Chapter 6: Spine and Spinal Cord Trauma

Objectives:

Upon completion of this topic, the physician will be able to identify principles of management, demonstrate the ability to assess spinal trauma, and apply immobilization techniques for patients with vertebral and/or spinal cord injuries.

Specifically, the physician will be able to:

A. Discuss the principles in evaluating vertebral and spinal cord trauma.

B. Identify the types of vertebral injuries and outline methods of treatment.

C. Given a simulated patient with suspected cervical vertebral and spinal cord injuries, demonstrate the ability to assess and manage the multiply injured patient.

D. Given a simulated patient with suspected cervical vertebral and spinal cord injuries and appropriate equipment, apply techniques to immobilize the neck and spine safely.

E. Given a series of roentgenograms depicting cervical spine injuries, outline anatomic assessment principles and techniques for detecting abnormalities.
I. Introduction

The physician must be continually cognizant that injudicious manipulation or movement, and inadequate immobilization can cause additional spinal injury and decrease the patient's overall prognosis.

Vertebral injuries may be present without spinal cord injury. However, the potential for cord injury is always present, and careful patient handling is essential. A vertebral column injury should be presumed and immobilization of the entire patient should be maintained until screening roentgenograms are obtained and fractures or fracture-dislocations are excluded. Under many circumstances it is not possible to obtain appropriate roentgenograms of the spine during the initial evaluation of the patient for technical reasons without causing undue delay in the management of serious injuries. Under these circumstances, the physician should maintain continued immobilization of the patient until more specialized help is available. It is important for the physician to keep in mind that as long as the patient is immobilized, clearance of the spine may be deferred safely, especially in the presence of systemic instability (eg, hypotension, respiratory inadequacy). It is the movement of the nonimmobilized patient with unrecognized, unstable vertebral column injuries that places the spinal cord at risk of damage.

II. History of Injury

Knowledge of the patient's neurologic condition prior to injury is very important. A description of how the patient sustained the injury is significant in order to understand the mechanism of injury and potential for further injury. Prehospital care personnel can provide valuable information, eg, presence of paralysis immediately postinjury or deterioration of the patient's sensorimotor status. This information is essential to assess and document the site and extent of injury and/or the paralysis present.

Any patient sustaining an injury above the clavicle or a head injury resulting in an unconscious state should be suspected of having an associated cervical spinal column injury. Any injury produced by high-speed vehicles should arouse suspicion of concomitant spine and spinal cord injury.

III. Assessment

A. General

Examination of any suspected case of spinal injury must be carried out with the patient in a neutral position and without any movement of the patient's spine. The neck and trunk must not be flexed, extended, or rotated. The patient should be brought to the emergency department properly immobilized. Although a semirigid cervical collar is useful, securing the head to a spine board and bolster-splinting the neck is more effective. The entire patient should be left immobilized until roentgenograms are taken to exclude vertebral fractures. If the patient must be moved from the spine board, for examination or treatment, a scoop-style stretcher should be used. (See Skill Station XI, Immobilization Techniques for Neck and Spinal Trauma.)
Total spinal immobilization is the goal. Not only the head and neck, but also the chest, pelvis, and lower extremities must be immobilized securely to provide protection to the thoracic and lumbar segments of the spinal column.

A conscious patient with paralysis is usually able to identify pain at the site of injury, because loss of sensation is below this level. As the spine is carefully palpated, listen to the patient and watch his face for signs of pain. Remember, paralysis and loss of sensation may mask intra-abdominal and lower-extremity injuries.

If the patient is unconscious, and the injury is due to a fall or a vehicular collision, the chance of a cervical spine injury is 5% to 10%. Clinical findings that suggest a cervical cord injury in the unconscious patient include:

1. Flaccid areflexia, especially with flaccid rectal sphincter.
2. Diaphragmatic breathing.
3. Ability to flex, but not extend the elbow.
4. Grimaces to pain above, but not below the clavicle.
5. Hypotension with bradycardia, especially without hypovolemia.
6. Priapism, an uncommon but characteristic sign.

All information obtained from the neurologic examination is carefully documented on the chart for easy identification of any changes. In the paralyzed patient, any movement or sensation at or below the level of the injury is important and may affect the prognosis.

Early consultation with a neurosurgeon and/or orthopedic surgeon is essential. Specific types of neurologic deficit are important only to establish that an injury is present. Once established, consultation and transfer to an institution with neurosurgical and/or orthopedic capabilities are essential.

Spinal immobilization should be continued until removed by the neurosurgical or orthopedic consultant. This usually occurs when no roentgenographic abnormality has been documented, and no symptoms or signs relating to the spine or cord exist.

B. Vertebral Assessment

Vertebral injuries usually are associated with local tenderness, and less often, with palpable deformity. Careful examination of the entire spine from the occiput to sacrum should begin with the patient in a supine position. To visually examine the back, the patient may be log-rolled, but only to the minimum degree necessary to permit the examination. This modified log-roll procedure requires the aid of at least four assistants - one to maintain manual, in-line immobilization of the patient’s head and neck, one for the torso (including the hips and pelvis), one for the legs, and one to direct the procedure and remove the spine board. (See Skill Station XI, Immobilization Techniques for Neck and Spinal Trauma.)

The physicians could assess for pain, tenderness, and a posterior "step-off" deformity. Pain usually will be localized when an injured spine is palpated, but the pain may radiate to the arms, around the chest and abdomen, or into the lower extremities. Other diagnostic signs and symptoms include prominence of spinous processes, local tenderness, pain with attempted
motion, edema, ecchymosis, visible deformity, and muscle spasms. The physicians should also
assess for tracheal tenderness or deviation and retropharyngeal hematoma. The position of the
head should be noted for muscle spasm and head tilt. These symptoms also help identify and
localize the site of injury.

C. Neurologic Assessment of Spinal Cord Injury

The patient is carefully examined for motor strength and weakness, sensory
disturbances, reflex changes, and autonomic dysfunction. Autonomic dysfunction is identified
by lack of bladder and rectal control and priapism.

Of the many tracts in the spinal cord, only three can be readily assessed clinically.
Each is a paired tract that may be injured on one or both sides of the cord. The corticospinal
tract, in the posterolateral aspect of the cord, controls motor power on the same side of the
body and is tested by voluntary muscle contractions or involuntary response to painful
stimulus. The spinothalamic tract, in the anterolateral aspect of the cord, transmits pain and
temperature sensation from the opposite side of the body. It is tested by pinch or pin prick.
The posterior columns carry proprioceptive impulses from the same side of the body and are
tested by position sense of the fingers and toes or tuning fork vibration.

No demonstrable sensory or motor function is exhibited with a complete spinal cord
lesion. This situation is dismal, because the chance of useful recovery is small. Incomplete
spinal cord lesions differ considerably, because recovery can occur. Therefore, a careful
examination to determine the presence of any sensory or motor function is essential.

Superficial (pin-prick) or deep pain discrimination indicates an incomplete lesion and
lateral column preservation. Because the sensation of light touch is conveyed in both the
lateral and posterior columns, it may be the one sensory modality preserved when all other
sensations are absent. Sparing of sensation in the sacral dermatomes may be the only sign of
incomplete injury. To assess sacral sparing, gently lift the leg and assess the anal, perianal,
and scrotal areas. The evaluation for sacral sparing should include sensory perception and
voluntary contraction of the anus.

D. Neurogenic and Spinal Shock

Neurogenic shock results from impairment of the descending sympathetic pathways
in the spinal cord, the results of which are loss of vasomotor tone, and loss of sympathetic
innervation to the heart. The former causes vasodilatation of visceral and lower extremity
vessels, pooling of blood intravascularly, and consequent hypotension. As a result of loss of
cardiac sympathetic tone, the patient may fail to become tachycardic or may be even
bradycardic. Therefore, the combination of hypotension and bradycardia due to neurogenic
shock is not due to true hypovolemia. The blood pressure is not usually restored by fluid
infusion alone, and thus aggressive attempts to treat the hypotension of neurogenic shock by
fluid replacement alone may result in fluid overload. The blood pressure often can be restored
by the judicious use of vasopressors. This is an exception to the general guideline of not using
vasopressors for the treatment of shock. Atropine may be used to counteract the bradycardia.
(See Chapter 3, Shock.)
Spinal shock refers to the neurologic condition shortly after spinal cord injury. The "shock" to the injured cord may make it appear completely functionless, even though all areas are not permanently destroyed. This produces flaccidity and loss of reflexes instead of the expected spasticity, hyperactive reflexes, and Babinski signs. Days to weeks later, spinal shock disappears and in areas where no function has returned, spasticity supersedes the flaccid state.

E. Effect on Other Organ Systems

Hypoventilation due to paralysis of the intercostal muscles will result from an injury involving the lower cervical or the upper thoracic spinal cord. If the upper or the middle cervical spinal cord is injured, the diaphragm also will be paralyzed due to involvement of the C-3 through C-5 spinal cord segments, where the motor nerve cells that innervate the diaphragm (via the phrenic nerve) are located. Abdominal breathing and the use of the respiratory accessory muscles will be evident in both instances. The inability to feel pain may mask a potentially serious injury elsewhere in the body, such as the usual signs of an acute abdomen.

F. Roentgenograms

A lateral c-spine roentgenogram should be obtained for every patient sustaining an injury above the clavicle, especially a head injury. In addition, films of the thoracic and lumbar sections of the spine should be obtained for any patient suspected of sustaining a multiple trauma, especially to the trunk. The finding of a c-spine injury mandates radiologic examination of the entire spinal column.

1. Cervical spine

Lateral c-spine roentgenograms should be obtained as soon as life-threatening problems are identified and controlled. The base of the skull, all seven cervical vertebrae, and the first thoracic vertebrae must be visualized. The patient's shoulders are pulled down routinely when obtaining the lateral c-spine roentgenogram to prevent missing fractures or fracture-dislocations in the lower c-spine. If all seven cervical vertebrae are not visualized with the lateral roentgenogram, a lateral swimmer's view of the lower cervical and upper thoracic area may be obtained.

