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Case Presentations of the Harvard Affiliated Emergency Medicine Residencies

FALL FROM HEIGHT

Laura A. Dean, MD,*†‡ Emily L. Aaronson, MD,*‡ Kathleen Wittels, MD,*† and Susan R. Wilcox, MD*‡

*Department of Emergency Medicine, Harvard Medical School, Boston, Massachusetts, †Department of Emergency Medicine, Brigham and Women's Hospital, Boston, Massachusetts, and ‡Department of Emergency Medicine, Massachusetts General Hospital, Boston, Massachusetts

Reprint Address: Susan R. Wilcox, MD, Department of Emergency Medicine, Harvard Medical School, 55 Fruit Street, Boston, MA 02114

Dr. Laura Dean: Today's case is that of a 26-year-old man who was transferred to the emergency department (ED) by ambulance from the scene of a fall from a fourth-story window. The patient had been drinking alcohol that evening and the fall was witnessed, however, no additional information regarding the context of the fall was available. On the arrival of emergency medical services (EMS), the patient was unresponsive with a systolic blood pressure in the 80s and a heart rate in the 110s. His breathing was agonal, and he was intubated in the field without medication. En route, he received 500 cc of normal saline.

Dr. Susan Wilcox: Did the patient have any medical history, surgical history, medications, or allergies that might be relevant to his presentation?

Dr. Dean: Limited information about the patient was available at the time of his initial assessment. Per EMS, he had no known significant medical, surgical, or psychiatric history. He had no known allergies and was not known to be taking any medications.

Dr. Wilcox: Can you describe the physical examination?

Dr. Dean: On arrival, the patient had a temperature of 36.2°C (97.2°F), a heart rate of 108 beats/min, and a blood pressure of 118/72 mm Hg. He arrived intubated, ventilated by a travel mechanical ventilator set to volume control with a tidal volume of 500 cc, positive end-expiratory pressure was 5 cm H_2O, respiratory rate was 18 breaths/min, but he was overbreathing at a rate of 24 breaths/min for a minute ventilation of 12 L/min. He had an oxygen saturation of 81% on 100% FiO_2.

On examination, the patient was morbidly obese, and his appearance was consistent with his known age. A right parietal hematoma was noted, and while the pupils were equal, round, and sluggishly reactive to light, corneal reflexes were absent bilaterally. An endotracheal tube was in place, confirmed by colormetric carbon dioxide detection, and connected to the ventilator. A cervical collar was applied in the trauma bay; no midline step-offs or deformities were noted on examination of the cervical spine. Breath sounds were diminished on the right. Cardiac examination revealed a regular tachycardia without murmurs, rubs, or gallops. Palpable pulses were noted in bilateral carotids, radial arteries, and femoral arteries, but his skin and extremities were cool. The abdomen was soft and non-distended. The pelvis was unstable. He had received 6 mg of midazolam i.v. for sedation en route, and his Glasgow Coma Scale (GCS) score was 3T, with no responses to painful stimuli noted. Bedside extended focused assessment with sonography in trauma (FAST) was notable for absent lung sliding on the right and free fluid in the right upper quadrant.

Dr. Jennifer Przybylo: Can you describe your initial management of this patient?

Dr. Dean: Life-threatening problems identified on the primary survey were addressed first. While the patient's airway was intact with an endotracheal tube in place, his breathing was compromised. Hypoxemia in the setting of decreased right-sided breath sounds and absent lung sliding suggested a pneumothorax, so a right-sided

chest tube was placed with return of air and 250 cc of blood. This resulted in an improvement in oxygenation and a decrease in his respiratory rate. His circulation assessment was notable for hypotension in the field responsive to a fluid bolus. On ED arrival, he was normotensive with normal pulses. Ongoing monitoring of the patient's vital signs was complicated by difficulty obtaining blood pressures in the trauma bay. A pelvic binder was placed to tamponade bleeding from suspected pelvic hemorrhage. The rapid transfusion protocol was initiated, and the patient received 2 units of packed red blood cells in the trauma bay. The patient was placed in a cervical collar, given concern for neurologic injury.

Dr. Kimo Takayesu: What was in your differential diagnosis at this point?

Dr. Dean: There are several considerations in this patient's presentation, some of which address his polytrauma, others of which concern the circumstances that may have preceded his fall. The patient arrived tachycardic and hypoxic with decreased breath sounds on the right on a ventilator, as well as with an unstable pelvis and GCS score of 3T.

The primary concern was for neurologic trauma. The patient's severely depressed mental status, initially agonal breathing, and sluggishly reactive pupils raised suspicion for intracranial insult, including massive intracranial hemorrhage secondary to the fall, or an underlying hemorrhagic stroke that may have precipitated the fall and with similarly compressive effects. In addition, the patient's presentation could be consistent with concomitant cervical spine injury, as the patient did not have any witnessed spontaneous movement.

