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Traumatic Atlantooccipital Dislocation: Two Cases with Survival

John C. Bools¹ and Barry S. Rose

Survival following traumatic atlantooccipital (AO) dislocation is rare. This report describes one case of anterior AO dislocation and a second case of posterior AO dislocation, both with long-term survival. Reliable findings for diagnosing AO dislocation with plain radiographs, anteroposterior polytomography, and CT are discussed. A simple rapid CT technique using axial sections to confirm AO dislocation is presented. Traumatic atlantooccipital (AO) dislocation is a common fatal injury in motor vehicle accidents [1-3]. Long-term survival has only been reported in 12 cases. During a recent 7-month period we encountered two cases of AO dislocation, one anterior and one posterior. Both patients survived, one with neurologic impairments and the other with no neurologic deficit. Our discussion includes techniques described previously for making this diagnosis as well as a CT technique for substantiating the diagnosis.

Case Reports

Case 1

A 30-year-old woman was involved in a high-speed motor vehicle accident in which she was the driver. At the scene, the patient was

unconscious but breathing spontaneously. Mild upper-airway obstruction was relieved by the insertion of an oral airway (as observed by one of the authors, JCB, who was the first person to arrive at the accident scene). On arrival at the emergency department, the patient was conscious but demonstrated a left hemiparesis. A crossfire lateral cervical radiograph showed an anterior AO dislocation with marked retropharyngeal soft-tissue swelling (Fig. 1A). The patient was placed in Gardner-Wells tongs for stabilization. Anteroposterior polytomography confirmed the approximately 1.0-cm anterior AO dislocation (Figs. 1B and 1C). When the patient again suddenly lost consciousness, an emergent CT examination of the brain and craniocervical junction was performed. CT showed the anterior AO dislocation with subarachnoid hemorrhage surrounding the upper cervical spinal cord and brainstem. Hemorrhage was also present in the third, fourth, and dependent portions of the lateral ventricles. No other intracranial abnormality was noted.

The patient was maintained in tongs with persistence of the dislocation. She regained normal consciousness. Her neurologic deficits were bilateral cranial nerve (CN) VI palsies, weak voice, difficulty swallowing, a weak left lower extremity, and impaired active mobility of the left upper extremity.

Posterior wire and bone fusion of the occiput to the upper cervical vertebrae was performed. The patient was placed in a halo jacket and was discharged to a rehabilitation center with improvement of her motor deficits.

