Review of the Acute Management of C-spine Trauma for the Non-Specialist

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The Alfred Hospital
Presentation goals

• Evidence based approach to the acute management of cervical spine trauma
• Its application in a major trauma center
• Basic science to enforce the clinical aspects

AANS/CNS Joint Guidelines Committee

The broad approach

- Review some basic core science
- Airway
- Breathing
- Circulation
- Disability and neurological assessment
- Exposure and additional care
Case description – Mr CR

• 43yr old gentleman
• Fall from horse
• Head strike
• Arrested at scene
• Resuscitated bystander Anaesthetist
• Transferred to spinal centre
Summary of Injuries

- Odontoid peg fractures: Type I and III
- Instability C1 and C2
- Occipital-atlanto instability
- Incomplete C4/5 lesion
- Modified Brown Sequard
The burden to society in 2012

• 270,000 patients suffering SCI in US
• 260-1207 new patients per year in Australia
• Young men 80.6%
• Average age risen from 28.7 yrs to 41 yrs
• Large financial burden to society

The financial burden

<table>
<thead>
<tr>
<th>Severity of Injury</th>
<th>Average yearly expenses in US Dollars 2012</th>
<th>Estimated Lifetime Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Yr</td>
<td>Subsequent yrs</td>
</tr>
<tr>
<td>High tetraplegia</td>
<td>$ 1,023,924</td>
<td>$ 177,808</td>
</tr>
<tr>
<td>Low tetraplegia</td>
<td>$ 739,874</td>
<td>$ 109,077</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>$ 499,023</td>
<td>$ 66,106</td>
</tr>
<tr>
<td>Incomplete motor-function</td>
<td>$ 334,170</td>
<td>$ 40,589</td>
</tr>
</tbody>
</table>
Mechanisms of injury

Presentation of Spinal Cord Injuries (SCI) in the ED

• 1.8% of all blunt trauma
• 1-3% of all head injuries will have a SCI
• Approximately 25% of SCI will have a head injury
SCI outcomes since the introduction of ATLS and resuscitation guidelines

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>1970’s</th>
<th>1980’s</th>
<th>1990’s</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Quadriplegia</td>
<td>55%</td>
<td>39%</td>
<td>48%</td>
<td>37%</td>
</tr>
<tr>
<td>Complete Paraplegia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete Quadriplegia</td>
<td>45%</td>
<td>61%</td>
<td>50%</td>
<td>62%</td>
</tr>
<tr>
<td>Incomplete Paraplegia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Injury Types
Clinically Stable Injuries

White et al defined stability as “the ability of the spine to limit its pattern of displacement under physiological loads so as not allow damage or irritation of the spinal cord or nerve roots”

Clinical instability occurs when physiologic loading causes patterns of vertebral displacement that jeopardize the spinal cord or nerve roots

A clinically significant SCI is present if there is any fracture, dislocation or ligamentous instability which is demonstrated on diagnostic imaging
Complete vs Partial SCI

A complete SCI is where there is complete loss of neurological function below the level of injury leading to complete para or tetraplegia.

