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A 41-Year-Old Man With an Incomplete Spinal Cord Injury

A 41-year-old man was at a cabin during deer hunting season. According to witnesses, he took 3 hydrocodone tablets, 3 shots of liquor, and 4 beers before climbing up into the loft to sleep. His friends were awoken by a crash. The patient had fallen 9 feet from the loft and landed onto the cement floor. The patient states that he landed on his head and then rolled onto his right side. He had been getting up to go to the bathroom and walked off the edge. Initially, he stated that he had lost consciousness. The witnesses stated that when they arrived he was awake, speaking, and laying on his right side. He complained of neck pain and a headache. He initially denied any numbness or paresthesia but stated he could not get up. His friends stated he was unable to roll on his back, and they had to assist him off of his right side before paramedics arrived on the scene. While waiting for ground emergency medical services, he felt his arms and legs were getting weaker. He was taken to a small community hospital where he was evaluated. The local flight service was contacted for transport to a trauma center.

Upon arrival, the flight crew obtained a complete history, and they began their physical assessment. The patient reported that he had a history of chronic low back pain with a history of lumbar fusion. Additionally, he reported a history of an ankle fracture requiring surgical repair. He only used hydrocodone as a prescribed medication and had no history of anticoagulant use. He did report using alcohol, marijuana, and cocaine regularly, but he only consumed alcohol that day as noted previously.

On physical examination, the patient did not appear to be in any acute distress. He was awake, alert, and could answer all questions. His vital signs were blood pressure of 99/50 mm Hg, pulse of 106 beats/min, respiration rate of 18 breaths/min and nonlabored, oxygen saturation of 100% on room air, and a Glasgow Coma Scale of 15. His head showed significant trauma. There was a large hematoma over the occiput. It was approximately 3 × 4 cm with no overlying laceration. His eyes were equal and reactive to light both directly and consensually. He had no hemotympanum, battle signs, or drainage from his ears. His neck revealed a midline trachea with no jugular venous distention. He had reproducible pain over C3-C7. The examination over his torso revealed no abnormalities. There was no pelvic instability and no priapism. He had no tenderness on his spinous processes from the thoracic to the sacral spine. He had diminished rectal tone but intact sensation. The patient had appropriate central and peripheral pulses with no other skin abnormalities. He did have 3 abrasions on his right ankle and 1 contusion on the anterior surface of his right foot.

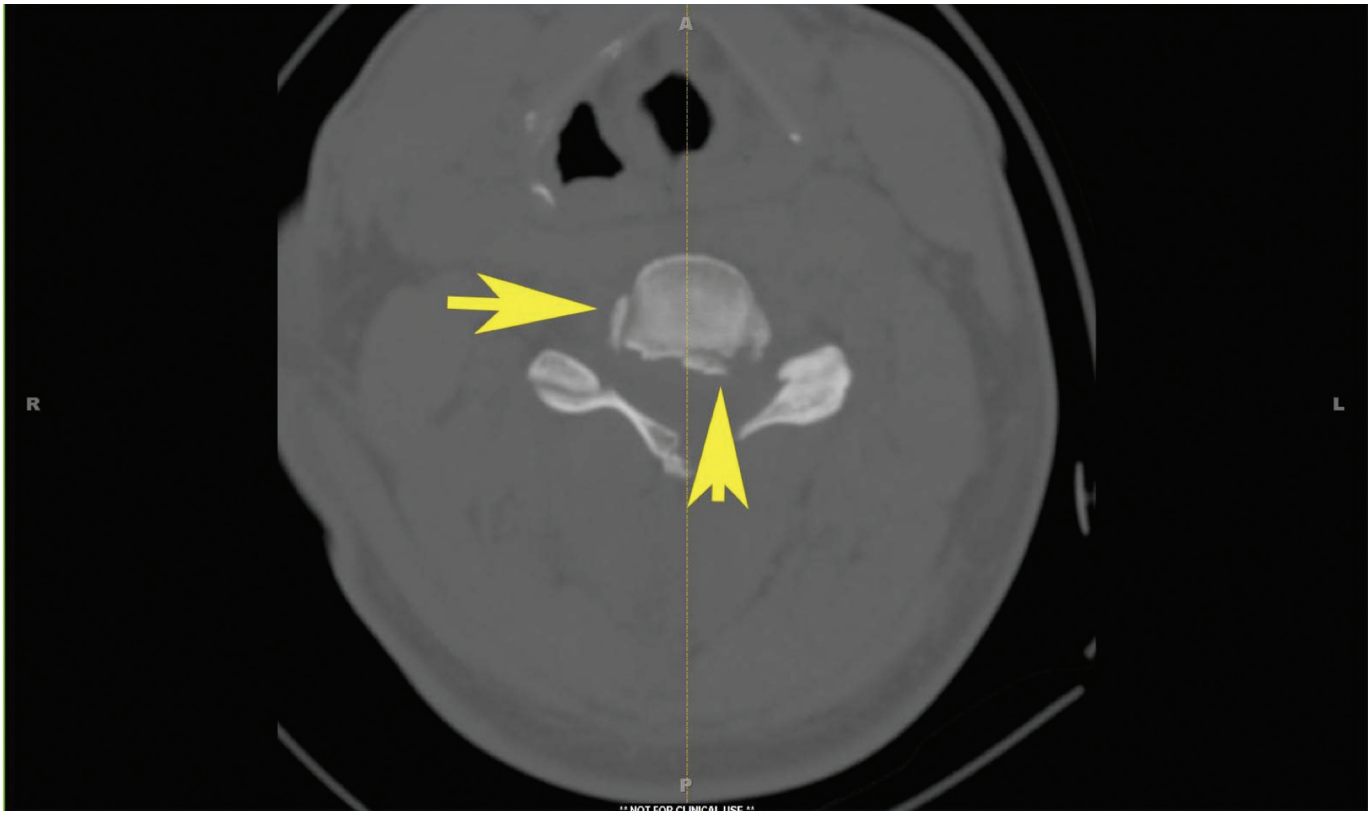
However, the patient's neurologic examination was compromised. The patient had 3+ strength (moves against gravity) in his deltoids, triceps, and biceps, but he was unable to form a grip with either hand. He had 2-point touch discrimination in his upper and lower arms bilaterally. His left foot showed abnormal sensation. He could not discriminate 2-point touch. When a more painful stimulus was applied to his left foot and leg, he did not withdraw to pain. He stated he did not feel the pressure or the pain. On command, he could plantar or dorsiflex his foot but could only lift his lower left leg against gravity approximately 2 cm off of the bed. The examination of the right side was significant for what the patient described as significant pain in his right foot and leg. He described it as a "searing sensation" after pressure was applied to the great toe. He was unable to plantar or dorsiflex. He could not lift the right leg up off the bed. The flight crew provided immobilization by keeping the patient in a cervical collar and ensuring a smooth in-line transfer to their cot. They initiated 2 large-bore intravenous catheters and administered oxygen via a nonrebreather mask. Because of the complexity of their neurologic examination, they completed serial examinations during transport that revealed worsening pain in the right extremity and weakness in his left leg. Vital signs were continued every 5 minutes to ensure no change in respiratory or circulatory status. The patient was able to maintain oxygen saturations of 98% on the nonrebreather mask and did not appear to have diminished function of his diaphragm.