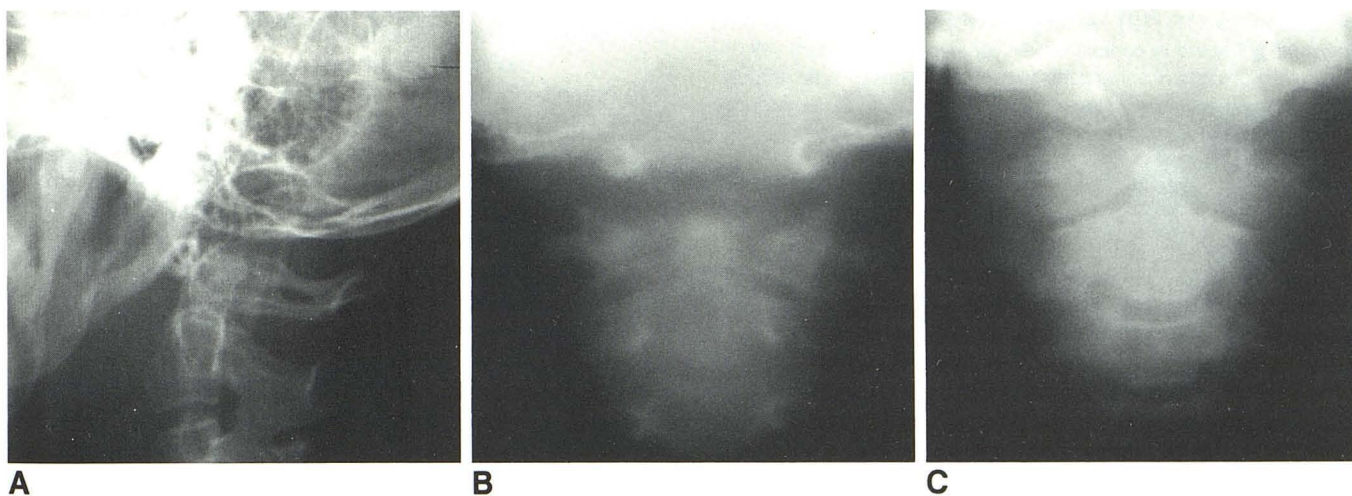


Fig. 1.—A, Anterior atlantooccipital dislocation (case 1). B and C, Anteroposterior polytomograms. B is 8.5 cm anterior to tabletop; C is 10 cm anterior to tabletop.

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Case 2

A 20-year-old woman passenger was involved in a high-speed motor vehicle accident and was initially evaluated at another hospital. She was alert, oriented, and had only mild abdominal complaints. A C1 fracture was diagnosed. She was immobilized with a soft collar, sand bags, and transported to our emergency department.

Upon arrival, she was dyspneic, with increasing abdominal complaints. She denied neck pain and was neurologically intact. Crossfire lateral cervical radiographs showed fracture of the posterior arch of C1 with posterior AO dislocation (Fig. 2A). A chest radiograph revealed right pneumothorax, which was treated by tube thoracostomy.

Gardner-Wells tongs were used for stabilization. Exploratory laparotomy and splenectomy were performed for fractured spleen. Her neurologic course was uncomplicated. A posterior wire and bone fusion of the occiput and upper cervical vertebrae was performed. The patient was maintained in a halo jacket for 4 months. Flexion and extension radiographs at that time showed stable fusion (Fig. 2B). She remains without neurologic deficit.

Discussion

A review of several series of injuries sustained by trauma victims who died at the accident scene suggests that AO dislocation accounts for up to one-third of the fatal cervical spine injuries [1-3]. Previously, only 17 cases of survival after traumatic anterior AO dislocation have been reported [4-15]. Of those, only 10 have survived long-term. Two cases of survival after posterior AO dislocation have been reported [16-17]. While AO dislocation is unusual, immediate recognition and treatment are essential for survival.

Extreme hyperextension and/or extreme lateral flexion have been the presumed mechanisms of injury. Rupture of the tectorial membrane, the cranial extension, and attachment of the posterior longitudinal ligament to the occiput allows the occiput to further extend until it contacts the spinous process of C2. At that point, bony contact limits further extension and acts as a fulcrum, allowing the occipital condyles to dislocate in relation to C1 [12]. A large retropharyngeal hematoma

usually accompanies these injuries and frequently compromises the upper airway. Extreme caution must be exercised in reestablishing the airway in these patients. Emergency tracheostomy may be the procedure of choice.

Most patients surviving the initial injury have significant neurologic impairment; however, some may initially be completely neurologically intact. The most common neurologic deficits are CN VI and CN IX-XII palsies. Cranial nerve VI is most commonly involved, frequently with a permanent deficit. Ischemia, contusion, or laceration of the brainstem can cause respiratory depression, labile hypertension, and cardiac arrhythmias. Spasticity, paralysis, paresis, and sensory deficits can occur, but often resolve once stability is reestablished at the craniocervical junction.