After adequate demonstration of all seven cervical and the first thoracic vertebrae, the physician can obtain chest and open-mouth odontoid roentgenograms. Other roentgenograms that can be obtained after the first hour to further evaluate the c-spine include anteroposterior (AP) and oblique cervical views. These or more sophisticated studies should be done for any patient with a normal crosstable lateral roentgenogram who is suspected (either by signs and symptoms or by mechanism of injury) of having cervical injury, because even the best portable films miss 5% to 15% of the injuries. A computed tomographic (CT) scan may be needed to determine the presence of bone fragments within the spinal canal. Alternatively, tomograms may be obtained to confirm a c-spine injury and determine its stability. Lateral flexion and extension roentgenograms of the cervical spine may be dangerous and should be done under the direct supervision and control of a knowledgeable physician.
2. Thoracic and lumbar spine

Anteroposterior films of the thoracic and lumbar areas of the spine are standard. Because the crosstable lateral diameter of the body is usually greater than the AP diameter, most portable roentgenographic equipment used in emergency departments provide better bony definition in the AP view. Subsequent films may be obtained in the more elective environment of the radiology department. Oblique thoracic films seldom add further information. Lateral and oblique films of the lumbar spine are obtained if indicated.

IV. Types of Spinal Injuries

A. Fractures and Fracture-Dislocation of the Spine

Roentgenograms of the cervical spine should be examined for:

a. Anteroposterior diameter of the spinal canal.

b. Contour and alignment of the vertebral bodies.

c. Displacement of bone fragments into the spinal canal.

d. Linear or comminuted fractures of the laminae, pedicles, or neural arches.

e. Soft-tissue swelling.

During the early evaluation of the patient with suspected thoracic and/or lumbar injuries, it usually is sufficient to view only AP films of the vertebral column. These films should be examined for:

f. Bilateral symmetry of the pedicles.

g. Height of the intervertebral space.

h. Central alignment of the spinous processes.

i. Shape and contour of the vertebral bodies.

j. Alignment of the vertebral bodies, should a lateral film be available.

1. Cervical spine injuries

Cervical spine injuries result from any one or a combination of these mechanisms of injury: (1) axial loading; (2) flexion; (3) extension; (4) rotation; (5) lateral bending; and (6) distraction. Cervical spine injuries resulting in unstable fractures, fracture-dislocations, and/or cord injury require transfer to a definitive-care facility. When in doubt, consult with a neurosurgeon or orthopedic surgeon.
a. C-1 (atlas) fracture

A fracture of C-1 (atlas) usually involves a blowout of the ring (Jefferson fracture). The mechanism of injury of a C-1 fracture is usually an axial load. It appears as a fracture of the lamina on the lateral roentgenogram and is seen best on an open-mouth view of the C-1 and C-2 area. **Remember, one third of these fractures are associated with a C-2 fracture.** They usually are not associated with cord injuries. However, they are unstable and should be treated initially with the application of a semirigid cervical collar and immobilization of the entire patient on a long spine board.

b. C-1, rotary subluxation

This injury is diagnosed by an odontoid-view roentgenogram. The odontoid will not be equidistant from the two lateral masses of C-1, because of the rotation of the ring of C-1 with reference to the odontoid. This injury is most often seen in children. The patient appears with a torticollis or persistent rotation of the head with reference to the neck. The child should not be forced to overcome the rotation. Rather, he should be immobilized in place and treated. Treatment of subluxation injuries is usually best managed in a definitive-care facility.

c. C-2, odontoid dislocation

Injuries to C-2 may displace the odontoid posteriorly into the spinal canal. Odontoid subluxation occurs because of injury to the transverse ligament that attaches the odontoid to the anterior arch of C-1. Bony injury may not occur, but this diagnosis should be considered whenever the space between the anterior arch of C-1 and the odontoid is greater than 3 mm. Displacement can occur **without** cord injury due to Steel's "Rule of Three": *one third of the spinal canal in the region of the atlas is occupied by the odontoid, one third is occupied by an intervening space, and one third is occupied by the spinal cord.* Room posterior to the odontoid is thus available for displacement. However, this situation is dangerous because excessive head motion can transect the cord. Head and spine immobilization is critical.

d. C-2, odontoid fractures

Three types of fractures may be associated with the odontoid. All can be very difficult to see on routine roentgenograms. If suspected, more views, tomograms, or CT are needed.

1) **Type I** usually occurs above the base of the odontoid and is most often stable.

2) **Type II** occurs at the base of the odontoid and is usually unstable. **Remember**, in children younger than six years, the epiphysis may be present and may appear as a fracture at this level.

3) **Type III** is a fracture of the odontoid that extends into the vertebral body.

