

■ CASE REPORTS

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Spinal Cord Injury as a Result of Endotracheal Intubation in Patients with Undiagnosed Cervical Spine Fractures

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REPORTS of neurologic injury as a result of tracheal intubation in patients with undiagnosed cervical spine injuries are uncommon.¹ Two reasons may account for this. First, failure to diagnose the injury and subsequent neurologic sequelae may be rare occurrences. Diagnostic delay is not infrequent, and as many as 67% of cervical spine injuries may be missed by a lateral radiograph.²⁻⁴ Although the contribution of tracheal intubation is not mentioned specifically, new neurologic deficits are reported to be 7.5 times more frequent in patients with an undiagnosed cervical spine injury,⁴ and permanent sequelae are common.⁵ Second, there may be an understandable reluctance to make such iatrogenic complications public knowledge, although unreported data of quadriplegia and death have been noted.⁶ We describe two patients in whom neurologic injuries followed tracheal intubation, discuss the reasons for their occurrence, and briefly review the care of patients with possible cervical spine injuries.

Case Reports

Case 1

A 45-yr-old unrestrained man suffered bilateral femoral shaft fractures and a closed head injury resulting from a motor vehicle collision

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in which he was the driver. On admission to a peripheral hospital, his Glasgow Coma Scale score was 15, although he was reported by the paramedical staff to have suffered a period of loss of consciousness at the scene. No cervical spine radiographs were obtained; bilateral Thomas splints were applied; and the patient was transferred to King Edward VIII Hospital for operative fixation of the fractures. On repeated examination by the orthopedic registrar, the patient was fully conscious with normal power and sensation in the upper limbs. No sensory deficit was detected in the lower limbs; power was not assessed because of the femoral fractures. Although he complained of neck pain, cervical spine radiographs were again omitted. The induction of general anesthesia was complicated by aspiration of gastric contents during tracheal intubation, which was achieved rapidly but without any effort to immobilize the cervical spine. On emergence after operation, the patient could not breathe spontaneously, and he was transferred to the surgical intensive care unit (SICU). Neurologic examination revealed complete quadriplegia. A lateral cervical spine radiograph showed a fracture of the pedicle of C2 with anterior subluxation of C2 on C3 (fig. 1). Results of computed tomographs of the lower cervical and upper thoracic spine were normal. Halter neck traction was applied. The SICU course was complicated by nosocomial pneumonia and acute renal failure, but the patient was discharged after 36 days. Complete neurologic recovery occurred within a further 5 weeks.

Case 2

A 22-yr-old man was admitted after multiple low-velocity gunshot wounds of the neck (through and through zone II—the area between the cricoid cartilage and angle of the mandible), abdomen (entrance-only subumbilical), and leg (through and through calf). On examination by the surgical registrar, he was found to be fully conscious, in no respiratory distress, and hemodynamically stable. There were no motor or sensory deficits in the limbs, and rectal examination revealed normal sphincter tone. Tenderness and guarding was found on abdominal examination. A lateral cervical spine radiograph showed the upper five cervical vertebrae only, of which no abnormality was evident. The film was not repeated nor were any other views obtained. The patient was transferred to the operating theater for laparotomy. Before induction of anesthesia, no neurologic deficits were evident. Anesthesia was induced, and tracheal intubation was performed without any effort to immobilize the cervical spine. At laparotomy, multiple small intestinal perforations were repaired. At the end of the procedure, neuromuscular blockade was reversed, and the trachea was extubated, but respiratory distress was noted, and the neck appeared to be swollen. The trachea was reintubated, again without cervical spine stabilization. Bilateral neck exploration was undertaken, but no reason for respiratory distress was found. The bullet track was described to pass toward the vertebral bodies, but no fracture was documented. Reversal of intramuscular blockade

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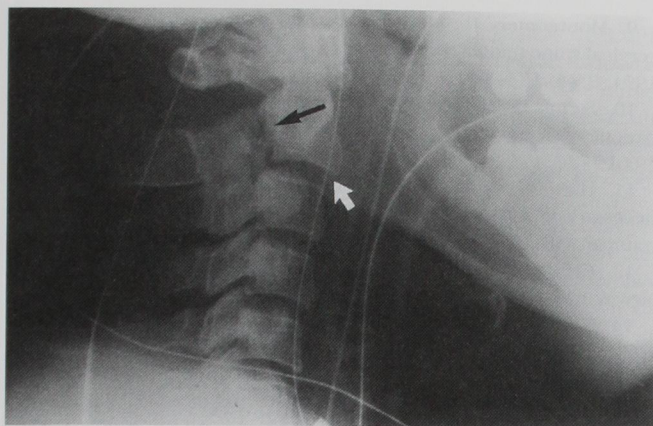


Fig. 1. Lateral cervical spine radiograph demonstrating a pedicle fracture of C2 (black arrow) with subluxation of C2 on C3 (white arrow).

was again complicated by severe respiratory distress, and thus the patient was transferred to the SICU with the trachea intubated. Neurologic examination revealed an incomplete deficit. Ventilation was by diaphragmatic movement alone. Sensation was intact, but motor function was absent in both upper limbs, trunk, and right lower limb. The left lower limb showed grade 1/5 power. Sphincter tone was normal. A computed tomography (CT) scan showed a burst fracture of the body of C6 with retropulsion of a large fragment with narrowing of the diameter of the spinal canal. Initial treatment was by Cones calipers with 2 pounds of traction for spinal immobilization. Later the patient had spinal fusion. The patient regained full mobility and function and was discharged from our care 7 months later.