The receiving facility had contacted their neurosurgeon who recommended methylprednisolone (MP) therapy. The bolus of 30 mg/kg was mixed at the sending hospital and was initiated before transport. The drip of 5.4 mg/kg/h was also mixed at the sending hospital, and the flight crew initiated this after completion of the bolus while in flight.

Upon arrival, the patient underwent a full trauma evaluation including blood work, radiographs, and computed tomographic (CT) scans. During the initial phase of evaluation, imaging of the chest and pelvis did not reveal any abnormalities. His blood work was essentially unremarkable with the exception of his blood alcohol level being 0.19. The CT scan of the head, chest, and abdomen /pelvis showed no acute injuries. A CT scan of the cervical spine revealed a comminuted fracture involving the left vertebral body, foramen transversarium, pedicle, lamina, and facet joint at C4 (Fig. 1).

Once the imaging revealed the noted fractures with neurologic compromise, a neurosurgeon was called to the bedside. A carotid Doppler examination was ordered to evaluate for the possibility of carotid dissection secondary to the axial loading injury that occurred. The test was completed, and no carotid injury was identified. Additionally, magnetic resonance imaging of the cervical spine revealed a fracture dislocation of C4

Figure 1. C4 vertebral body fracture with yellow arrows showing noted fractures.



and C5 with a 5-mm anterior subluxation of C4 in relation to C5 (Fig. 2). There was also a 4-mm fracture fragment with a disc bulge, which caused compression of the spinal cord at C4. Posttraumatic contusion edema of the spinal cord was noted at C4. There was a tear in the anterior and posterior longitudinal ligament at C4-C5.

After the diagnostics were completed, the patient underwent an anterior discectomy and subsequent fusion of C4 and C5. He tolerated the procedure appropriately and was transferred for intensive rehabilitation. At 3 months after the injury, his neurologic examination was still significant for weakness of the biceps, wrist extensors, and instrinsic muscles of the right hand. There is minimal weakness of the right lower extremity. Additionally, there was minimal sensory deficit on the left side. Neurosurgery predicts that with continued rehabilitation most muscle weakness will resolve.

Brown-Séquard syndrome (BSS) is an incomplete spinal cord lesion that is caused by damage to a portion of the spinal cord. This often occurs in the cervical spinal cord region and is considered to be equivalent to a hemicordectomy. A patient who presents with pure BSS will suffer from ipsilateral (same side) paralysis and loss of vibration and position sense below the level of the lesion. In addition, loss of pain and temperature sensation occur contralaterally (opposite side) below the level of the lesion. Other clinical findings include hyperreflexia and an extensor toe sign. Often, a pure BSS is not observed but rather a clinical picture composed of fragments of the syndrome. These less pure forms of the disorder are often referred to as Brown-Séquard–plus syndrome.[1] Although traumatic and nontraumatic causes of BSS have been described, traumatic injury is more often cited in the literature. Mechanisms include penetrating trauma such as stab wounds, gunshot wounds, motor vehicle collisions, and falls.[2,3] This condition is rare.

Understanding the anatomy of the spinal cord will help understand the clinical symptoms found within the major spinal cord syndromes. The central and peripheral nervous systems are complex. This next section is not meant to be all inclusive but rather to provide some general information on the spinal tracts found within the spinal cord. Spinal tracts are communication pathways within the central nervous system. There are many tracts, but the focus of this article is on those that pertain specifically to this syndrome. The motor tracts include the lateral corticospinal tracts. A signal is sent from the brain to the muscle via this tract. It crosses at the level of the medulla within the brain. Thus, the right side of the brain is actually controlling the left side of the body. Because these tracts cross at the level of the brain, the actual motor loss will occur on the same side of the injury. Sensory tracts include the dorsal column–medial lamniscus and the spinothalamic tract.

The dorsal column–medial lamniscus is a common term that is used to describe those fibers that carry the information regarding light touch, deep pressure, vibration, and proprioceptive senses back to the brain. These fibers enter the spinal cord and ascend in the ipsilateral side (same side) of the

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