Emergency War Surgery Course
Joint Trauma System

Spinal Injury Management

Joint Trauma System Battlefield Trauma Educational Program
A 26-year-old vehicle driver arrives after an Improvised Explosive Device (IED) explosion hits the vehicle, penetrating the cab. The patient has altered mental status with penetrating wounds to the legs and abdomen. Responders report the patient walked at the scene, but is now having trouble moving all four of his extremities.

1. What are your priorities in managing this patient?
2. What possible spine interventions should be done?
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Objectives

- Understand the initial management of spine fractures and spinal cord injuries in the deployed setting.
- Understand medical management of patients with spinal cord injury.
- Understand the principles of transportation of patients with spinal cord injury.

Marine caught adjacent to IED explosion

Source: Out Of The Crucible: How The US Military Transformed Combat Casualty Care In Iraq And Afghanistan, Borden Institute.
Between Oct 2001 to December 2009, there were 594 casualties with spine injuries.

- 66.7% were due to explosions, 17% gunshot wounds, 3% falls
- 15% (91) of the casualties had spinal cord injuries and of that number 45% (41) were complete.

Battlefield spinal cord injuries also differ from civilian trauma by often being open, contaminated and usually associated with other organ injuries.
During Oct 2001 to Dec 2009, there were 594 casualties with spine injuries, 91 (15%) of the casualties had spinal cord injuries.
Pathophysiology of Injury to the Spinal Cord

Battlefield spinal cord injuries differ from civilian trauma. Often injury is open, contaminated and associated with other organ injuries.

- **Primary**: Initial mechanical injury due to local deformation and energy transmission – mostly unpreventable.
- **Secondary**: Cascade of biochemical and cellular processes initiated by the primary process that causes cellular damage and death.

Critical care of spinal cord injury patients includes attempts to minimize secondary injury from hypoxia, hypotension, hyperthermia, and edema.
After initial ABC’s of a trauma evaluation, spine evaluation and management follow 4 principles:

1. Initial spine stabilization to prevent neurological deterioration
2. Diagnosis
3. Definitive spinal stabilization
4. Functional recovery
Instability must be presumed in any patient with:
- Complaints of a sense of instability (holds head in hands)
- Vertebral column pain
- Tenderness in the midline over the spinous processes
- Neurological deficit: Includes TBI patients
- Altered mental status
- Suspected, but not proven, injury
In prehospital setting, safety of the patient and care giver is of primary importance.

- Evacuation to a more secure area takes precedence over spine immobilization.
- Once safe, spine immobilization if indicated, should be done.

Medic carrying injured soldier
Courtesy of Defense Visual Information Distribution Service
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Treatment

Patients who have sustained injuries through the following mechanisms should have a rigid cervical collar in place in the pre-hospital environment (if tactical situation allows):

1. Trauma resulting in loss of consciousness or even the question of loss of consciousness due to any form of head injury.
2. Trauma resulting in temporary amnesia/loss of consciousness.
3. Major explosive or blast injury.
4. Mechanism that produces a violent impact on the head, neck, torso or pelvis.
5. Mechanism that creates sudden acceleration/deceleration or lateral bending forces on the neck or torso.
6. Fall from height (vs. fall from standing).
7. Ejection or fall from any motorized vehicle.
8. Vehicle roll-over.

*Patients should keep the cervical collar through continuum of care until cleared by a qualified medical provider with appropriate documentation.*
Transport of thoracolumbar injuries may require additional precautions depending on stability of spine.

- Standard NATO litter with or without a memory foam pad may be adequate for some.
- If unstable fracture, Critical Care Air Transport Team (CCATT) using a vacuum spine board (VSB) may be required.

VSBs for prolonged transport must be deflated and re-inflated intermittently to reduce risk of pressure ulcers in addition to patient log roll every 2 hours.
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- Evaluation includes a thorough neurologic examination.
  - Motor exam of the 10 American Spinal Injury Association (ASIA) key motor groups.
  - Sensory examination (pin prick and light touch) using ASIA dermatomal standards.
  - Digital rectal exam that assesses voluntary anal sphincter contraction strength, pinprick sensation, resting tone, and bulbocavernosus reflex.
  - Normal and pathological reflex testing such as biceps, triceps, knee responses as well as evaluation of Babinski reflex.

- Patients with a suspected injury, but no neurologic findings, need frequent repetition and surveillance of the neurologic examination.