An incomplete SCI is loss of neurological functions with varying degrees of residual function.
Ligament and Bony Structures
<table>
<thead>
<tr>
<th>Fracture</th>
<th>Mechanism</th>
<th>Description</th>
<th>Cause</th>
<th>Neuro/Vasc Involvement</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hangmans</td>
<td>Extension</td>
<td>Pedicles of axis</td>
<td>MVA / Diving</td>
<td>Neuro not Severe***</td>
<td>Variable Stability</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Axial compression</td>
<td>Burst fracture of atlas</td>
<td>Diving</td>
<td>None Neuro/ Dmge Vert Art</td>
<td>Extremely unstable with Rupture Transverse Lig</td>
</tr>
<tr>
<td>Odontoid I-III</td>
<td>Mixed mechanism</td>
<td>Common</td>
<td></td>
<td>Type I*</td>
<td>Most Stable Unstable</td>
</tr>
<tr>
<td>Tear Drop</td>
<td>Flexion</td>
<td>Ant/Inf fracture VB</td>
<td>MVA/ Diving</td>
<td>Type II**</td>
<td>Most Stable Unstable</td>
</tr>
<tr>
<td>Bilateral Facet Dislocation</td>
<td>Flexion</td>
<td>Anterior subluxation</td>
<td></td>
<td>Type III</td>
<td>Most Stable Unstable</td>
</tr>
<tr>
<td>Atlanto-Occipital Dislocation</td>
<td>Flexion</td>
<td>Ant/Post Lig Disruption</td>
<td></td>
<td>Rare Neuro</td>
<td>Most Stable Unstable</td>
</tr>
<tr>
<td>Clay Shovelers Fracture</td>
<td>Flexion</td>
<td>Avulsion fracture C7</td>
<td></td>
<td>Neuro Intact</td>
<td>Stable</td>
</tr>
<tr>
<td>Simple Wedge Compression</td>
<td>Flexion</td>
<td></td>
<td></td>
<td></td>
<td>Stable</td>
</tr>
</tbody>
</table>
Basic Science
The injured spinal cord

- Scar Tissue
- Inflammation
- Necrosis
- Penumbra
- Cut Axon
- Demyelinated Axons
- Spared Axons
- Degenerated Axons
The Pathogenesis of SCI from secondary injury

Primary Injury
- Hypoxia and Hypotension
  - Inflammation
  - Mitochondrial Dysfunction
  - Oxidative Stress
  - Cellular Oedema
  - Cell Death Apoptosis
  - Excitotoxicity
  - Cytokines

Secondary Injury
Clinical Management of Acute Spinal Cord Injury
Making it reality
The clinical pathway

Primary Survey (Ongoing Assessment)
- Airway with C spine Immobilisation
- Breathing
- Circulation
- Disability and Exposure

Secondary Survey

Tertiary Survey

Final Disposition:
- ICU
- Theatre
- Ward

Injury → Pre-hospital → Transfer → Emergency Department
Spinal Immobilisation is **not** indicated if the patient is:

- Awake
- Alert
- Not Intoxicated
- Neurologically intact
- Without neck pain or tenderness
- No distracting Injuries
- Uncomplicated penetrating trauma

1. Rigid blocks (lateral supports) – head in neutral position
2. Rigid cervical collar
3. Backboard
4. Straps
Airway management goals

• *Primum non nocere* – minimise amount of c-spine displacement
• Rapidly secured airway – minimise risk of aspiration
• Minimise physiological disruption
• Avoidance of hypoxia and hypotension is paramount
• Plan for a failed airway
Publications

- ATLS

- A Cadaveric Studies
  Eg WF Donaldson *Original Papers*

- Spinal Cord Injury and Direct laryngoscopy: AD McLeod and I Calder *Editorial*

- Airway Management in Neuroanaesthesia Video laryngoscopy *Review*

Practice

- Direct laryngoscopy with MILS

- Blind Nasal Intubation

- Awake Fibreoptic Intubation

- Direct laryngoscopy with MILS With Introducer

- Video laryngoscopy with MILS

- Direct laryngoscopy with MILS
## Videolaryngoscopy and the C-spine

<table>
<thead>
<tr>
<th>Study</th>
<th>Device</th>
<th>Control</th>
<th>Cervical Precautions</th>
<th>Major Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hirabayashi et al 2007</td>
<td>AWS Pentax</td>
<td>DL</td>
<td>None</td>
<td>Reduced extension</td>
</tr>
<tr>
<td>Maruyama et al 2008</td>
<td>AWS Pentax</td>
<td>DL &amp; McCoy</td>
<td>None</td>
<td>Reduced extension</td>
</tr>
<tr>
<td>Robitallie et al 2008</td>
<td>GlideScope</td>
<td>DL</td>
<td>MILS</td>
<td>No Decrease in Cervical Movement</td>
</tr>
<tr>
<td>Maruyama et al 2008</td>
<td>AWS Pentax</td>
<td>DL</td>
<td>MILS</td>
<td>Reduced Cumulative movement</td>
</tr>
<tr>
<td>Turkstra et al, 2009</td>
<td>Airtraq</td>
<td>DL</td>
<td>MILS</td>
<td>No difference at C1-C2 segment less extension at C2-C5</td>
</tr>
<tr>
<td>McElwain et al 2011</td>
<td>C-Mac, Airtraq</td>
<td>DL</td>
<td>MILS</td>
<td>Airtraq best in reduction in IDS</td>
</tr>
</tbody>
</table>
A practical approach to the SCI airway

