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Care of the patient with cervical

spine injury

By Tiffiny Strever, BSN, RN, CEN

The trauma patient can sustain a variety of physical injuries based on mechanism of injury, preinjury health, and lack or misuse of protective devices. Data show that during motor vehicle crashes (MVCs), misuse or lack of using restraints increased the likelihood of death and injury. This is especially evident when seat belts aren't used in the presence of air bags. Seat belts alone have been effective in reducing fatalities and injury severity by 40% to 50% and 45% to 60%, respectively.[1] Even more evident is that cervical spine fractures increase over 50% when seat belts aren't used when air bags are present. Drivers and passengers are more likely to suffer cervical spine fractures (1.7 times and 6.7 times respectively) when both air bags and seat belts aren't used.[1] Data also show improper air bag use results in more severe injuries and a higher injury severity score (ISS) and lower Glasgow Coma Scale (GCS) scores.

Injuries to the spinal cord occur at a rate of approximately 11,000 new cases annually in the United States, according to the Brain and Spinal Cord Injury Center.[2] About half of these injuries are at the cervical level.[3] The injuries result primarily from MVCs, falls, jumps, and assaults. Forty-two percent are directly related to MVCs. The results can be devastating, ranging from complete paralysis to death (see *Spinal cord injury*). The large majority of patients with spinal cord injuries will return to their preinjury environment, despite their paralysis. It's estimated that there are currently 300,000 people living with spinal cord injuries in the United States.[2] Of those, about 52% are paraplegics and the rest are quadriplegics (also referred to as tetraplegics).[4]

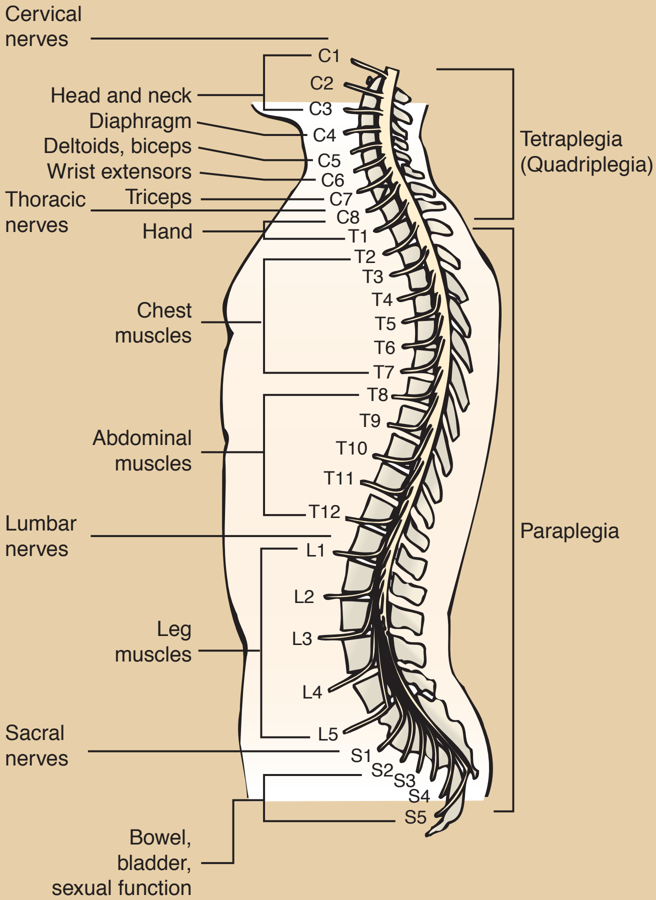
The cervical spine-injured patient is one of the greatest challenges in healthcare. Injury to the cervical spine not only leads to paralysis but also affects the ventilatory status of the trauma patient. Of the new cases each year, 40% will require some level of mechanical ventilation. Furthermore, 5% of those who require mechanical ventilation will need it long-term.[3] The care of these injured patients starts in the emergency medical setting with stabilization of the cervical spine. Inadequate immobilization and unsupervised or unprotected movement of the spine may lead to (additional) neural injury and, ultimately, significantly worsen the outcome.[5] The outcome of that patient will be dependent on care initiated by the emergency medical team and conclude with rehabilitation. This article focuses on the surgical implications for the cervical spine-injured patient.

Case study

A 5-year-old male involved in a MVC sustained a cervical spine injury. He was the restrained front seat passenger in a sports utility vehicle (SUV) that was being driven from a day-care center to home. The vehicle was traveling at 25 mph when it impacted with a pick-up truck resulting in a head-on collision for the SUV. The patient made contact with the

Spinal cord injury

The level of the spinal cord injury directly relates to the degree of functional loss. The higher the spinal cord injury, the more motor, sensory, and autonomic functional losses are incurred.