Patients with Type I fractures may be treated with a semirigid cervical collar or brace. However, patients with all types should be transported to a definitive-care hospital for further evaluation and possible surgical intervention or halo immobilization.
e. Posterior element fracture of C-2

The "Hangman's Fracture" (name derived from judicial hangings) involves the posterior elements of C-2. The mechanism of this injury is extension and distraction or extension and axial compression. This is an unstable fracture. Patients with a "Hangman's Fracture" should not be placed in cervical traction if the mechanism of injury is secondary to distraction. Rather, such patients should be maintained in external immobilization and transferred to a definitive-care facility.

f. C-3 through C-7, fractures and fracture-dislocations

Various combinations of fractures and/or fracture-dislocations may be seen in C-3 through C-7. The mechanism of injury in stable fractures is usually flexion axial loading, extension axial loading, or flexion rotation injuries.

When examining a lateral c-spine film assess the distance between the pharynx and the anterior/inferior border of C-3. The soft-tissue prevertebral thickness at this level should be less than 5 mm between the pharynx and vertebral body. An increase in this area of density is indirect evidence of a vertebral fracture, notoriously associated with a minimally displaced C-2 fracture.

Children normally have prevertebral thickness that is two thirds of the vertebral thickness of C-2. The distance will vary with inspiration and expiration. When assessing for a hematoma at this level in children, remember that forced expiration or crying increases the distance between the pharynx and the anterior/inferior border of C-3.

Below the larynx, the tracheal air shadow is further from the anterior vertebral bodies because of the interposition of the esophagus. The best rule for prevertebral hematoma in this area is that the distance to the air shadow should be less than the width of the vertebral body.

Patients with unstable vertebral injuries of C-3 through C-7 require transfer to a definitive-care hospital. Typically, these patients include those with one or more of the findings listed herein:

1) A fracture identified by disruption of the anterior and all of the posterior elements.

2) A fracture with overriding of a superior vertebra on the adjoining inferior vertebra by more than 3.0 mm.

3) A fracture with angulation between two adjoining vertebra greater than 11 degrees.

g. Facet dislocations

Facet dislocations also may produce an unstable vertebral injury, especially bilateral facet dislocations. Consider a unilateral facet dislocation if the superior vertebra is displaced on the adjoining inferior vertebra by 25%. Consider a bilateral facet dislocation if displacement is greater than 50%. Malalignment of the cervical spinous processes on an AP roentgenogram also is suggestive of unilateral facet dislocation.
2. Cervical spinal cord injuries

A bony fleck off the superior aspect of the vertebral body demonstrates an extension-type injury. It usually is stable and does not involve cord damage. The classic tear-drop sign may be seen with a bone chip off the anterior/inferior aspect of the vertebral body. Cord injuries are often associated with this radiographic tear-drop finding, an ominous sign that may indicate displacement of the disc or posterior fragment of the vertebral body into the spinal canal.

Spinal cord injuries can occur in the c-spine with an otherwise stable compression fracture of the body, because the vertebral body collapses and is displaced posteriorly into the cord. These injuries may range from fracture of the body without displacement and cord damage, to severe vertebral disruption with complete paralysis.

3. Thoracic spine fractures (T-1 through T-10)

Fractures in this region are usually the result of hyperflexion that produces wedge compression of one or more vertebral bodies. The amount of wedging is usually quite small, and the anterior portion of the vertebral body is rarely more than 25% shorter than the posterior body. Because of the rigidity of the rib cage, most of these fractures are stable. Where the kyphosis exceeds 30 degree, internal stabilization probably will be required to prevent further deformity. The thoracic spinal canal is narrow in relation to the spinal cord, so that thoracic spinal cord injuries commonly are complete. If the deformity is associated with rotation, spinal cord injury is quite common.

4. Thoracolumbar fractures (T-11 through L-1)

Fractures at this level are frequently due to the relative immobility of the thoracic spine compared with the lumbar spine. They most often result from a combination of acute hyperflexion and rotation, and consequently they are commonly unstable. Because the spinal cord terminates at this level, the nerve roots that compose the cauda equina arise at the thoracolumbar junction. An injury at this level will produce bladder and bowel signs from spinal cord injury, and decreased sensation and movement in the lower extremities in various combinations from injury to the cauda equina. Because log-rolling may be destabilizing to this segment of the spine with fractures, this maneuver should be performed only to the minimal degree required under the circumstances to examine the patient's back.

5. Lumbar fractures

Disruption of the posterior ligaments by an acute hyperflexion injury in the lumbar region may produce an unstable vertebral column fracture. The neurologic signs associated with a lumbar fracture may be similar to those of a thoracolumbar fracture. However, lumbar fracture neurologic signs result only from involvement of the cauda equina, which include those nerve roots innervating the bladder.
B. Open Wounds

The most common of open spinal wounds are those caused either by missile injuries or stabblings. A bullet passing through the vertebral canal usually results in complete neurologic deficit. The physician should assess for CSF drainage from the wound. Hemopneumothorax, acute abdomen, or great vessel injury is often associated with an open spinal injury and takes precedence for treatment.