- RSI /bimanual cricoid/ direct laryngoscopy with MILS
- Haemodynamically stable induction
- Consider use of rigid video-laryngoscopes
- Bougie/ introducer should be considered on all views*
- Consider anterior neck maneuvers
- Confirm placement with end-tidal CO2
- Plan for a failed intubation

*Anaesthesia 48(7):630-3, 1993 Nolan and Wilson
The Alfred Experience

• C spine fractures occurs in 10% of trauma admissions
• Incidence of severe SCI very rare (<1%)
• Of the patients that have a SCI, two thirds will be complex major trauma

Data supplied by Louise Niggemyer from the Alfred trauma register with thanks.
Breathing

- Multiple reasons for hypoxia
- Severity of respiratory failure is dependent on level of injury
Management of Ventilation

- Avoid Hypoxia: PaO2 > 60mmHg or SpO2 > 90
- Maintain a low normal PaCO2: 35-40mmHg
- Rapid correlation of PaCO2 with ETCO2
- Judicious use of PEEP

Circulation

SCPP = MAP - (CSFP or CVP)

CPP = MAP - (ICP or CVP)

- Hypotension proven to be associated with poor outcomes EV Level III

- Neurogenic shock just one cause

SCPP Spinal cord perfusion pressure, CSFP Cerebrospinal fluid pressure
Management of Circulation

- Avoid hypotension: MAP 85-90mmHg
- Invasive monitoring and aggressive medical management in an ICU environment
- Early use of vasopressors in addition to volume resuscitation
- Treat bradycardia: atropine or pacing
<table>
<thead>
<tr>
<th>Ascending Spinal Cord Tracts</th>
<th>Function</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal Column</td>
<td>Fine touch</td>
<td>Dorsal column</td>
</tr>
<tr>
<td></td>
<td>Proprioception</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two point discrimination</td>
<td>Cross at level of medulla</td>
</tr>
<tr>
<td>Spinothalamic</td>
<td>Sharp pain</td>
<td>Ventrolateral column</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crude touch</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Descending Spinal Cord Tracts</th>
<th>Function</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Corticospinal</td>
<td>Fine motor function</td>
<td>Lateral column</td>
</tr>
<tr>
<td>Anterior Corticospinal</td>
<td>Gross and postural motor function</td>
<td>Anterior column</td>
</tr>
</tbody>
</table>
Steroids and SCI \textit{EV Level I}

- No uniform recommendations for their use (2013 guidelines)
- Class I, II and II evidence that high dose steroids associated with harmful side effects
Adjuncts of Care

- NG tube to limit aspiration
- Indwelling urinary catheter
- Careful temperature monitoring and care
- Monitor renal function
- DVT prophylaxis \textit{EV Level II}
- Pressure area monitoring and care
Take Home Messages

• Appropriate immobilisation is essential
• Avoid hypoxia and hypotension
• Use familiar and well rehearsed intubation techniques
• During a failed airway, release of MILS/Cricoid pressure should be considered
• Steroids are now not recommended
From Superman to Superhero

- Underwent spinal fixation
- Lived with his wife for the following 10yrs
- During those years he established a charity and became an ambassador for those affected by SCI
- Died of sepsis related complications in 2004
- His name is Christopher Reeve and you know him better as superman
“So many of our dreams first seem impossible, then they seem improbable, and then, when we summon the will, they soon become inevitable”

*Christopher Reeve, August 1996*
References:


