificant
- Dislocations/subluxations:

<table>
<thead>
<tr>
<th>Spinal Interspace</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1-C2</td>
<td>10.0</td>
</tr>
<tr>
<td>C2-C3</td>
<td>9.1</td>
</tr>
<tr>
<td>C3-C4</td>
<td>10.0</td>
</tr>
<tr>
<td>C4-C5</td>
<td>16.5</td>
</tr>
<tr>
<td>C5-C6</td>
<td>25.1</td>
</tr>
<tr>
<td>C6-C7</td>
<td>23.4</td>
</tr>
<tr>
<td>C7-T1</td>
<td>3.9</td>
</tr>
</tbody>
</table>

C5-7=58%
Anatomy of Spinal Cord Injury
Crosby. Anesth 2006; 104: 1293-318

Space available for spinal cord (SAC): 1/3 odontoid; 1/3 cord; 1/3 space
Cervical Collars & Spinal Boards

“The best place for cervical collars is in the bin”

Dr Per Kristian Hyldmo
Cervical Immobilisation

Oteir et al. Injury Int J Care Injured 2015; 46: 528–535

• Systematic review of pre-hospital immobilisation
• 4 studies from 1471 citations (no RCTs)
  – Increased mortality in penetrating trauma (OR 2.77)
  – Increased risk of neurological injury (AOR 2.03)
  – Scene time doubled
  – Longer ICU stay (7.5 vs. 2.3 days)

“..lack of high-level evidence on the effect of prehospital cervical spine immobilisation on patient outcomes”
Cervical Collars & Spinal Boards
Sundstrøm et al. J Neurotrauma 2014; 31: 531-40

• Most spinal injuries are stable; those that are unstable have already caused irreversible damage
Cervical Collars & Spinal Boards

Sundstrøm et al. J Neurotrauma 2014; 31: 531-40

• Most spinal injuries are stable; those that are unstable have already caused irreversible damage
• Collars do not immobilise the cervical spine
• Exaggerated rate of secondary SCI without collars
• Numerous associated complications:
  – Pressure sores/sepsis (6-67%)
  – Increased ICP
  – Agitation & discomfort
  – Difficulties with inventions/care bundles
Cervical Collars & Spinal Boards
Sundstrøm et al. J Neurotrauma 2014; 31: 531-40

• Authors suggest:
  – Spinal board with head blocks & straps if high-risk
  – Collars only for difficult extrication
  – Unconscious, non-intubated trauma patients should be transported in modified left lateral
Cervical Collars & Spinal Boards
Spinal Clearance with CT

Patel et al. J Trauma Acute Care Surg 2015; 78: 430-441
Pacnczykowski et al. J Neurosurg 2011; 115:541-9

- HRCT CT of C-spine (1-2 mm slices)
  - C0 – T2 (but T4 better)
  - Reported by consultant musculoskeletal/neuroradiologist
  - Discussed with spinal/neurosurgical consultant

- CT reconstructions of thoracolumbar spine
- AP/Lateral radiographs thoracolumbar views
- Semi-rigid collar (Aspen/Philadelphia) in interim
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- Semi-rigid collar (Aspen/Philadelphia) in interim

- Sensitivity/specificity of CT >99.9% (cf NEXUS 99%)
- 1 in every 4776 patients have missed injury
Anaesthetic Negligence

Being anaesthetised is a complicated process but anaesthetists are highly trained medical professionals with extremely in depth knowledge. However, mistakes are made and problems do occur. Anaesthesia errors can be devastating: they can cause permanent or semi-permanent paralysis, brain damage, anaesthetic awareness, and in serious cases, death.
Manual In-line Stabilisation


- Origin uncertain – ATLS guidance 1984
- Data from cadaveric studies, healthy volunteers and case series (n=96)
- Several studies suggest MILS has no effect on cervical segment movement

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>Grade 1</th>
<th>Grade II</th>
<th>Grade III</th>
<th>Grade IV</th>
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<tbody>
<tr>
<td>Nolan &amp; Wilson. Anaesthesia 1993; 48:630-33</td>
<td>Optimal position</td>
<td>129</td>
<td>26</td>
<td>2</td>
<td>-</td>
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<tr>
<td></td>
<td>MILS</td>
<td>75</td>
<td>48</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MILS</td>
<td>12</td>
<td>27</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Collar/tape/sandbags</td>
<td>2</td>
<td>16</td>
<td>25</td>
<td>7</td>
</tr>
</tbody>
</table>
Risk of Laryngoscopy
Hindman et al. Anesth 2011; 114: 782-795

• 10 case reports of worsening SCI after intubation
  – Little to implicate laryngoscopy as cause

• Closed Claims Analysis:
  – 1970-2007 (n=7740)
  – 48 cases identified (0.9% of GA claims)
  – Majority (>75%) had stable c-spines prior to procedure
  – Nine had unstable cervical spines
    • Two cases of cord injury with direct laryngoscopy implicated
    • Two cases occurred despite AFOI
Neurological Deterioration after Surgery
Harrop et al. Spine 2001; 26: 340-46