- Recording of findings imperative as patients move between levels of care to identify progression and identify discrepancies in evaluation.
Diagnosis of injuries requires full examination of the neck and the entire spine.

- Cervical collar can mask penetrating injuries to both spine and soft tissue.
- During removal for evaluation, cervical stabilization should be maintained.

*Metal fragment in right anterior neck*
EWS Spinal Injury Diagnosis

Diagnosis of spine injuries depends on clinical status of the patient.

- The spine can be cleared clinically in reliable patients without distracting injuries.

- For purposes of exam, distracting injury is defined as:
  
  “Any injury, which is so painful that it may obscure the patient’s ability to notice pain in their neck.”

- Treating physician determines distracting injury qualification.
Cervical spine clearance algorithm

Reliable patient

Physical Exam. While maintaining C-spine control, remove collar, inspect for deformities, palpate for point tenderness. If none, then check for active full range of motion.

No Findings
- 1. C-spine cleared.
- 2. Remove collar.

Any Findings (Keep Collar On)

Patient complaining of neck pain, paresthesia or weakness?

No
- No Findings
- Normal Imaging
  - 1. C-spine cleared.
  - 2. Remove collar.

Yes
- Imaging: CT Scan C-spine* (If no scanner, obtain lateral, AP, odontoid films)
  - Decreased level of consciousness (GC<15) or painful distracting injury?
    - No to both
      - Proceed to Unreliable Patient Algorithm
    - Yes to both
      - Is the patient unable to communicate adequately?
        - Yes
          - Abnormal Imaging
            - 1. Keep collar on.
            - 3. MRI C-spine.
        - No
          - Imaging Inadequate*
            - 1. Keep collar on.
            - 2. Repeat films needed.

Abnormal Imaging

Normal Imaging

*Film Adequacy: Axial CT from the occiput to T1 with sagittal and coronal reconstructions.
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Algorithm: Unreliable Patient

Cervical spine clearance algorithm
Unreliable patient

**Limited Exam.** While maintaining C-spine control, remove collar, visually inspect and palpate for deformities. Replace collar.

**Decreased level of consciousness (GC<15) or painful distracting injury?**

**Is the patient able to communicate adequately?**

**Imaging: CT Scan C-spine**

Yes to both

Normal Imaging

**Will the distraction injury be stabilized or LOC issue be cleared up in 72 hours?**

Yes

No

Abnormal Imaging

**Maintain immobilization. Clinical decision to clear per policy at definitive level of care. Document in chart.**

1. Keep collar on.
2. Obtain Neurosurgery Consult.
3. MRI C-spine.

Imaging Inadequate*

1. Keep collar on.
2. Repeat films needed.

**Cervical collar to remain in place until work-up complete**

Yes

**Proceed to Reliable Patient Algorithm**

No

**Imaging Inadequate**

1. Keep collar on.
2. Obtain Neurosurgery Consult.
3. MRI C-spine.

*Film Adequacy: Axial CT from the occiput to T1 with sagittal and coronal reconstructions.

**Physical Exam** (after distracting injury stabilized and LOC clear). While maintaining C-spine control, remove collar, inspect for deformities, palpate for point tenderness. If none, check for active full range of motion.

- No Findings
  - 1. C-Spine cleared.
  - 2. Remove collar.

- Any Findings

1. C-Spine cleared.
2. Remove collar.
Imaging the spine is a decision based on mechanism and clinical findings (physical exam and mental status).

- Obtunded patients should undergo computed tomography (CT) of the spine with fine cuts and multi-planar reconstructed images.
- If CT not available, X-rays can be performed.
  - For cervical spine, full C-spine plain radiographs include AP, lateral, and odontoid views.

Patients with clear cervical spine on CT but obtunded, the incidence of cervical instability is not zero.

- An MRI is ideal to clear an obtunded patient, but a negative CT scan is enough to clear the spine if the patient cannot undergo MRI.
When complex wounds involve head, thorax, abdomen, or when extremities coexist with vertebral column injuries, *life-saving measures take precedence* over definitive diagnosis and management of spinal column and cord.

During life-saving interventions, take protective measures to prevent further injury to the unstable spine.
Medical Management of Spinal Cord Injuries (SCI)

- Patients should have an invasive arterial line for continuous blood pressure monitoring.
  - Goal Mean Arterial Pressure of 85-90 mm Hg for up to 7 days post injury.
  - Vasopressors in the euvolemic patient may be necessary.
  - Hypotension SBP<90 must be avoided.