Notably, while the patient's hypotension was initially fluid-responsive and normalized upon presentation to the ED, his tachycardia and persistent inability to register a blood pressure suggested shock was developing. Hypovolemia is the most common cause of shock in trauma and leads the list in this case, given that initial management has demonstrated free fluid in both the pleural and abdominal cavities. Cardiogenic shock, such as that from myocardial infarction, could explain the etiology of the patient's fall, depressing cardiac output and increasing vascular resistance. One potential cause of obstructive shock, pulmonary embolism, could have contributed to the initial fall, however, it does not fully explain the range of examination findings. Cardiac tamponade, also obstructive in effect, could have resulted from the trauma, however, there was no pericardial effusion noted on FAST examination. Other obstructive etiologies include tension pneumothorax, which could have been a concern prior to the chest tube, and abdominal compartment syndrome; however, in such a situation, we would expect to see hypovolemia before enough blood fills the abdomen to compress the inferior vena cava. Neurogenic shock, categorized as distributive, is another consideration, particularly in the setting of profound neurologic dysfunction, which can result from the sympathectomy of acute neurologic trauma. Finally, septic shock, another distributive etiology, while quite common in a hospital setting, is less likely in this afebrile patient whose extremities were noted to be cool to the touch.

Furthermore, the team had concern for additional trauma, including rib fractures, traumatic aortic dissection, and intra-abdominal vital organ injury.

Dr. Takayesu: What were your next steps in management?

Dr. Dean: Following the primary and secondary survey, the patient underwent portable x-ray studies of the chest and pelvis. As suggested by the return of air and blood following chest tube placement, the chest radiograph demonstrated right-sided pneumothorax, as well as multiple bilateral rib fractures, patchy opacity suggestive of lung contusion, and mild interstitial pulmonary edema. Pelvic x-ray study demonstrated an open book fracture, with 6.3 cm diastasis at the pubic symphysis, as well as disruption to the bilateral sacroiliac joints, which as noted, was stabilized with a pelvic binder.

Dr. Przybylo: What was the patient's clinical course in the ED?

Dr. Dean: Shortly after presentation, the patient's blood pressure rose to 183/104 mm Hg, consistent with suspicion for intracranial hemorrhage. He remained mildly tachycardic with heart rates in the low 100s. While the team had significant difficulty obtaining an arterial line or consistent blood pressure readings, given the patient's habitus, he was deemed stable enough to be moved emergently to obtain computed tomography (CT) scan to evaluate polytrauma. CT scan of the head without contrast demonstrated no intracranial hemorrhage, acute infarct, or evidence of fracture. CT scan of the cervical spine revealed acute atlanto-occipital dissociation with a fracture of the C1 vertebral body, as well as a mildly displaced C7 transverse process fracture (Figures 1 and 2). In the scanner, the patient acutely decompensated, becoming severely bradycardic and hypotensive. He was promptly transferred to the surgical intensive care unit for further management. Despite extensive resuscitative efforts, the patient died approximately 3 h after his initial trauma.

Dr. Takayesu: This patient presented with polytrauma after a fall from height. Of all the injuries, what were the most life threatening?

Dr. Dean: Of his multiple injuries, two warrant additional discussion: his pelvic fractures and his spinal fracture. Pelvic fractures account for approximately 9% of trauma patients admitted to U.S. hospitals, with an overall mortality rate estimated at 10–16% (1). While open-book fractures, those that significantly disrupt the pelvic ring,

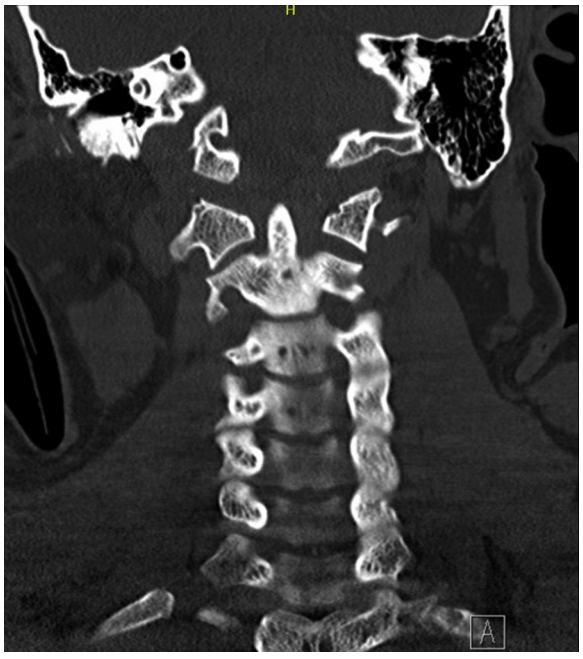

Figure 1. Coronal image of computed tomography demonstrating atlanto-occipital dissociation.

represent only a small fraction, the mortality rate in these cases in as high as 45% (1). The great danger in these fractures is damage to the large vascular network that runs through the pelvis, injury to which can cause life-threatening hemorrhage into the retroperitoneal space, which can accommodate a patient's entire blood volume. Any trauma assessment of a hemodynamically unstable patient should include high suspicion for pelvic trauma, which can be evaluated at bedside by examining pelvic stability, performing a FAST examination, and obtaining a portable radiograph. In the case of suspected pelvic fracture, the goal of pelvic stabilization is to prevent additional vascular and tissue injury, while also decreasing pelvic volume to tamponade any bleeding vessels. With that said, the mechanism by which pelvic binding contributes to controlling bleeding is controversial, and there is no consensus demonstrating a statistically significant decrease in patient mortality following binding (2). Still, it remains the standard of care, because of the ease of application, low potential for complication, and benefit to pelvic stability. Definitive care for severe pelvic fracture can include resuscitative endovascular balloon occlusion of the aorta, preperitoneal pelvic packing, or angioembolization, with the type of intervention determined by hemodynamic stability and degree of further injuries.

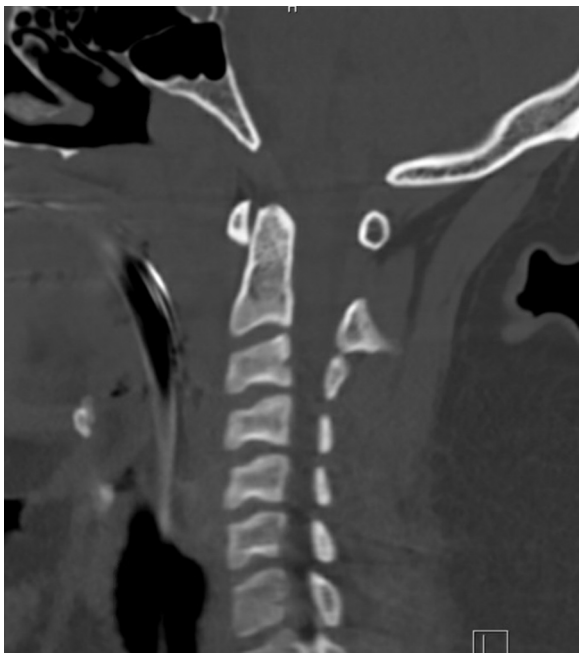

Figure 2. Sagittal image of computed tomography demonstrating atlanto-occipital dissociation.

Dr. Przybylo: What can you tell us about atlanto-occipital fractures?

Dr. Dean: Traumatic atlanto-occipital dissociation results from ligamentous injury to the craniocervical junction and is associated with significant neurologic morbidity and mortality, typically from injury to the spinal cord and lower brainstem (3). Mortality in the broader category of craniocervical dislocation has been reported between 57% and as high as 90% (4,5). However, we are limited in our understanding of the extent of mortality, given that many patients die before assessment or are missed diagnoses (6). The prominent force responsible for producing such fractures is hyperextension with resultant rupture of the tectorial membrane, enabling laxity for anterior dislocation of the cranium. Patients can present with a wide range of neurologic damage, including cranial nerve injury and respiratory instability (7).

Radiographic findings may be absent on x-ray studies, so CT scan is the imaging modality of choice. The degree of injury is judged based on measuring the distances between vertebral condyles as well as between the dens and the anterior skull base (5). If the patient is eligible for operative repair, treatment involves fixation of the cervical spine to the skull base (occipitocervical fusion), which will prevent the patient from rotating their head in the horizontal plane (7). Patients are also at high risk for dissection or injury to both the vertebral and carotid arteries, which can result in both ischemia and subarachnoid hemorrhage (5).

Dr. Wilcox: What are the major teaching points of the case?

Dr. Dean: While it is true that our management of acute trauma patients can be formulaic, it is important to remember that any given case is primed to disrupt the algorithm and demand integrated medical decision-making. In this situation, the polytrauma presentation

forced the providers to simultaneously manage apparent neurologic injury and developing hemorrhagic shock, presenting overlapping and divergent disease processes with potentially contradictory therapeutic interventions. Consider, for example, the patient's blood pressure: while initially normalized by a prehospital fluid bolus, it subsequently fluctuated between a high of 183/104 mm Hg and a low of 88/60 mm Hg, demonstrating the conflicting forces of intracerebral hypertension and hypovolemic hypotension that developed in the CT scanner. We are reminded in reviewing this patient's case that we must treat the entire clinical picture, not simply disparate vital signs or single laboratory values. His injuries were temporized as efficiently and effectively as possible by a multidisciplinary team, however, the physiological stress of unrelenting blood loss and deteriorating neurologic function was ultimately unsurvivable.

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