V. Treatment

A. Immobilization

Prehospital care personnel usually immobilize patients before their transport to the emergency department. Any patient with a suspected spine injury must be immobilized above and below the suspected injury site until injury has been excluded by roentgenograms. The proper technique for spinal immobilization is outlined in Skill Station XI. Remember, these protective devices must not be removed until absence of c-spine injury is documented. Proper immobilization is achieved with the patient in the neutral position, ie, supine without rotation or bending of the spinal column. It is necessary that proper padding be used to prevent the development of decubiti. Skin injury may occur after two hours of unprotected pressure. The more common sites of injury are the occiput and the sacrum.

Immobilization with a semirigid collar does not necessarily assure stabilization of the c-spine. Immobilization to a spine board with appropriate bolstering devices may be more effective in limiting certain neck motions. Cervical spine injury requires continuous immobilization of the entire patient with a semirigid cervical collar, backboard, tape, and straps before and during transfer to a definitive-care facility. Spinal curvature varies with the patient's age and any disease processes. Therefore, padding may be required beneath the shoulders of a pediatric patient and behind the head of an adult patient to avoid hyperextension or flexion of the neck. (See Skill Station XI, Immobilization Techniques for Neck and Spinal Trauma.)

Of special concern is the maintenance of adequate immobilization of the restless, agitated, or violent patient. This condition may be due to pain, confusion associated with hypoxia or hypotension, alcohol or drugs, or simply a personality disorder. The physician should search for and correct, if possible, the cause. If necessary, a sedative or tranquilizer, eg, chlorpromazine, may be administered, keeping in mind the need for adequate airway control and ventilation.

B. Intravenous Fluids

Intravenous fluids usually are limited to maintenance levels unless specifically needed for the management of shock. As a result of loss of cardiac sympathetic tone, the patient may fail to become tachycardic or may be even bradycardic. Hypovolemic shock usually can be differentiated from neurogenic shock by tachycardia in the former and bradycardia in the latter. If the blood pressure does not improve after a fluid challenge, the judicious use of vasopressors may be indicated. Overzealous fluid administration may cause pulmonary edema in a patient with a spinal cord injury. A urinary catheter is inserted to monitor urinary output.
and prevent bladder distention.

C. Medications

Proper limitation of fluid intake usually obviates the need for diuretics. The value of steroids is controversial; however, they are frequently used in the early management of spinal injuries. Steroids may be of value in certain patients with incomplete spinal cord injuries. Their use should be determined in consultation with a neurosurgeon. A management protocol should be established by prior consultation.

D. Transfer

Patients with unstable fractures or a documented neurologic deficit should be transferred to a definitive-care facility. For physicians who do not see such injuries routinely, the safest procedure is to transfer the patient after telephone consultation with a specialist. Avoid unnecessary delay. The patient's condition should be stabilized; necessary splints, backboards, and/or semirigid cervical collar should be applied; and the patient should be transferred under medical supervision. Remember, high c-spine injuries can result in partial or total loss of respiratory function. These patients are best managed by maintaining an adequate airway and ventilation. (See Chapter 2, Airway and Ventilatory Management.)

VI. Summary

A. Attend to life-threatening injuries, avoiding any movement of the spinal column.

B. Establish and maintain proper immobilization of the patient until vertebral fractures or spinal cord injuries have been excluded.

C. Obtain lateral c-spine roentgenograms as soon as life-threatening injuries are controlled.

D. Documentation of the patient's history and physical examination are of paramount importance to establish a baseline for any changes in the patient's neurologic status (ie, ascertaining progress or deterioration of an incomplete lesion).

E. Obtain consultation with a neurosurgeon and/or orthopedic surgeon.

F. Transfer patients with unstable vertebral fractures or spinal cord injury to a definitive-care facility.
Skill Station X: Roentgenographic Identification of Spine Injuries

Equipment and Resources

This list is the recommended equipment to conduct this skill session in accordance with the stated objectives for and intent of the procedures outlined. Additional equipment may be used providing it does not detract from the stated objectives and intent of this skill, or from performing the procedure in a safe method as described and recommended by the ACS Committee on Trauma.

1. Cervical, thoracic, and lumbar spine roentgenograms (available from the ACS, ATLS Division).

2. Identification key to roentgenograms.

3. View boxes to display films.

Objectives

1. Upon completion of this station, the participant will be able to identify various c-spine injuries by using four specific anatomic guidelines for examining a series of c-spine roentgenograms.
   a. Alignment.
   b. Bones.
   c. Cartilage.
   d. Soft-tissue space.

2. Upon completion of this station, the participant will be able to identify various thoracic and lumbar spine injuries by analyzing these areas:
   a. Alignment.
   b. Body contour.
   c. Disc space.
   d. Pedicles.
   e. Spinous processes.
   f. Canal.

3. Given a series of roentgenograms, the participant will be able to:
   a. Diagnose fractures.
   b. Delineate associated injuries.
   c. Define other areas of possible injury.
Skill Procedure: Roentgenographic Identification of Spine Injuries

Note: The guidelines outlined herein identify areas of the spine that should be assessed when examining a spine film. Each of these areas should be assessed for potential injury when viewing the roentgenograms associated with this skill station.

I. C-Spine Roentgenograms - Assessing for Injury

A. Identify Presence of All Seven Cervical Vertebrae and Superior Aspect of T-1

B. Anatomic Assessment

1. Alignment - Identify and assess the four lordotic curves.
   a. Anterior vertebral bodies.
   b. Anterior spinal canal.
   c. Posterior spinal canal.
   d. Spinous process tips.

2. Bone - Assess for:
   a. Vertebral body - contour and axial height.
   b. Lateral bony mass
      1) Pedicles.
      2) Facets.
      3) Laminae.
      4) Transverse processes.
   c. Spinous processes.

3. Cartilage - Assess for:
   a. Intervertebral discs.
   b. Posterolateral facet joints.

4. Soft-tissue spaces - Assess for:
   a. Prevertebral space.
   b. Prevertebral fat stripe.
   c. Space between spinous processes.

C. Assessment Guidelines for Detecting Abnormalities

1. Alignment
   a. Vertebral malalignment > 3.0 mm - dislocation.
   b. Anteroposterior spinal canal space < 13 mm - spinal cord compression.
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c. Angulation of intervertebral space > 11 degrees.

2. Bones

a. Vertebral body

1) Anterior height < 3 mm posterior height - compression fracture.
2) Oblique lucency - tear-drop fracture.

b. Lack of parallel facets of the lateral mass - possible lateral compression fracture.

c. Lucency through the tip of the spinous process - avulsion fracture.

d. Atlas and axis (C-1 and C-2)

1) Distance between posterior aspect of C-1 to anterior odontoid process > 3 mm - dislocation.

2) Lucency through the odontoid process of C-2 - fracture.

3. Soft-tissue space

a. Widening of the prevertebral space > 5 mm - hemorrhage accompanying spinal injury.

b. Obliteration of prevertebral fat strip - fracture at same level.

c. Widening of space between spinous processes - torn interspinous ligaments and likely spinal canal fracture anteriorly.

II. Thoracic and Lumbar Roentgenograms - Assessing for Injury

A. Anteroposterior View

Assess for:

1. Alignment.

2. Symmetry of pedicles.

3. Contour of bodies.

4. Height of disc spaces.

5. Central position of spinous processes.

B. Lateral View
Assess for:

1. Alignment of bodies/angulation of spine.
2. Contour of bodies.
4. Encroachment of body on canal.

III. Review Spine Roentgenograms
Skill Station XI: Immobilization Techniques for Neck and Spinal Trauma

Equipment and Resources

This list is the recommended equipment to conduct this skill session in accordance with the stated objectives for and intent of the procedures outlined. Additional equipment may be used providing it does not detract from the stated objectives and intent of this skill, or from performing the procedure in a safe method as described and recommended by the ACS Committee on Trauma.

1. Live patient model (participants may serve as patients).
2. Semirigid cervical collar*.
3. Long spine board with straps*.
4. Rolled towels or similar bolstering devices*.
5. Blankets for padding.
6. Roller-type dressing/bandage.
7. Tape.
8. Scoop stretcher (optional).
9. Four assistants (three assistants in addition to the Instructor; participants may serve as assistants).

* Type of equipment used in individual locale.

Objectives

Upon completion of this station the participant will be able to:

1. Discuss and demonstrate the assessment techniques for examining a patient suspected of having neck and/or spinal injuries.
2. Discuss the principles and techniques for immobilizing the patient with neck and/or spinal injuries.
3. Demonstrate the proper method of immobilizing a patient with suspected neck and/or spinal injuries on a long spine board using the modified log-roll technique.
4. Discuss when and demonstrate how to transfer a patient with a possible spine injury from a long spine board to a firm, padded gurney or operating table.
5. Identify when the patient has been properly immobilized in accordance with the techniques and principles outlined during this skill station.

**Procedures**

1. Assessment of neck and spine injuries.

2. Patient immobilization and application of a long spine board using the modified log-roll technique.

3. Application and use of a scoop stretcher (optional skill).

**Note:** The procedures outlined in this skill station **must be taught by ATLS physician faculty.** Instructional assistants, eg, paramedic instructor, may assist with the application of these devices. This skill station is conducted in conjunction with Skill Station XII, Extremity Immobilization, Application of the Leg Traction Splint.
Skill Procedures: Assessment and Immobilization of Neck and Spine Injuries

Note: Universal precautions are required whenever caring for the trauma patient.

I. Assessment of Neck and Spine Injuries

A. Assess Respiratory Status

1. Airway patency - establish patent airway as needed while maintaining in-line immobilization of the c-spine.

2. Respiratory efforts.

B. Assess Patient's Level of Consciousness

C. Obtain Vital Signs

D. Palpate Cervical Spine

Note any abnormality and assess for:

1. Deformity.

2. Grating crepitus.

3. "Boggy" sensation.

4. Increased pain with palpation.

E. Assess for:

1. Pain
   b. Level of pain.
   c. Location of pain.

2. Paresis
   b. Level/location of paresis.

3. Paresthesia
b. Level/location of paresthesia.

4. Paralysis


b. Level/location of paralysis.

F. Continually reassess patient's status

II. Primary Management: Supine Patient

A. Application of Long Spine Board Using Modified Log-roll Technique

Note: Four individuals are needed to perform this modified log-rolling procedure: (1) one to maintain manual, in-line immobilization of the patient's head and neck; (2) one for the torso (including the pelvis and hips); (3) one for the pelvis and legs; and (4) one to direct the procedure and move the spine board. This procedure maintains the patient's entire body in neutral alignment, minimizing any untoward movement of the spine. This procedure assumes that suspected upper and lower extremity injuries are already immobilized.

1. Prepare the long spine board with straps, placing the board next to the patient's side. The straps are to be positioned for fastening later across the patient's thorax, just above the iliac crests, thighs, and just above the ankles. Straps or tape may be used to secure the patient's head and neck to the long board.

2. Apply gentle, in-line manual immobilization to the patient's head (assistant 1), and apply a semirigid cervical collar (assistant 2).

3. Gently straighten the patient's arms and place them (palm-in) next to the torso.

4. Carefully straighten the patient's legs, placing them in neutral alignment with the patient's spine. Gently, yet firmly, tie the patient's ankles together with roller-type dressing or cravat.

5. Assistant 1 continues to maintain alignment of the patient's head and neck. Assistant 2 reaches across the patient grasping the patient at the shoulder and wrist. Assistant 3 reaches across the patient grasping the patient's hip just distal to the wrist with one hand and with the other hand firmly grasps the roller bandage or cravat that is securing the ankles together.

6. At the direction of assistant 4 (Instructor), the patient is cautiously log-rolled as a unit toward the two assistants at the patient's side, but only to the minimal degree necessary to position the board under the patient.

a. Assistant 1 (at the patient's head) closely observes the log-rolling process and maintains neutral alignment of the patient's head and neck with the torso, avoiding any flexion or hyperflexion of the patient's neck.
b. Assistant 2 controls movement of the patient's torso and maintains neutral alignment of the thoracolumbar spine.

c. Assistant 3 helps to maintain neutral alignment of the patient's thoracolumbar spine and pelvis with his hand on the patient's hip. Additionally, the legs are maintained in neutral alignment with the torso by firmly grasping the cravat securing the patient's ankles together with the other hand, and elevating them approximately 4 to 6 inches. This latter maneuver helps to maintain neutral alignment of the lumbar spine and avoid pelvic tilt.

7. Assistant 4 (Instructor) places the long spine board beneath the patient.

8. Carefully log-roll the patient back as a unit onto the long board. At the same time, Assistant 4 (Instructor) helps to slide the patient into position in the center of the board. Extreme care is exercised by all assistants during this step to avoid untoward movement and maintain neutral alignment of the patient's spine.

9. The patient is then secured to the long board.

a. Assistant 1 continues to maintain in-line immobilization of the patient's head and neck.

b. Assistant 2 securely tightens two straps - one across the patient's upper arms and thorax, and a second just proximal to the iliac crests. The wrists are secured to the patient's sides by this second strap.

c. Assistant 3 securely tightens two straps - one across the patient's thighs, and one just above the ankles. Blanket rolls, placed on the outer sides of the patient's lower legs, may be required to prevent lateral movement of the lower extremities.

d. Assistant 4 (Instructor) places padding under the patient's head as necessary to avoid hyperextension and flexion of the neck.

e. Padding, rolled blankets, or similar bolstering devices are placed on either side of the patient's head and neck. The patient's head is secured firmly to the board by tightening a strap over the lower part of the forehead or using tape. Another strap or piece of tape is placed over the bolstering devices and cervical collar, further securing the patient's head and neck to the long board.

10. Pediatric considerations:

a. A pediatric-sized, long spine board is preferable when immobilizing the small child. If only an adult-sized board is available, blanket rolls are placed along the entire sides of the child to prevent lateral movement.

b. The child's head is larger proportionately to his torso than the adult's. Therefore, padding should be placed under the shoulders to elevate the head and maintain neutral alignment of the child's spine. Such padding extends from the child's lumbar spine to the top of the shoulders, and laterally to the edges of the board.
11. Complications

If left immobilized for any length of time on the long spine board, the patient may develop pressure sores at the occiput, scapulae, sacrum, and heels. Therefore, padding should be applied under these areas as soon as possible, and the patient should be removed from the long spine board as soon as his condition permits.

B. Removing a Patient From a Long Spine Board

Movement of a patient with an unstable vertebral injury may cause or permanently worsen a spinal cord injury. To reduce the risk of spinal cord damage, mechanical protection is necessary for all patients at risk. Such protection should be maintained until unstable spine injuries have been excluded.

