Management of Spinal Cord Injury

by Thomas G. Saul, MD, FACS, in conjunction with the Joint Section on Neurotrauma and Critical Care of the American Association of Neurological Surgeons and Congress of Neurological Surgeons

General Principles

- The ABC priorities of trauma management take precedence. Bew protective of spinal cord injury when there is weakness, numbness, spine pain, head injury, high-velocity injury, and multisystem injuries.
- Careful handling of the patient is essential. Always suspect that a spinal fracture exists until an X-ray analysis is obtained and a fracture is ruled out. All injured patients who are comatose are presumed to have cervical spine fracture until it is ruled out.
- Because 10%-15% of patients with a spinal injury will have a second injury of the spine at another level, carefully immobilize and assess the entire spine.

Assessment and Initial Management

I. Maintain patient in the supine position and immobilize head, neck, and body by using:
   A. Semi-rigid plastic collar
   B. Long spine board

II. Assess respiratory status
   A. Establish airway, avoiding unnecessary movement of the head and neck
   B. Administer supplemental oxygen
   C. Obtain arterial blood gases
   D. Assess ventilation
   E. Support ventilation if needed:
      1. By intubation (2-man orotracheal or fiberoptic orotracheal)
      2. Consider cricoidotomy

III. Assess circulation
    A. Monitor blood pressure continuously
    B. If hypotensive, differentiate hypovolemic shock (BP<80, HR>110) from neurogenic shock (BP<80, HR<110)
    C. Replace fluids if there is hypovolemic shock
    D. If spinal cord injury is present, fluid resuscitation should be guided by central venous pressure monitoring; some patients may need intracardiac support

IV. Assess neurologic status
    A. Establish level of consciousness (Glasgow Coma Scale)
    B. Palpate the entire spine posteriorly without moving the patient
    C. Document neuroexamination (Glasgow Coma Scale)
       1. Test sensation to pinprick in all dermatomes (see sensory chart; record the most caudal dermatome that feels pinprick)
       2. Check motor function (see motor examination chart)

Radiologic Investigation*

I. Cervical spine
   A. Order cross-table lateral cervical spine X-ray study first; all seven cervical vertebrae and C7-T1 junction should be seen; to do so may require:
      1. Firmly pulling down patient's shoulders, without movement of the neck; or
      2. Lateral swimmer's view
   B. Order anterior/posterior cervical X-ray and an open-mouth odontoid X-ray, if possible
   C. Specifically look at (see C-spine X-ray to correlate numbers below):
      1. All 7 cervical vertebrae
      2. Shape, size, and alignment of vertebral bodies
      3. Pro-vertebral swelling
      4. Position and integrity of the odontoid process
      5. Orientation and clarity of facet joints
      6. All 7 spinous processes
      7. Alignment of the spinolaminar lines
      8. Relationship to occiput to C1

II. Thoracic spine
   A. Order lateral and anterior/posterior X-rays
   B. View all thoracic vertebrae

III. Lumbar spine
   A. Order lateral and anterior/posterior X-rays
   B. View all lumbar vertebrae

IV. Standard chest and abdominal X-rays

*Warning: Even with this conscientious X-ray survey, some spine fractures may go undiagnosed. Continue index of suspension in high-risk groups.

Further Treatment

(with neurosurgical and/or orthopaedic consultation)

I. Immobilization, Protective devices (that is, cervical collar, spine board) must not be removed until X-rays have been reviewed and spinal injury has been ruled out.
II. Corticosteroids should be given to patients with neurologic deficits if treatment can be started within 8 hours of injury: methylprednisolone IV, bolus dose of 30 mg per kg of body weight over 15 minutes, followed by maintenance dose of 5.4 mg per kg per hour for 23 hours if treatment can begin within 3 hours of injury, and for 48 hours if treatment is begun between 3 and 8 hours of injury.
III. Consider removing from spine board to prevent decubitus ulcers. Log-roll patient until entire spine is cleared.
IV. Intravenous fluids. Limit to appropriate levels.
V. Bladder catheterization.
VI. Insert nasogastric tube in patients with para- or quadriplegia.

