# INTRODUCTION

Trauma patients constitute an important subgroup that comes to our emergency department. The evaluation and management of cervical spine injuries is a core component of the practice of emergency medicine. The incidence of serious cervical spine injuries is low but associated rates of death and disability are high; therefore, the emergency physician must have a strong knowledge base to identify these injuries as well as clinical skills that will protect the patient's spine during assessment. Cervical spine injury causes an estimated 6000 deaths and 5000 new cases of quadriplegia in the United States each year.Males are affected 4 times as frequently as female. [(1)]

Two to three percent of blunt trauma patients who undergo cervical spine imaging are diagnosed with a fracture. The second vertebra is most commonly injured, accounting for 24% of fractures; the sixth and seventh vertebrae together account for another 39% of fractures.From a clinical perspective, it is crucial for the emergency physician to diagnose a fracture. Older age is an important risk factor for cervical spine injury: patients 65 years or older have a relative risk twice that of younger trauma victims.The associated mortality rate in this age group is 24 %.[(2-4)]

While cervical spine injury is more common in patients with multiple injuries, isolated injury may occur following comparatively minor traumatic incidents.A recent meta-analysis of 65 studies including almost 282 000 trauma patients, found that cervical spine injury occurs in 3.7% of patients overall, with 2.8% of alert patients and 7.7% of obtunded patients having an acute abnormality detected. Of the patients with cervical spine injury identified, 42% were found to have fracture, dislocation or pure disco ligamentous injury requiring external immobilization or operative stabilization. [(5, 6)]

The most common mechanisms of injury include motor vehicle collisions, falls, sporting/recreational pursuits and assaults. Injury results from hyperflexion, hyperextension, axial loading or rotational forces. Higher velocity or greater force magnitude equates with a greater risk of injury. However, injuries at low velocity or force can also occur, such as falls from a low height or low speed rear-end traffic collisions, particularly when cervical spondylosis is present. Potential serious injuries include vertebral body fracture, disc extrusion, cord contusion or compression, ligamentous rupture, epidural hematoma, facet displacement and vertebral or carotid arterial injury. [(7, 8)]

The presence of cervical spine injury is often overt, indicated by neurologic deficit or radio graphically demonstrated fracture or mal alignment. Other more subtle injuries, such as occult cervical soft tissue disruption, or associated vertebral or carotid arterial injuries can be difficult to detect, but may also result in permanent neurologic sequelae. However, spinal cord injury is a very rare occurrence and is most often associated with major trauma.[(7, 8)]

A disproportionate number of cervical spine injuries are associated with moderate and severe head injuries sustained in motor vehicle crashes. Head-injured patients are almost 4 times as likely to have a cervical spine injury as those without head injuries. Those at highest risk have an initial Glasgow Coma Scale (GCS) score of 8or lower and are likely to sustain unstable injuries in the high cervical spine.[(9)]

The early management of the patient with a potential cervical spinal cord injury begins at the scene of the accident. The chief concern during the initial management of patients with potential cervical spinal injuries is that neurologic function may be impaired due to pathologic motion of the injured vertebrae. It is estimated that 3% to 25% of spinal cord injuries occur after the initial traumatic insult, either during transit or early in the course of management. Multiple cases of poor outcome from mishandling of cervical spinal injuries have been reported.[10-17]

# Anatomy

The cervical spine consists of 7 cervical vertebrae, the spinal cord, intervertebral discs beginning at the C2-C3 interspace, a complex network of supporting ligaments, and neurovascular structures. General vertebral anatomy consists of an annular body and the vertebral arch, including the symmetric pedicles, laminae, superior and inferior articular surfaces, transverse processes, and a single posterior spinous process. The cervical vertebrae are smaller than their thoracic or lumbar counterparts, and each transverse process contains a foramen (transverse foramen). The first 2 and the seventh bones have exceptional anatomic features.[18]

The first cervical vertebra is called the atlas because it supports the head. Distinct from all other vertebrae, the atlas has no body and no spinous process; it is a ring-like structure with anterior and posterior arches separated by lateral masses on each side. The superior surfaces of the lateral masses articulate with the occipital condyles of the skull, forming the atlanto -occipital joint. Functionally, this joint allows 50% of neck flexion and extension. [18]

The second cervical vertebra, the axis, forms the surface on which the atlas pivots to allow lateral rotation of the head. The dens, also called the odontoid process, is the cranial extension of the body of the axis into the ring of the atlas; it is the most characteristic feature of C2. The dens articulates with the posterior aspect of the anterior ring of C1 and is stabilized by the transverse ligament. This articulation provides stability as the atlas pivots during rotation. Half of neck rotation occurs at this atlantoaxial joint. [18]

The distinctive feature of the seventh vertebra is its prominent spinous process. Its length extends beyond the other cervical vertebrae, rendering it palpable on physical examination. The seventh vertebra is the highest spinous process that is reliably identifiable, making it a useful landmark.The length and prominence of the spinous process predispose this vertebra to fracture. [18]

Intervertebral discs are interposed between the vertebral bodies from C2 down to the sacrum; they account for about 25% of the height of the spinal column. Structurally, discs are composed of a soft gelatinous center, the nucleus pulposus, surrounded by a cartilaginous ring of tissue (the annulus fibrosus). Functionally, discs provide support, elasticity, and cushioning to the spine. Intervertebral discs deteriorate with age; much of the gelatinous center is replaced with fibrous tissue, resultingin decreased elasticity and mobility. [19]

The cervical spine is connected and supported by a complex network of ligaments.Three of the most important are the anterior longitudinal ligament and the posterior longitudinal ligament, which extend from the occiput to the sacrum, and the

Ligamentum flavum. The anterior longitudinal ligament, connecting the anterior aspects of the vertebral bodies, becomes taut and resists hyperextension. The posterior, connecting the posterior aspect of the vertebral bodies, tightens and limits hyper flexion.The posterior longitudinal ligament forms the anterior surface of the spinal canal. The ligamentum flavum connects the laminae of adjacent vertebrae and forms the posterior surface of the spinal canal. This ligament is susceptible to thickening with age and may cause spinal stenosis, resulting in cord and nerve root compression. The interspinous ligaments are thin and membranous, and span the length of the spinous processes. (20)

The blood supply to the spinal column and cord is complex. The main spinal arteries consist of a single anterior and posterior vessels originating from the vertebral arteries; they run longitudinally from the medulla along the length of the cord. These arteries supply only the superior portion of the cord and are supplemented by segmental medullary arteries originating from the vertebral arteries in the cervical spine; they enter the spinal column through the intervertebral foramen. the anterior cervical artery, is particularly vulnerable to damage associated with hyperextension injuries. The result is ischemia to the anterior two-thirds of the cord, a devastating complication. (19)

When considering cervical spine anatomy in the clinical context, emergency physicians should think of the spinal column as 2 parallel entities. The vertebral bodies and associated intervertebral discs form the anterior column, which is stabilized by the anterior and posterior longitudinal ligaments. The posterior column containing the spinal cord and canal consists of the structures posterior to the anterior column: pedicles, transverse processes, superior and inferior articulating facets, laminae, and spinous process. The ligamentum flavum and the interspinous ligaments stabilize the posterior column. When only one column is injured, the other provides stability, substantially lowering the risk of spinal cord injury compared with when both are compromised. (21)

The widest portion of the spinal canal is from C1 to C3, where the mid-sagittal diameter ranges from 16 to 30mm.This diameter narrows from C4 to C7 to a range of from 14 to 23 mm. At this level, the spinal cord normally occupies 40% of the diameter of the canal in a healthy adult. Hyperextension decreases the canal diameter approximately 2 to 3 mm, which becomes clinically important in the context of hyperextension injury.The cervical spine, is vulnerable to trauma; injury occurs when forces applied to the head or neck overwhelms the anatomic stabilizers of the bony and ligamentous support structures. Degenerative changes resulting in spinal stenosis increase vulnerability to cord damage, particularly with hyperextension mechanisms. Fatal injuries are most common at the craniocervical junction or atlantoaxial level. (19)

## Pathophysiology

Cervical spine injuries can be considered by degree of mechanical instability. White and colleagues defined the concept physiologically and radio graphically. These investigators defined “stability” as limitation of displacement of the spine underapplied physiologic loads, which prevents spinal cord or nerve root damage. In the adult spine, instability may be diagnosed (radio graphically) when there is more than3.5 mm of displacement in the sagittal plane relative to an adjacent vertebra on resting radiographs or with flexion/extension views. This work led to a complex scoring system that may be applied to injuries that are not clearly stable or unstable. (22)

When evaluating patients in the emergency department, it is not always clear which fractures are stable. Some of the difficulty is the lack of a consistent convention for classifying cervical spine injuries. Some injuries are named, for example, the Jefferson, hangman, and clay shoveler's fracture. Others are described by mechanism of injury, pathologic lesion, or combinations of the two. Another source of confusion is lack of agreement among investigators about which injuries are stable. The reality is that each cervical spine injury is unique and its relative stability depends on individual factors such as the patient's age, associated injuries, and underlying health. It is useful to consider White's strategy of combining radiologic findings with response to physiologic stress when unsure. All but the most minor cervical spine fractures in the emergency department should be treated as unstable injuries until proven otherwise. [(22)]

# Axial Compression Injury

The Jefferson fracture is an unstable burst fracture of the atlas caused by severe axial compression. Diving is a common mechanism. The injury is characterized by unilateral or bilateral fractures of the anterior and posterior arches of C1. As an isolated injury, the Jefferson fracture is not usually associated with neurologic injury because of the width of the spinal canal at that level. However, when it is associated with rupture of the transverse ligament that stabilizes the odontoid to the anterior arch of C1, the Jefferson fracture is very unstable.Associated injuries may include damage to the vertebral artery and a second fracture at a lower level.A Jefferson fracture may be diagnosed on an open-mouthed odontoid view by noting displacement of the lateral masses of C1 relative to C2. Overhang of C1 of 6.9 mm over the lateral mass of C2 is diagnostic of a fracture.If this finding is not present but clinical suspicion remains, a computed tomography (CT) scan should be obtained. [(23-25)]

# Multiple or Complex Mechanism

Odontoid fractures may be 1 of 3 types. The mechanisms are mixed and often unclear. Flexion, extension, and rotation may contribute to the fractures. When evaluating odontoid trauma, emergency physicians should consider that the dens occupies one-third of the spinal canal, the spinal cord occupies another third, and the remaining third is empty space.[(24)]

A Type I fracture is an avulsion of the tip of the dens above the transverse ligament, thought to be an avulsion fracture from the alar ligaments. In isolation, this injury is usually not associated with instability or spinal cord injury; however, Type I odontoid fractures may be seen in association with atlanto-occipital dislocation. This extremely dangerous injury must be ruled out before conservative treatment is initiated. [(24)]

A Type II odontoid fracture, the most common of the 3, is localized to the base of the dens. Ten percent of these fractures are associated with damage to the transverse ligament. This complication represents very unstable injury associated with high mortality. Because of limited blood supply to the fractured dens, nonunion is high. Patients may be treated with halo immobilization or open surgery. Risk factors for nonunion are age older than 50 years and displacement of the fracture. Hadley and colleague reported that displacement of 6 mm or more correlated with a 67%rate of nonunion compared with 26% when displacement was less than 6 mm. [(24, 26, and 27)]

A Type III fracture extends into the body of C2. It is a mechanically unstable injury because it allows the atlas and occiput to move as a unit. Nonunion is uncommon. Most patients are successfully managed with halo immobilization. (26)

## Flexion Mechanism

Among flexion injuries of the cervical spine, the 2 most unstable are the flexion tear drop fracture and the bilateral facet dislocation. The flexion tear drop is a devastating injury in which substantial force is required to fracture the anterior inferior aspect of the vertebral body. Common mechanisms are motor vehicle crashes and diving. For the tear drop fracture to occur there must be disruption of the ligaments of the posterior column, displacing the vertebral body posteriorly into the spinal canal.Neurologic injury is very common. The result is often the anterior cord syndrome, manifesting as quadriplegia and loss of pain and temperature sensation. The most common level for a teardrop fracture is C5. (24)

Bilateral facet dislocation is the most severe form of anterior subluxation. At the subluxed level, the inferior facets dislocate superiorly and anteriorly to the superior articulating facets of the lower vertebra, causing complete anterior and posterior longitudinal ligamentous disruption. Subluxation of more than 50% will be seen on a lateral radiograph. Neurologic injury is common. (24)

Less devastating flexion injuries of the cervical spine include wedge fractures, anterior subluxations, and clay shovelers fractures (an avulsion fracture of the spinousprocess of C7).

These injuries are usually stable, without neurologic deficit.An anterior subluxation must be evaluated very carefully to rule out disruption of posterior ligaments. (24)

## Extension Mechanism

Hangman’s fracture is a fracture of the pedicles of the axis or second cervical vertebra. The usual mechanism of injury is extreme hyperextension during a diving accident or motor vehicle collision. This fracture is considered unstable because of its location, but spinal cord injury is not common because the spinal canal is widest at C2. The pedicle fracture allows decompression of the canal, preventing pressure on the spinal cord.(23)

The extension teardrop fracture is a potentially unstable injury caused by neckextension. The most common location is C2. This fracture is radio graphically similar to the flexion teardrop fracture; however, the pathophysiology and mechanismof injury are different. In forced hyperextension, tension on the anterior longitudinal ligament causes avulsion of the anterior inferior aspect of the vertebral body. Neurologic injury is usually not severe, but it is extremely important to prevent neck extension and thus avoid injury to the anterior ligament. When the extensor teardrop occurs at lower levels, typically C5 to C7, central cord syndrome may be caused by buckling of the ligamentum flavum into the cord (24, 28)

## Vertebral Artery Injury

Vertebral artery occlusion complicates 17% of cervical spine fractures.The cause of occlusion is usually vasospasm or dissection. Most unilateral injuries are not symptomatic because collateral blood is supplied through the Circle of Willis. When present, typical clinical findings are vertigo, unilateral facial paresthesia, cerebellar signs, lateral medullary signs, and visual field defects.The clinical significance of dissection is the predisposition to thrombus formation, leading to basilar stroke. Cothren and colleagues note a consistent 20% stroke rate in untreated patients. [29-31]

Cervical spine injuries at high risk for vertebral artery injury are fractures associated with subluxation, transverse process fractures extending into the foramen transversarium, and fractures of C1 to C3. Patients with these injuries should be screened for vertebral artery injury.The gold standard test has been 4-vessel cerebrovascular angiography.The increasing availability of multi slice CT scans has improved the accuracy of CT angiography for identification of vertebral artery injury. [32, 33]

## Spinal cord injury without radiographic abnormality

Most often a spinal cord injury is associated with radiographic findings such as fractures, ligamentous injuries, or subluxations. However, a spinal cord injury can occur when bony abnormalities are not present. Spinal cord injury without radiographic abnormality (SCIWORA) is defined as the presence of a spinal cord injury on magnetic resonance imaging (MRI) in the absence of a fracture or subluxation on CT or plain radiography. [34, 35]

Most studies limit SCIWORA to injuries of the spinal cord, not justa neurologic deficit that can also represent a peripheral nerve injury or a brachial plexus injury. Once thought to be a finding primarily in children, SCIWORA has now been found to occur more often in adults. A retrospective review of the NEXUS data found that 3.3% of adult patients had SCIWORA, similar to the 4.2% prevalence documented in another more recent retrospective study. [34, 35]

## Spinal and neurogenic shock

Spinal shock is the phenomenon of loss of reflexes and sensorimotor function below the level of a spinal cord injury. It manifests as flaccid paralysis, including the loss of bowel and bladder reflexes and tone. Spinal shock is a temporary physiologic response to trauma that lasts from hours to days. The degree of recovery depends on the extent of the initial insult. Even with severe injury, patients will recover spinal cord reflex arcs such as the bulbocavernosus and anal wink. [36]

Neurogenic shock refers to hemodynamic instability that occurs in high spinal cord injury, including cervical cord and T1-T4. The 3 major manifestations are hypotension, bradycardia, and hypothermia. Hypotension is the result of sympathetic denervation that causes loss of arteriolar tone and results in venous pooling. Bradycardia occurs with interruption of cardiac sympathetic, allowing unopposed vagal stimulation. A neurogenic source of shock is suggested by the combination of hypotension and bradycardia or variable heart rate response.Loss of autonomic regulation occurs in high spinal injuries, contributing to hemodynamic instability and altered thermoregulation, typically manifesting as hypothermia. [37, 38, 39]

## Prehospital management

Emergency medical services systems (EMS) have one basic principle: deliver fast and efficient patient care for prompt transfer to a hospital. When managing cervical spine injuries, on-scene EMS personnel must rapidly triage patients and attend to the most critical injuries. When performing the initial evaluation, the ABCDEs (airway, breathing, circulation, disability, and exposure) should be monitored first. The airway must be secured before proceeding with the initial evaluation. If the airway needs immediate attention, manual in-line stabilization should be maintained at all times.[40]

The first responder must always assume that an injured patient has a spinal cold injury until proven otherwise. The initial insult causes the most damage to the cervical spine, and caution must be taken to prevent further injury. Good immobilization techniques prevent secondary injury and prevent the initial insult from progressing. [40]

EMS personnel follow protocols when approaching a patient with a potential cervical spine injury. The first step is to survey the scene and ensure that it is safe to approach the patient. After securing the ABCs, the EMS provider can move on to the secondary survey, assessing the extent of injuries. For any trauma patient, EMS providers follow standard immobilization procedures. The physician who receives the patient in an emergency department will see various types of immobilization.The most common are the backboard, the rigid cervical collar, spider straps, and head blocks. The most important point is to secure the patient to the backboard to minimize movement in case the patient vomits and needs to be rolled onto the side to prevent aspiration. [40]

The protocol for spinal immobilization is as follows:

1. Maintain the head in neutral in-line position with a cervical collar in place
2. Logroll the patient onto the backboard
3. Secure the torso with spider straps or buckle straps
4. Secure the head to the backboard with foam blocks or towel rolls
5. Secure the legs to the backboard.

The backboard has claimed itself as the gold standard for spine immobilization in the prehospital setting. The backboard helps maintain neutral position of the spinal column en route and helps facilitate easy transfer once at the hospital. Occipital padding achieves the most neutral position; without it 98% of the patients would be in relative extension. [41]

Studies are unclear regarding how long the patient should remain on the backboard before he or she is at risk for developing complications, such as increased discomfort or pressure ulcers. Current recommendations suggest timely removal from the backboard as soon as the primary survey is complete and the patient is stable, to avoid such complications. [42]

# Emergency department evaluation

## Clinical Assessment

A missed cervical spine injury can have devastating consequences. When approaching the trauma patient to evaluate the cervical spine, the emergency physician should first consider whether the spine can be cleared without the use of imaging. It is best to approach the cervical spine evaluation in a structured manner. An unstructured approach to examining the cervical spine has low sensitivity compared with a more systematic approach. [(43)]

One can apply structured clinical decision rules in alert stable patients without neurologic deficits to determine how to proceed with the workup to evaluate for a clinically significant cervical spine injury. A clinically important cervical spine injury is defined as any fracture, dislocation, or ligamentous instability demonstrated on diagnostic imaging. A clinically unimportant injury is defined as an isolated avulsion fracture of an osteophyte, an isolated fracture of a transverse process not involving a facet joint, an isolated fracture of a spinous process not involving the lamina, or a simple compression fracture involving less than 25% of the vertebral body height. [(43)]

## Airway Management

Patients presenting to the emergency department may require emergency airway management before a full assessment for cervical spine injuries can be performed.When approaching the trauma patient, the physician should assume that an injury to the cervical spine is present. If the patient has an associated head injury, with a GCS score of less than 9, the risk of cervical spine injury increases significantly.

This patient is also the one who most likely needs an emergent airway. Lesions above C3 cause immediate need for airway management because of respiratory paralysis. Lower lesions may cause phrenic nerve paralysis or increasing respiratory distress from ascending edema. Injuries to the cervical spine may cause local swelling, edema or hematoma formation that may obstruct the airway, necessitating intubation. [(44)]

Recommendations for managing the airway of a trauma patient are:

1. Rapid-sequence intubation (RSI): When managing an unconscious patient, standard drugs should be used for paralysis and induction
2. Manual in-line stabilization: An assistant firmly holds both sides of the patient's head, with the neck in the midline and the head on a firm surface throughout the procedure, to reduce cervical spine movement and minimize potential injury to the spinal cord
3. Oro tracheal intubation is preferred in trauma patients requiring intubation
4. Use a tracheal tube introducer such as a Bougie or stylet
5. Have a selection of blades ready: evidence supports the use of a Macintosh blade
6. A laryngeal mask airway (LMA) can be used as a temporary device.

Manual in-line immobilization (MILI), as described by Crosby is designed to hold sufficient forces on either side of the head to prevent movement during interventions such as airway management. There are 2 approaches to MILI: (1) an assistant standing at the head of the bed grasps the patient's mastoid process with the finger tips and then cradles the occiput in the palms of the hands; or (2) an assistant standing at the side of the bed cradles the mastoids and grasps the occiput with the fingers.

Once the head and neck are stabilized by one of these methods, the front of the cervical collar can be removed to increase mouth opening and visualization by direct laryngoscopy. The neck should be maintained in neutral position throughout the procedure, and the anterior aspect of the collar should be replaced promptly when it has been completed. [(45)]

Ideally, MILI should prevent all movement that may worsen a spinal cord injury. In practice, this goal is not necessarily achieved. Crosby found that MILI minimizes distraction and angulation at the level of injury but has no effect on subluxation at the injury site. MILI may improve laryngoscopic views compared with immobilization with a collar, sandbags, or tape. In Crosby's series, only poor views (grade 3 or 4), caused by limited mouth opening, were obtained in 64% of patients immobilized with techniques other than MILI and in 22% of the MILI group.[(45)]

In a retrospective study, Patterson evaluated neurologic outcome in patients with cervical spine injury who required emergent intubation in the emergency department. No patients in whom cervical spine injury was subsequently identified had a worsening of neurologic outcome related to immobilization. This study did not consider the specific technique used to immobilize the cervical spine, but did assume that a cervical spine injury was present in all patients presenting with trauma. [(46)]

## Cord-Level Findings

Neurologic deficits correlate with the level of the injury, resulting in weakness or paralysis below the lesion. There are 8 pairs of spinal nerves in the cervical spine. The dermatomal distribution for the cord at each vertebra is listed in Fig. 1. From C1 toC7, the nerve root exits above the level of the vertebra; from C8 and below, the nerve root exits below the level of the vertebra.

The presentation of incomplete cord injuries depends on the level and location of the lesion. The anterior column conveys motor function, pain, and temperature, and the posterior column conveys impulses related to fine touch, vibration, and proprioception. Syndromes resulting from partial injuries are described here.

## Partial Cord Syndromes

Anterior cord syndrome results from compression of the anterior spinal artery, direct compression of the anterior cord, or compression induced by fragments from burst fractures. Anterior cord syndrome manifests as complete motor paralysis, with loss of pain and temperature perception distal to the lesion. Posterior cord syndrome is very rare; involvement of the posterior column is most often seen in Brown-Se´ quardsyndrome.

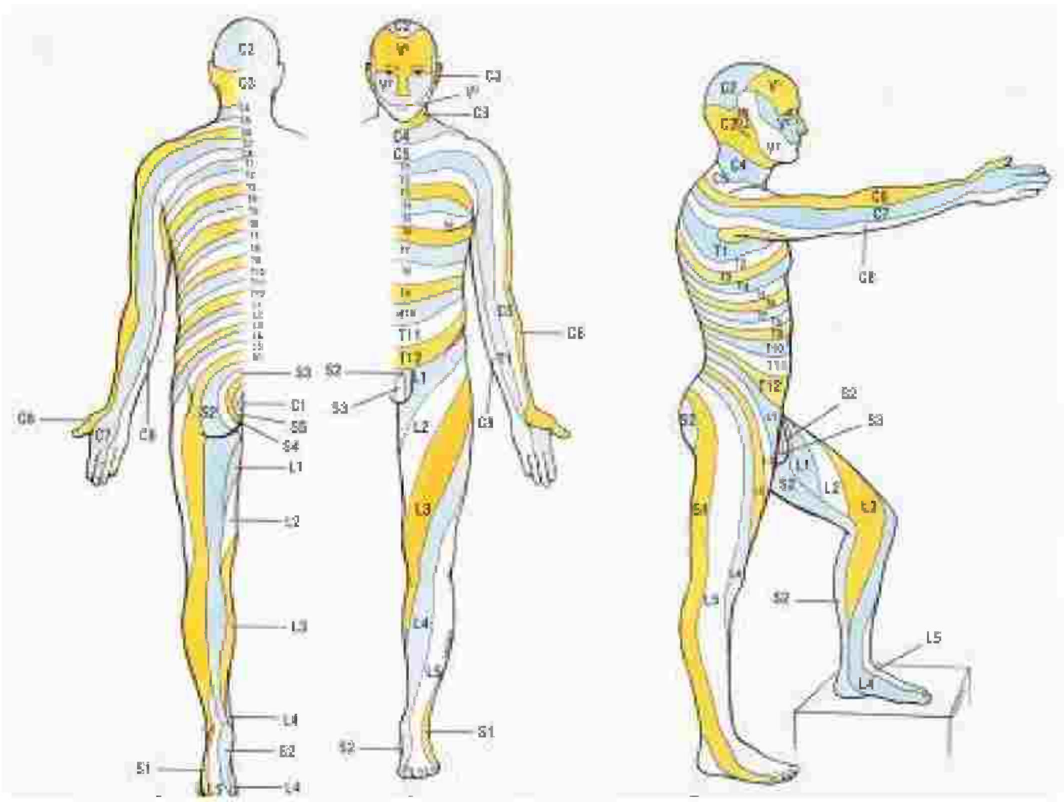


**Fig. (1):** Dermatome map. (From Agur AMR, Lee MJ, Anderson JE.Dermatomes. In: Grant's atlas of anatomy. 9th edition. Philadelphia: Lippincott Williams & Wilkins; 1991. p. 252.)

Brown-Se´quard syndrome is characterized by paralysis, loss of vibration sensation and proprioception ipsilateral, with contralateral loss of pain and temperature sensation. These signs and symptoms result from hemi section of the spinal cord, most often from penetrating trauma or compression from a lateral fracture.

Central cord syndrome, induced by damage to the corticospinal tract, is characterized by weakness in the upper extremities, more so than in the lower extremities. The weakness is more pronounced in the distal portion of the extremities. This injury is usually caused by hyperextension in a person with an underlying condition such as stenosis or spondylosis.

In acute severe trauma, Advanced Trauma Life Support (ATLS) guide lines should be followed. In other settings a thorough history of the traumatic incident should be sought before clinical evaluation. Physical examination of the cervical spine requires careful inspection and palpation from the nuchal ridge to at least the first thoracic vertebral prominence. [47]

From a standing position behind the patient, place opposing thumbs on the spinous processes of C2, applying progressive systematic gentle circular pressure down the midline to ascertain the presence of tenderness. Repeat this process 2–3 cm from the midline to determine whether facet pain can be elicited. [48]

Acute abnormality may be indicated by tenderness, a gap or step in the continuity of the cervical structures, edema, and hematoma or associated muscle spasm. Neurologic examination includes assessment of sensation, motor function and reflexes to identify objective signs of focal deficit, such as par aesthesia, weakness or decreased/absent deep tendon reflexes. (49)

Importantly, pain may not necessarily be a principal feature initially, despite the presence of serious injury, if pain from other injuries is more severe, or if edema has not yet reached a significant extent. (50)

# Cervical Spine Imaging

## Choice of investigation

If radiographic imaging is indicated, it is useful for this to occur as soon as possible. International guidelines support the use of cervical computerized tomography (CT) as first line imaging in suspected cervical spine injury. The most recent ATLS Spine and Spinal Cord Trauma guideline in 2008 however, continues to recommend plain films with targeted axial CT imaging for areas of suspected injury, or if the entire cervical spine is not able to be visualized on plain imaging. (57-59)

Similarly, the Western Australian Department of Health, Diagnostic Imaging Pathways for Cervical Spine Injury propose that plain radiography is appropriate when adequate X-rays are obtainable, thepatient is at low risk of injury, concurrent CT imaging of other areas of suspected injury is not required, or in children. However, plain X-rays miss significant proportions of injury due to poor image quality, inadequacy demonstrated by the absence of the craniocervical and/ or cervicothoracic junctions from the field of view or incorrect image interpretation by clinicians. (60-64)

A recent study of 1577 trauma patients, who were unable to be cleared of injury clinically and where all patients underwent five-view plain radiography (anteroposterior, lateral, odontoid and right and left oblique views) and helical CTimaging, found that plain X-rays failed to identify 299/416 fractures (72%) detected on CT. Mounting evidence against plain radiography suggests that this option should only be used in areas where CT is unavailable or in children where exposure to medium to high levels of ionizing radiation is contraindicated.(65)

Where CT is unavailable, high quality five-view plain X-ray with visualization of all seven vertebrae, and preferably reported by a radiologist, is recommended. If the plain films are abnormal or inadequate, the patient should be transferred to a center where CT is available. Abnormal neurologic findings, regardless of CT or radiographic results, should prompt referral to a major trauma service to exclude injury to the cervical spine discs, ligaments and cord, which are better evaluated with magnetic resonance imaging (MRI).(55)

## Missed diagnosis of cervical spine injury

A missed or delayed diagnosis of cervical spine injury May produce 10 times (10.5% vs. 1.4%) the rates of secondary neurological injury (65). Up to 4.3% of all Cervical fractures may be missed, with 67% of these Patients suffering neurological deterioration as a result (66) and 29.4% cases of delayed diagnosis of cervical spine injury developing permanent neurological deficit7s (67).

Before the widespread adoption of Advanced Trauma Life Support guidelines [68] up to 10% of patients‹ initially neurologically intact, developed a neurological deficit during their emergency care [69].