Source: Hickey JV. *The Clinical Practice of Neurological and Neurosurgical Nursing.* 6th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2009:411.

dashboard and the deploying air bag, despite being restrained by a seat belt.

The issue in this case was improper restraints for age. Children ages 4 to 8 years should be in a booster seat as a seat belt does not fit them properly. Children who are restrained by adult seat belts too early are four times more likely to be injured than children in child passenger safety seats or booster seats.[6] As noted earlier, the outcomes of improper use of seat belts and air bags are more severe injuries, higher ISS, and lower GCS. The National Highway Traffic Safety Administration (NHTSA) and the American Academy of Pediatrics recommend that children under 13 years of age ride properly restrained in the back seat due to the potential for injuries caused by the air bag.[7] Studies have shown that children who are improperly restrained in the front seat are twice as likely to be injured than children properly restrained.[8] The fact that the child in the case study was in front of an air bag and not in a booster seat very likely contributed to his injuries.

The emergency medical services team positioned the child on a long spineboard with a Kendrick Extrication Device (KED) board as added support. However, before completely securing the KED board the flight nurse noted that the child's head was positioned to the right side; further assessment revealed he had tracheal deviation. The deviation of the trachea was attributed to spinal injury and not respiratory compromise, as the patient was alert, oriented, and talking. Additional assessment findings included adequate respirations (along with the ability to talk) and no subcutaneous emphysema. In addition to the deviation of the trachea, the child didn't respond to painful stimuli, such as I.V. catheter placement or repositioning of an obvious fracture of the lower right leg.

Younger children present an additional challenge, as they are developmentally unable to communicate crucial symptoms.[9] Also, the exam may be clouded by a lack of cooperation. In this case, however, the child was noted previously to have minimal to no movement or sensation, and when assessed for pain, he denied any. Although intubation is a consideration with a patient who has a cervical spine injury due to the potential for respiratory failure, the decision was not to intubate in this case. This child was alert, talking, and maintaining adequate oxygenation. It should also be noted that a cervical collar wasn't placed due to the angle of the patient's head and the tracheal deviation. If a cervical collar can't be used, manual stabilization of the cervical spine must be maintained.

The child was transported via helicopter to a Level I Pediatric Trauma Center. On arrival into the trauma bay the child remained calm, alert, and oriented. The flight crew gave a detailed report including their initial assessment and decision as to why the child was not placed in a cervical collar at the scene. During the initial resuscitation phase he remained immobilized with his head supported in the original position. After the initial assessment phase in the trauma bay, a cervical collar was placed and he was intubated in anticipation of his need for surgery.

A computed tomography scan of the cervical spine and abdomen was done, and it was noted he had a C6-C7 transection injury as well as intra-abdominal injuries. The patient was taken to surgery for exploration and repair of a splenic injury. Neurosurgery was consulted for evaluation of the cervical injury. Repair of the spinal injury was delayed, pending further studies and stabilization of the patient's hemodynamic status. Additional studies included a magnetic resonance imaging scan, which confirmed C6-C7 cord injury. The patient underwent cervical spine stabilization by the neurosurgeon on hospital day 2.

Pathophysiology

Spinal cord injuries are classified as complete or incomplete transection. A patient with a complete cord transection will have loss of motor and sensory function below the injury, and will also have loss of bowel and bladder function. With an incomplete transection the patient will have motor and sensory deficits, but may not have the bowel and bladder function loss. Resolution of function will be dependent on type and level of injury. The types of incomplete cord syndromes include central, anterior, posterior, and Brown-Séquard. Depending on the syndrome, the symptoms will vary, as will the recovery prognosis. Central cord syndrome is most common and has the best recovery prognosis[10] (see *Incomplete spinal cord injury syndromes*).

Differences between adult and pediatric patients

Anatomic differences between the pediatric and adult cervical spine are prominent until approximately 8 years of age and persist to a lesser degree until approximately 12 years of age.[9] These differences seen in children include flatness of the upper cervical spine facets, and also the vertebral bodies are wedged anteriorly and have a tendency to slide forward with flexion.[11] Additionally, the neck ligaments in children are more lax, resulting in spinal cord damage even in the absence of boney structure disruption. The condition known as SCIWORA (spinal cord injury without radiographic abnormality) is often seen in children. SCIWORA occurs more commonly in children under 8 years old, and in those with a high ISS.[12] In addition, the pediatric population is at a higher risk for hypothermia and fluid volume overload than the adult surgical patient. Hypothermia can be exacerbated by a spinal injury because loss of thermal regulation is often a result of spinal cord injury. Keeping the pediatric patient warm is critical.