1. As previously described, properly securing the patient to a long spine board is the basic technique for splinting the spine. Generally, this is done in the prehospital setting, so that the patient arrives at the hospital immobilized on a long spine board. The long spine board provides an effective splint and permits safe transfers of the patient with the smallest practical number of assistants. However, the unpadded spine board may soon become uncomfortable for a conscious patient and poses a significant risk for pressure sores on posterior bony prominences - occiput, scapulae, sacrum, and heels. Therefore, as soon as it can be done safely, the patient should be transferred from the spine board to a firm, well-padded gurney or equivalent surface. Before removing the patient from the spine board, c-spine, chest, and pelvis radiographs should be obtained as indicated.

2. A strategy should be developed, dependent upon the patient's needs and the institutional resources, to allow as many appropriate transfers as to be completed while the patient remains on the board. All the necessary assistants must be assembled before moving the patient. If a spine injury exists or is strongly suspected, orthopedic and/or neurosurgical consultation should be obtained first.

3. Safe movement of a patient with an unstable or potentially unstable spine requires continuous maintenance of anatomic alignment of the vertebral column. Rotation, flexion, extension, lateral bending, and shearing-type movements in any direction must be avoided. Manual, in-line immobilization best controls the head and neck. No part of the patient's body should be allowed to sag as the patient is lifted off the supporting surface. The transfer options listed herein may be used, depending on available personnel and equipment resources.

a. Modified log-roll technique

The modified log-roll technique, previously outlined, is reversed to remove the patient from the long spine board. Four assistants are required: (1) one to maintain manual, in-line immobilization of the patient's head and neck; (2) one for the torso (including the pelvis and hips); (3) one for the pelvis and legs; and (4) one to direct the procedure and remove the spine board.
b. Multi-hand or "fireman's" lift

This procedure may be used instead of log-rolling the patient. Six assistants are needed to maintain the spine in a neutral position while lifting an adult, supine patient off the board. One assistant maintains in-line immobilization of the patient's head and neck. Four assistants - two on each side of the patient's torso, pelvis, and legs - are required to slide their arms under the patient and grasp each other's wrists to provide adequate support to the entire patient when he is lifted. This procedure requires precise coordination by all assistants. The patient must be lifted in unison as directed by the sixth assistant who removes the spine board as soon as the patient is lifted clear of the board.

c. Scoop stretcher

An alternative to the preceding two techniques is use of the scoop stretcher for patient transfer.

C. Application and Use of the Scoop Stretcher to Transfer a Patient off the Long Spine Board (Optional Skill)

Note: The proper use of this device can provide rapid safe transfer of the patient from the long spine board onto a firm, padded patient gurney. Remember, after the patient is transferred from the back board to the gurney and the scoop stretcher is removed, the patient must be reimmobilized securely to the gurney. The scoop stretcher is not a device on which the patient is immobilized. Additionally, the scoop stretcher is not used to transport the patient, nor should the patient be transferred to the gurney by picking up only the foot and head ends of the scoop stretcher. Without firm support under the stretcher it can sag in the middle, resulting in loss of neutral alignment of the spine.

Five individuals are needed to assist with application of the scoop stretcher, patient transfer, and removal of the device: (1) one at the head of the patient; (2) one at the patient's feet; (3) one on the patient's left side; (4) one on the patient's right side; and (5) one to remove the long board from under the patient.

1. Adjust the scoop stretcher to the length of the patient, and separate it by disconnecting the split frame at both ends.

2. Disconnect the straps and tape used to secure the patient to the long spine board, leaving in place the cervical collar and other boltering devices used to immobilize the head and neck. Manually immobilize the patient, especially the head and neck. Once assistant 1 manually immobilizes the patient's head and neck it must not be released until the patient has been reimmobilized securely on the gurney.

3. With the straps and tape removed, place the left split frame on top of the long board to the patient's left side and the right frame to the patient's right side. The frames should be placed under any boltering devices used to immobilize the patient's head and neck.

4. Two assistants carefully slide the split frames beneath the patient, first one side then the other. The assistants should carefully slide their hands under the patient assuring that the
patient's clothing or skin will not be caught in the stretcher frame once it is locked into place.

5. With the two frames in place, reconnect the stretcher at both ends, securely locking the components.

6. Reimmobilize the entire patient on the scoop stretcher. Manual immobilization of the patient's head and neck can then be released.

7. A minimum of five assistants are required to transfer the patient off the long board - one at the head of the patient, one at the patient's feet, one on either side of the patient, and one to remove the board. With one assistant directing the transfer, carefully lift the scoop stretcher up as a unit approximately four inches. Assistant 5 quickly removes the long board. The patient is then lowered back onto the firm gurney.

8. Reapply manual immobilization, and remove the tape securing the patient's head and neck. Remove the straps securing the patient to the scoop stretcher.

9. Disconnect the locks at either end of the stretcher and gently remove the split frame, one side at a time.

10. **Im mobilize** the entire patient, as outlined in II.A., to the gurney.

11. This procedure and device can be used to transfer the patient from one transport device to another or to a previously designated place, eg, x-ray table. **Remember,** the patient must remain securely immobilized until a spine injury is excluded.

**III. Continued Management: Reassess the Patient's Status**