• Due to prolonged deformation and/or hypotension
  – Hyperflexion worse than hyperextension
  – In animal models need > 30 min of continuous cord compression
• Both are unlikely during DL
• 6% patients with SCI will deteriorate
  – Early (24 h)
  – Later (24h to 7 days)
  – Late (weeks [post-traumatic ascending myelopathy])
Cervical Spine & Direct Laryngoscopy
Sawin et al. Anesth 1996; 85:26-36

- Ten volunteers with normal cervical spines
- Minimal glottic exposure
- Majority of motion at C0-C1 & C1-C2
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Sawin et al. Anesth 1996; 85:26-36

• Ten volunteers with normal cervical spines
• Minimal glottic exposure
• Majority of motion at C0-C1 & C1-C2
Cervical Spine & Direct Laryngoscopy
McCahon et al. Anaesthesia 2015; 70: 452-61

- Odontoid peg fracture in cadavers
- Minimal glottic exposure
- MILS
- Assessed “space available for spinal cord”
- Airtraq, McCoy & Mac 3
  – no significant difference
Video Laryngoscopy
Suppan et al. BJA 2016; 116: 27-36

- Meta-analysis (n=1886)
- Primary outcome: time to intubation
- C/L view not relevant
- No assessment of: SAC
  - Cervical spine movement
Cervical Spine & Airway Manoeuvres

Donaldson et al. Spine 1997; 22: 1215-18
Donaldson et al. Spine 1993; 18: 1220-23

• Cadavers with unstable C1-2
  – MILS
  – Glottic view achieved not stated
  – Space available for cord assessed

• Jaw thrust > chin lift > laryngoscopy

• Cadavers with unstable C5-6
  – No MILS
  – Glottic view achieved not stated
  – Cervical spine motion assessed

• Chin lift/jaw thrust ≈ cricoid pressure ≈ laryngoscopy
Cervical Spine & BVM Ventilation

- Cadavers studied within 40 min of death
  - Collar, spinal board, tape
  - Glottic view achieved not stated
  - Neck maintained in neutral

- Mask ventilation >> tracheal intubation [P=0.00004]
Cervical Spine & Other Airway Techniques

  – Done in cervical collars
  – LMA & iLMA similar to Macintosh

• GlideScope [Robitaille et al. Anesth Analg 2008; 106: 935-41 ]
  – MILS
  – No difference between Macintosh and GlideScope

• Fibreoptic intubation [Sahin et al. EJA 2004; 21: 819-23]
  – No MILS
  – Best possible glottic view achieved
  – FOI significantly less movement at C1/2 (8°) but not C2/3 compared to direct laryngoscopy
MR. STEROID
by Roger Hangovers
Steroids for Acute SCI
Bracken MB. Cochrane Database Syst Rev 2012; 1:CD001046

Authors' conclusions

High-dose methylprednisolone steroid therapy is the only pharmacologic therapy shown to have efficacy in a phase three randomized trial when administered within eight hours of injury. One trial indicates additional benefit by extending the maintenance dose from 24 to 48 hours, if start of treatment must be delayed to between three and eight hours after injury. There is an urgent need for more randomized trials of pharmacologic therapy for acute spinal cord injury.
NASCIS II

• All +ve results are from post hoc analyses
• Time cut off (8 h) is arbitrary
• 78 discrete post hoc tests
• 60 t-tests for neurological outcomes
The Acute Cardiopulmonary Management of Patients With Cervical Spinal Cord Injuries

- Correct hypotension (SBP <90mmHg) ASAP (III)
- Target MAP 85-90 mmHg for 7 days post injury (III)
  - Compared to historical controls
  - >50% with cervical injuries will require vasopressors
  - Complications common in first 7 days post injury
    - Hypotension, bradycardia
    - Ventilatory failure on average 4.5 days post injury
    - Intubation rates: ≥C5 100% cf 79% ≤ C6
Spinal Cord Perfusion Pressure

- Proof of concept study; n=18
- Subdural pressure probe at site of injury
- Targeted therapy improved amplitudes of motor-evoked potentials
- In two patients, increased SCPP improved motor function
Lung volumes fall to 33% at time of injury
  - Recover to 45% by 5 weeks & 60% by 5 months

Supine better than erect

TVs higher (10 to 15 mls kg\(^{-1}\))

Caution with PEEP (impairs diaphragm)

If injury > C5 high probability of needing trache
  - FVC < 11.9 ml kg\(^{-1}\)
  - endotracheal suction more than every hour
  - PaO\(_2\)/FiO\(_2\) < 25 kPa
Summary

• Maximal insult to the spinal cord occurs at the time of injury
Summary

• Maximal insult to the spinal cord occurs at the time of injury
• Secure the airway carefully with whatever technique that works best in your hands
• Avoid hypotension & hypoxia
• Patients with high SCI may be best managed on HDU/ICU for > 7 days
• There is no place for steroid therapy in SCI