Preoperative positioning/safety considerations

Preoperative assessment for positioning needs should be made before transferring the patient to the procedure bed.[13] This is especially important when the patient has a cervical spine injury to prevent further damage to the cord. Maintenance of spinal immobilization throughout the transfer process is essential while keeping in mind that a cervical collar alone doesn't completely immobilize the spine. The collar provides an increased level of stability, but it is not complete immobilization.[14]

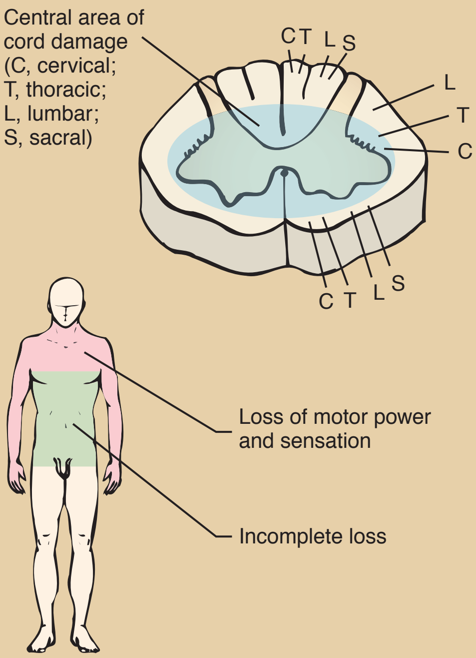
Moving the patient to the bed should be a coordinated team approach, with one person, preferably the team leader coordinating all moves. The person manually stabilizing the spine is much more effective in restricting motion during patient transfer than any external immobilization.[14] Using a team of four or more and logrolling the patient will make a transfer smooth, while reducing the risk of further injury. Keeping the cervical collar in place until skin is prepped is another way to decrease potential for additional injury.

There are aides to assist with the moving of the spine-injured patient. One of those is a sled. The term "sled" is actually a layman's term for patient shifter or transfer board. The board is placed under the patient and used to move the patient from stretcher to bed. Another device that can be used is a roller board, similar to a sled. However, in the case of this child a sled was used.

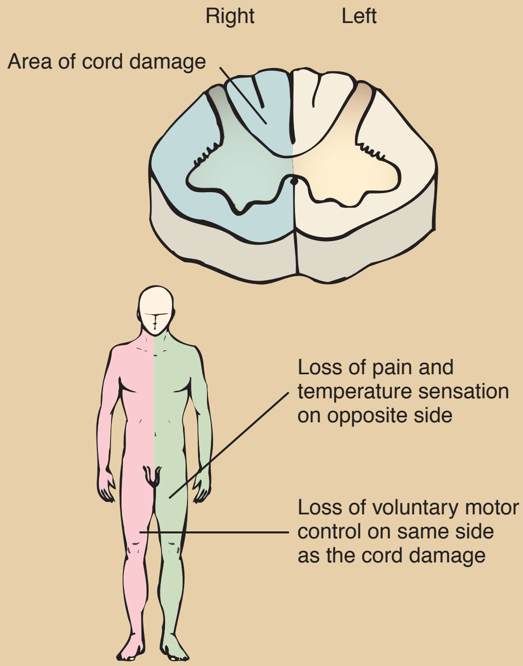
The preoperative assessment should include assessing the patient for conditions that will affect proper positioning or lead to intraoperative complications, such as extremes of age, degenerative changes, or poor skin integrity. The neurosurgical perioperative team faces additional challenges related