Discussion

Test results of as many as 70% of patients with serious cervical spine injuries may be neurologically normal.⁷ For this reason, a systematic evaluation of the cervical spine is recommended in patients with major blunt trauma⁸ and in those with gunshot wounds of the neck. There is no consensus with regard to the number and type of radiographs required to exclude injury, and investigation should be dictated according to the clinical circumstances. In symptomatic, hemodynamically stable patients or in those with an altered sensorium or previous analgesia, three views (cross-table lateral, anteroposterior, and open mouth) are essential. All seven cervical and the upper border of the first thoracic vertebrae should be visualized.⁹ These will be sufficient to exclude or confirm cervical spine injury in most patients provided that the films are interpreted by an experienced radiologist.⁸ Even if these radiographs appear normal, as many as 10% of cervical injuries may be missed,¹⁰ and right and left oblique views also have been

routinely recommended.¹¹ Patients with unexplained neck pain require more specialized imaging techniques.^{8,9} Fractures near the base of the skull (Jefferson C1 fracture) are best diagnosed by CT scan and injury of the spinal cord or disc protrusions by magnetic resonance scanning.⁹ Ligamentous injury should be excluded by flexion and extension lateral views with the patient controlling spinal movement. In the absence of such information and given the reported data, it is prudent to treat patients as if they had serious injuries. The available level of skill may dictate the choice of intubation technique,⁶ but the route chosen is less important than ensuring in-line immobilization of the cervical spine.¹² Although routine imaging has been criticized because of the low yield,¹³ failure to diagnose a cervical injury may have disastrous neurologic consequences.^{1,5}

These guidelines were not followed in either of the cases noted here. In the first patient, no cervical spine evaluation was performed despite unequivocal indications to do so. As a result, the patient underwent direct laryngoscopy, which results in maximal movement and extension of the entire cervical spine. This is most marked at the occipitoatlantal and atlantoaxial joints.¹⁴ The result was complete quadriplegia. In the second patient, although a lateral cervical spine film was obtained, it was inadequate and failed to demonstrate the fracture. Although spinal cord injury may have resulted from reasons other than tracheal intubation, such as progressive cord swelling, lateral rotation, or displacement of the posterior fragment by nasogastric tube insertion, this does not excuse an incomplete assessment and missed diagnosis. The most common reasons for missed cervical spine injuries are simple: a low level of suspicion and failure of clinicians to adhere to the basic tenets of cervical spine assessment.^{1,8,9} Appropriate investigations are not requested despite indications,⁴ are undertaken but inadequate,³⁻⁵ or are adequate but misinterpreted.^{2,5,8} Fractures of the second (misinterpretation) and sixth and seventh vertebrae (incomplete views) are missed most frequently.⁵

These cases illustrate the potential consequences of incomplete diagnosis of cervical spine injuries and subsequent inappropriate management. If tracheal intubation is required in patients with trauma to the cervical spine, it is incumbent on the surgeon and anesthesiologist to ensure either that an injury has been satisfactorily eliminated and, if not, to maintain in-line immobilization of the neck at all times.

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Perioperative White Matter Degeneration and Death in a Patient with a Defect in Mitochondrial Oxidative Phosphorylation

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MITOCHONDRIAL dysfunction is being diagnosed increasingly in children and adults who have hypotonia, seizures, stroke, failure to thrive, renal and hepatic dysfunction, or cardiomyopathy.^{1,2} The symptoms and severity of the disorder vary.² In this case report, we describe a child with a defect in oxidative phosphory-

lation whose immediate postoperative course after a semiemergent cholecystectomy was complicated by severe neurologic deterioration and ultimately early death.

Case Report

A 13-month-old girl was admitted for a semiemergent cholecystectomy. Her medical history included hypotonia, gross motor delay, intermittent lethargy, and frequent emesis that developed during the first 2 weeks of life. Extensive gastrointestinal investigations did not reveal a cause, but chronically increased lactate and pyruvate levels in blood and urine and Krebs cycle intermediates in the urine suggested a disorder in energy metabolism.³ Cardiac ultrasound showed normal anatomy and no cardiomyopathy. As a result of persistent vomiting, she received parenteral nutrition and, later, gastrostomy tube feedings after placement of a gastrostomy tube during general anesthesia when she was aged 4.5 months. There were no intraoperative problems, but after operation, she had periods of increased lethargy in part as a result of a urinary tract infection. At age 8 months, as part of a diagnostic evaluation, muscle and liver biopsies were performed during general anesthesia (samples were analyzed in the Molecular Diagnostics Laboratory by Drs. N. Krawiecki and J. Schoff-

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