Motor Examination Chart

Motor Function

- Curl toes or push foot down (plantar flex)
- Bend great toe toward heel (dorsiflex)
- Extend leg or straighten and lock knee
- Flex leg at hip or raise knee to chest
- Spread fingers
- Flex wrist
- Extend forearm or straighten elbow (triceps)
- Flex forearm or bend elbow (biceps)
- Raise elbow to shoulder level (deltoii)

Reflex Chart

<table>
<thead>
<tr>
<th>Biceps</th>
<th>Triceps</th>
<th>Patellar</th>
<th>Achilles</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5-C6</td>
<td>C6-C7</td>
<td>L4</td>
<td>S1</td>
</tr>
</tbody>
</table>

This publication is designed to offer information suitable for use by an appropriately trained physician. The information provided is not intended to be comprehensive or to offer a defined standard of care. The user agrees to release and indemnify the American College of Surgeons from claims arising from use of this publication.

©1998 American College of Surgeons
Radiologic Investigation*

I. Cervical spine
   A. Order cross-table lateral cervical spine X-ray study first; all seven cervical vertebrae and C7-T1 junction should be seen; to do so may require:
      1. Firmly pulling down patient's shoulders, without movement of the neck; or
      2. Lateral swimmer's view
   B. Order anterior/posterior cervical X ray and an open-mouth odontoid X ray, if possible
   C. Specifically look at (see C-spine X ray to correlate numbers below):
      1. All 7 cervical vertebrae
      2. Shape, size, and alignment of vertebral bodies
      3. Pre-vertebral swelling
      4. Position and integrity of the odontoid process
      5. Orientation and clarity of facet joints
      6. All 7 spinous processes
      7. Alignment of the spinolaminar lines
      8. Relationship to occiput to C1

II. Thoracic spine
   A. Order lateral and anterior/posterior X rays
   B. View all thoracic vertebrae

III. Lumbar spine
   A. Order lateral and anterior/posterior X rays
   B. View all lumbar vertebrae
   IV. Standard chest and abdominal X rays

*Warning: Even with this conscientious X-ray survey, some spine fracture may go undiagnosed. Continue index of suspension in high-risk groups.

Further Treatment

(with neurosurgical and/or orthopaedic consultation)

I. Immobilization. Protective devices (that is, cervical collar, spine board) must not be removed until X rays have been reviewed and spinal injury has been ruled out.

II. Corticosteroids should be given to patients with neurologic deficits if treatment can be started within 8 hours of injury: methylprednisolone IV, bolus dose of 30 mg per kg of body weight over 15 minutes, followed by maintenance dose of 5.4 mg per kg per hour for 23 hours if treatment can begin within 3 hours of injury, and for 48 hours if treatment is begun between 3 and 8 hours of injury.

III. Consider removing from spine board to prevent decubitus ulcers. Log-roll patient until entire spine is cleared.

IV. Intravenous fluids. Limit to appropriate levels.

V. Bladder catheterization.

VI. Insert nasogastric tube in patients with para- or quadriplegia.

Motor Examination Chart

<table>
<thead>
<tr>
<th>Motor Function</th>
<th>Nerve Root Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curl toes or push foot down (plantar flex)</td>
<td>S1</td>
</tr>
<tr>
<td>Bend great toe toward head (dorsiflex)</td>
<td>L5</td>
</tr>
<tr>
<td>Extend leg or straighten and lock knee</td>
<td>L3, L4</td>
</tr>
<tr>
<td>Flex leg at hip or raise knee to chest</td>
<td>L1, L2</td>
</tr>
<tr>
<td>Spread fingers</td>
<td>T1</td>
</tr>
<tr>
<td>Flex wrist</td>
<td>C8</td>
</tr>
<tr>
<td>Extend forearm or straighten elbow (triceps)</td>
<td>C7</td>
</tr>
<tr>
<td>Flex forearm or bend elbow (biceps)</td>
<td>C6</td>
</tr>
<tr>
<td>Raise elbow to shoulder level (deltoid)</td>
<td>C5</td>
</tr>
</tbody>
</table>

Reflex Chart

<table>
<thead>
<tr>
<th>Reflex Test</th>
<th>Spinal Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps</td>
<td>C5–C6</td>
</tr>
<tr>
<td>Triceps</td>
<td>C6–C7</td>
</tr>
<tr>
<td>Patellar</td>
<td>L4</td>
</tr>
<tr>
<td>Achilles</td>
<td>S1</td>
</tr>
</tbody>
</table>