Incomplete spinal cord injury syndromes

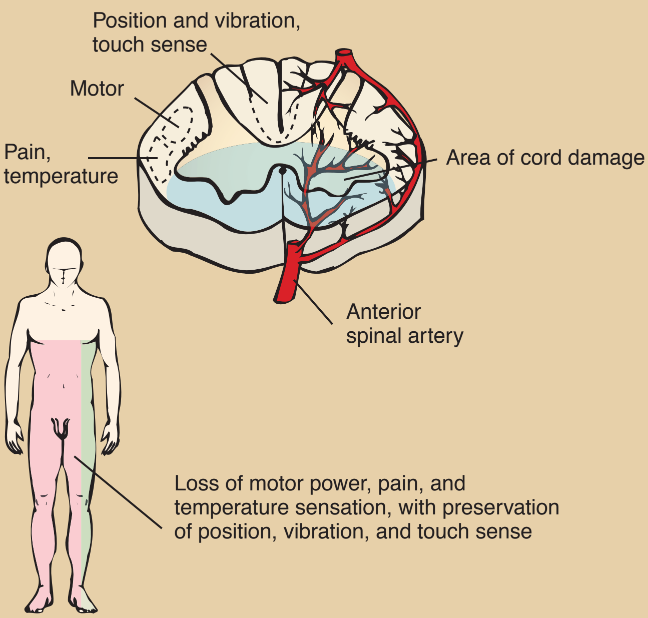
Three types of incomplete spinal cord injury syndromes, central, Brown-Séquard, and anterior, are discussed below. The patient's clinical presentation and prognosis will vary depending on the syndrome.



Central cord syndrome



Brown-Séquard syndrome

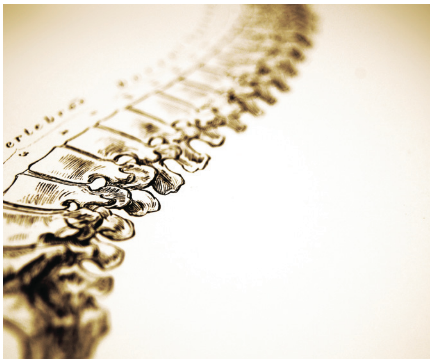


Anterior cord syndrome

Adapted from: Hickey, JV. *The Clinical Practice of Neurological and Neurosurgical Nursing.* 6th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins. 2009; 424-425.

to positioning because of the potential for complications during prolonged and complex procedures.[15]

The team must determine what equipment and positioning devices will be needed and have them ready for use. Maintaining a variety of sizes should also be considered as each patient is unique. It is important to remember that devices used for positioning during procedures are for injury prevention. Although it's important to prevent pressure ulcers, that is not the primary function of the devices. There are multiple positioning devices that can be used to reduce the pressure on the nerves and tissues intraoperatively. Pillows, blankets, molded foam devices, beanbags, and sandbags are used primarily to maintain patients' surgical positions.[16] Foam devices may include mattresses, headrests, and bolsters. There are air devices, such as alternating pressure mattresses and gel pads. The gel pads are filled with liquid or semiliquid silicone and are resistant to moisture. The OR beds also have parts (for example, headrest) that will aid in positioning. There's a common OR bed available for spinal surgery that has rotational patient positioning and imaging capabilities. However, it's not commonly used in the pediatric population. Regardless of the devices used, frequent reassessment is necessary to monitor patient's condition and response.



It takes a team effort to maintain good spinal stabilization throughout transfer and positioning until definitive care is accomplished.

OR considerations

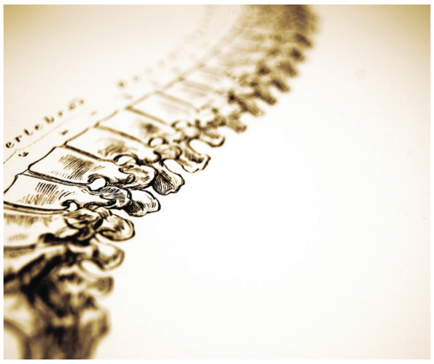
Positioning the patient for surgery is an important part of perioperative nursing care that shouldn't be underemphasized. Normal body alignment must be maintained without excess flexion, extension, or rotation.[7] The patient's position in the OR will depend on the surgical approach used by the surgeon. The perioperative RN should actively participate in safely positioning the patient under the direction of and in collaboration with the surgeon and anesthesia provider.[17] As noted previously, maintaining good spinal stabilization throughout transfer and positioning until definitive care is accomplished is a team effort.

The most common positions for patients requiring cervical spine surgeries are supine or prone. However, the sitting position can also be utilized. The sitting position is frequently used for patients with degenerative disease where lying flat would be difficult. One advantage of the sitting position is the positive effect on the patient's respiratory system.[16] There's better expansion as the thorax is less restricted. For the purpose of this article, we're going to focus on the supine and prone positions in more detail.