- Hypoxemia (SaO2 < 92%) must be avoided; supplemental oxygen may be required.

- Bed can usually be placed in 30 degrees reverse Trendelenburg.

- Logroll patients every 2 hours to prevent skin breakdown.

- Corticosteroids are not recommended.
Medical Management of SCI (continued)

- Aggressive deep vein thrombosis (DVT) prophylaxis should be initiated early.
  - Mechanical prophylaxis with pneumatic compression devices.
  - Chemoprophylaxis initiated within 24-72 hours of injury or repair.
  - IVC filter for DVT present and anticoagulation is contraindicated.

- Cefazolin 2 gm IV q 8 hrs for 24-72 hours for penetrating spine injuries without evidence of contamination.
  - If fragments pass through contaminated viscus: 3rd generation cephalosporin for 7-10 days.
  - If cerebrospinal fluid (CSF) leak: Broad spectrum coverage with CSF penetration.
Possible Effects of Spinal Cord Injury on Medical Care

- Neurogenic Shock: traumatically induced sympathectomy with spinal cord injury.
  - Bradycardia and hypotension.
  - First treated with volume resuscitation to euvolemia.
  - May use vasopressors to maintain BP only after euvolemia.

- Gastrointestinal Tract
  - Ileus common – may require nasogastric tube.
  - Stress ulcer prophylaxis.
  - Bowel training includes schedule of suppositories initiated within 1 week of injury.
Possible Effects of Spinal Cord Injury on Medical Care (continued)

- **Bladder Dysfunction**: failure to decompress the bladder may lead to autonomic dysreflexia and a hypertensive crisis.
  - Emptied by intermittent or indwelling catheterization.
  - Antibiotic prophylaxis for the urinary tract is not advised.

- **Paralysis**
  - Frequent turning and padding of prominences and diligence by caretakers essential to protect insensate limbs.
  - Physical therapy started early to maintain range of motion in all joints to make seating and perineal care easier.
Non-Operative Treatment of Spine Injuries

- External immobilization options include:
  - Semi rigid cervical orthosis (i.e. Aspen Collar)
  - Halo device: Expect difficult transport
  - Sternal-occipital-mandibular immobilizer
  - Thoracic lumbar sacral orthosis and lumbar sacral orthosis devices (Best for stable injuries where it would be primary treatment)
    - Should not be worn during transport
    - May need Vacuum Spinal Board
  - Gardner-Wells Tongs

Operative Treatment of Spine Injuries

- Best, if possible, to delay to Role 4/CONUS and maintain spine immobilization until then.

- Patients who may benefit from in-theater surgery include:
  - Incomplete injuries (most likely to benefit).
  - Neurological deterioration.
  - Open CSF Leak.
  - Prolonged delay in transport.
  - Urgent reduction may improve degree of “root sparing” in cervical spinal cord injury.
In-theater Operations Risks

- Retrospective review of patients treated at Role 3 and Role 4
  - Role 3 with twice the perioperative complications as Role 4
  - Role 3 operations result in 23% patients needing additional spinal surgery vs. 0% at Role 4
In-theater Operations: Potential Benefits.

- Incomplete injuries
  - Staged laminectomy in setting of severe stenosis with progressive neurologic deficit with initial operation at Role 3 and stabilization at Role 4 resulted in neurologic improvement in 66% of patients.

- Open CSF leaks

- Theoretical benefits, but given most combat casualties have polytrauma, may not be true in military populations:
  - Early operation in-theater includes earlier mobilization: better DVT risk and improved pulmonary hygiene.
  - Better analgesia and protection of neural elements during transport.
Operative Treatment for Penetrating Spinal Injuries

- Penetrating injuries have potential cavitation and blast effects to spinal cord in addition to direct trauma which can’t be treated with operation.
  - Penetrating injuries with complete spinal cord injury SCI, even if no radiographic findings of penetration of the canal, do not benefit from operations.

- If instability present in spine, infectious risks and neurologic status are key factors in determining need and timing of operations.

- For an incomplete spinal cord injury with continued canal compromise, decompression, if attempted, should be done within 24-48 hours.
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References


Photos are part of the JTS image library unless otherwise noted.