Pang and Wilberger [12] have previously published a review of the radiographic criteria for diagnosis of AO dislocation. Wholey et al. [17] suggested the dens-basion (DB) distance with the head and cervical spine in neutral position and the top of the spine directly below the basion averages 5 mm in adults. A distance of 1 cm may be normal in infants and young children due to incomplete bone growth; however, DB varies with flexion and extension. Dublin et al. [11] stated that the distance between the posterior mandibular cortex and the anterior arch of the C1 (A) and the distance between the posterior mandibular cortex and odontoid (B) in normal individuals falls between a certain range, which is exceeded only if AO dislocation is present. Because the sagittal planes of the mandible and odontoid are widely separated, rotation alters the measurements considerably. Dublin et al. recognized this and suggested choosing a midpoint between the posterior cortices of the mandibular bodies as the reference point. Flexion and extension, however, also influence the distances A and B. A fracture of the mandible could also invalidate these measurements.

The BC/AO ratio proposed by Powers et al. [10] appears to be the most sensitive parameter of AO alignment. However, this applies only to anterior dislocations. (BC is the distance

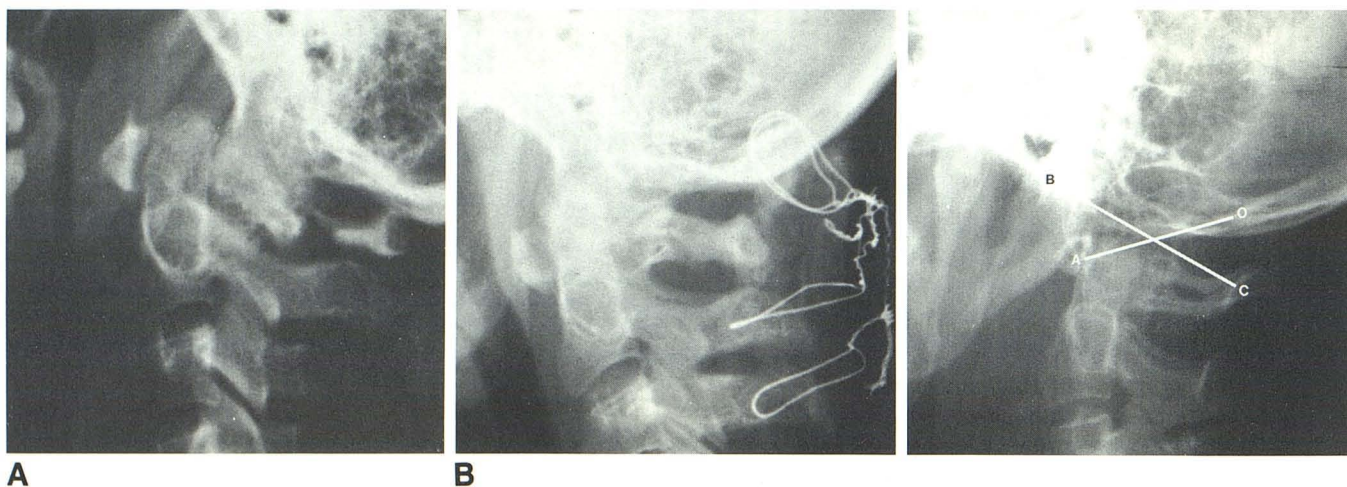


Fig. 2.—A, Posterior atlantooccipital dislocation (case 2) with fracture of posterior arch of C1. B, Posterior atlantooccipital dislocation (case 2) 4 months after fusion.

Fig. 3.—Anterior atlantooccipital dislocation (case 1), same as Figure 1, with Powers ratio BC/AO (1.4).

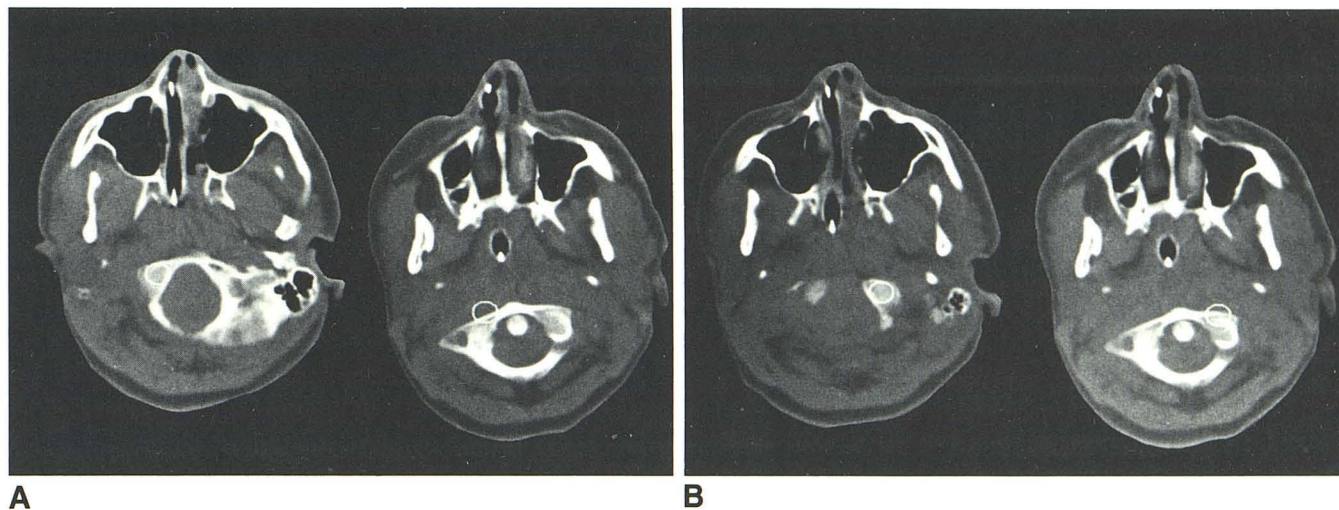


Fig. 4.—Anterior atlantooccipital dislocation (case 1) axial CT demonstration of dislocation using region-of-interest cursor placed at occipital condyles and at C1 facets: A, right; B, left.

between the basion, the midline anterior margin of the foramen magnum, and the midpoint between the arch-canal line of the atlas; AO is the distance between the opisthion and the midpoint of the posterior surface of the anterior arch of the atlas.) Occasionally it may be difficult to see the basion and opisthion, making tomography necessary. All patients with anterior dislocations have ratios greater than 1.0, whereas all normal patients have ratios less than 0.9 (Fig. 3). The landmarks are essentially uninfluenced by rotation, flexion, or extension. Moreover, because a ratio is dimensionless, problems with anatomic variation and magnification are eliminated.

We feel the subjective assessment of alignment of the tip of the basion to the mid portion of the dens and Powers ratio provide the most useful and easily obtainable plain radiographic information regarding the AO junction.

CT is the method of choice when more sophisticated evaluation is necessary after plain radiographs [12, 14]. CT allows detailed assessment of the cranial cervical junction both for bony as well as soft-tissue detail. While previous reports have described the use of CT with coronal and sagittal reconstructions to evaluate the AO junction [14], we describe the following simple technique for confirming AO dislocation. Rather than obtaining the numerous thin, overlapping sections necessary to generate satisfactory reformations, we acquired contiguous 5-mm axial slices through the foramen magnum and C1. Our scans were obtained with a Technicare 2060 CT using 120 KVp, 600 mAs, 75 mA, and 8 sec. Then, using a region of interest cursor placed on the occipital condyles, we changed to a slice through the superior articular facets of C1. Since the region remains fixed, any change in alignment between the two sections will be demonstrated as malalignment of the cursor and the facets (Figs. 4A and 4B). CT also has the advantage of keeping the patient supine, and is frequently necessary to evaluate possible intracranial trauma.

If CT is unavailable, anterior posterior polytomography can

confirm suspected AO dislocation (Case 1). This examination provides adequate information and avoids subjecting the patient to the risks of being turned into the lateral position.

Summary

These two cases with long-term survival after anterior and posterior AO dislocation point out the importance of making the diagnosis. Our simple technique of rapid CT confirmation of AO dislocation is a practical adjuvant procedure, particularly in patients with suspected intracranial injury.

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