The supine position is often used in neurosurgery because it offers good exposure to the anterior and middle fossae of the cranium, anterior aspect of the neck, face, and anterior medial and lateral aspects of the upper and lower extremities.[15] Using this method may allow the patient to remain awake during the pre-op transfer. Maintaining cervical spine stabilization and patient safety remains the priority. Positioning includes placing the arms at the patient's side, in a neutral position, palms up, and the head and spinal column in a straight line. Supine positioning has less adverse effect on the patient's circulatory system than other surgical positions.[16] This position does have a positive effect on the patient's breathing as the diaphragm in not restricted. Knees should be flexed in a natural position and placement of a pillow can protect the peroneal nerves. Heels should also be off the bed to prevent pressure ulcers. One mechanism that can be used to facilitate the proper positioning of a patient for this approach is the use of a neurosurgical three-point or neurosurgical horseshoe headrest stabilizing device. Make sure that head remains in neutral position.

A third position commonly used for spinal surgery is the prone position. The prone position provides good exposure of the dorsal surface.[15] Surgery can be done on areas of the spine including cervical, thoracic, and lumbar areas as well as the occipital part of the head. With this approach the patient is often put to sleep before transfer, so care by the staff during the transfer process is of great importance. Body rolls are placed anteriorly from the patient's shoulders to the pelvis to lift the chest off the OR bed to ensure adequate lung expansion during respiration.[16] Other areas to consider at risk in this position include forehead, chin, and male genitalia. Regardless of the position it's a team approach with the role of the perioperative nurse to assure that the patient is properly positioned with adequate padding to ensure safety during the operative phase.

Regardless of the approach, the role of the circulating nurse includes making sure stabilization is maintained until the surgical procedure starts, and making sure that all areas are padded appropriately with frequent reassessment during the procedure as neurosurgery cases can be quite long. The circulating nurse represents the coordinating link between the patient's needs and the surgical team's responsibilities and, therefore, must ensure that all members of the surgical team perform patient care at the highest level according to nationally accepted standards, recommended practices, and guidelines.[15] All this is done to ensure the best outcome for the patient and prevention of further injury.



Cervical spinal cord injury is associated with dysfunction of the sympathetic nervous system.

Case progression

The right anterior approach was used in the initial treatment of the case study patient. Once the spine was accessed by removal of the anterior portion of the cervical vertebrae, a completely transected spinal cord was revealed.

The patient underwent a decompressive diskectomy, with an open reduction and interbody fusion. A bone graph with adult hardware consisting of a plate and two screws was used to obtain stabilization after the spine was reduced. Adult hardware was used because, currently, no pediatric specific spine hardware is available. Complete reduction wasn't accomplished, but the procedure was considered successful. Halo traction was applied for additional support and the patient was transferred to the pediatric ICU for management of multiple I.V. infusions to control BP.

In the pediatric ICU, the patient received multiple I.V. infusions, including norepinephrine (Levophed) for treatment of neurogenic shock. Spinal precautions were maintained including logrolling the patient and maintenance of the Halo traction. The patient was cared for by the pediatric intensivist, the neurosurgery team, and the trauma services team, and his condition stabilized. Neurogenic shock frequently develops in cord-injured patients. Cervical spinal cord injury is associated with dysfunction of the sympathetic nervous system and cardiovascular deficits, including hypotension, severe bradycardia, asystole, and loss of peripheral vascular tone.[18]

On hospital day 13, the patient returned to the OR due to further distraction of C6-C7 and new distraction at C3-C4. In addition to the neurosurgical team, the plastic surgeon assisted on the case. The patient was placed in the prone position with appropriate padding. The surgeon fused C2-T2 using hardware commonly employed in mandibular fixation. Good alignment was established and the patient returned to the pediatric ICU. The patient developed respiratory insufficiency, thought to be secondary to fluid overload, pulmonary edema, and intercostal muscle function loss. Because of these complications the patient required prolonged ventilatory support and eventually a tracheotomy. As noted earlier, prolonged ventilatory support is not uncommon with cervical spine-injured patients.

Case study conclusion

In preparation for rehabilitation a tracheotomy was performed for long-term ventilatory management, and a feeding tube placed. After 8 weeks in acute care he was transferred to a pediatric rehabilitation center. As of November 2009, approximately 9 months after his initial insult, he was a paraplegic. He had improved motor function of both hands, with the ability to wave with his right hand, and improved fine motor movement of his left hand. He was able to swim and appears to be developmentally intact for a child his age. The care of this patient and his positive outcome was due to the coordinated efforts by all providers from the scene to the ED, those who provided him surgical care, and the pediatric intensivists on through rehabilitation.

Global conclusions

The care of the cervical spine-injured patient depends on a variety of factors. This includes early recognition of potential spinal cord injury, correct immobilization of the spine by emergency medical personnel, and transport to an appropriate facility where definitive care can be received. The role of the perioperative nurse is critically important in relation to proper transfer, positioning, and patient safety. **OR**

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