Combined Traumatic Occiput-C1 and C1-C2 Dissociation: 2 Case Reports

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Abstract

Occiput-C1 and C1-C2 dissociations and dislocations have been well documented in the literature. However, after thorough review of the literature, we found very little in the literature regarding combined occiput-C1 and C1-C2 dissociations in adults who survived.

We present 2 case reports describing the clinical presentation, initial management, operative treatment and postoperative course of 2 patients who sustained traumatic combined occiput-C1 and C1-C2 dissociations.

After initial stabilization, both patients underwent open reduction and posterior occipital-cervical fusion with segmental fixation. At recent follow-up, both patients maintain good sagittal alignment without loss of reduction, and they have radiographic progression to fusion, minimal pain, and improved neurologic function.

Combined occiput-C1 and C1-C2 dissociations are rare but serious injuries. Incomplete dissociations may not be evident on initial radiographs. Computed tomography or magnetic resonance imaging is recommended for formal diagnosis. A traumatic dural tear may be present. We recommend open reduction and posterior occipital-cervical fusion with segmental fixation for these patients.

Atlanto-occipital and atlanto-axial subluxations and dislocations are rare and serious injuries.[1] Although incomplete dissociation of occiput-C1 and C1-C2 have been written about as separate events,[2-13] this report documents 2 cases in which an adult with the combination of these 2 rare events was successfully treated in our institution. These injuries are associated with subtle findings not obvious on radiographs,[14] so orthopedic physicians seeing patients who may be at risk for atlanto-occipital and atlanto-axial subluxations and dislocations should have a high clinical suspicion and thoroughly review imaging for more definitive diagnosis, specifically computed tomography (CT) scans with sagittal reconstructions. Rapid recognition of subluxations in emergency room settings will often prevent neurologic deterioration and/or potentially fatal outcomes.[15,16]

The authors attest that we have obtained the written informed consent of the patients in this case report to print their case reports and radiographs.

Case Report 1

A man in his early 20s was involved in a rollover motor vehicle collision. He sustained a subdural hematoma, a right pneumothorax, bilateral pulmonary contusions, and a right acetabular fracture with posterior hip dislocation. He was intubated and resuscitated in the emergency department. An initial 3-dimensional CT scan showed atlanto-occipital dissociation characterized by a normal atlanto-occipital joint distance with a slight anterior translation and rotation of the occiput relative to C1 (Figures 1A, 1B). The right atlanto-occipital joint measured 6 mm (normal is 1-2 mm)[4] on the coronal reconstructions, but the left was normal at <1 mm (Figure 1B). The patient was also found to have C1-C2 dissociation characterized by widening of the intraspinous distance between C1 and C2 and widening of the right facet joint of C1 and C2. The intraspinous distance between C1 and C2 measured 12 mm in extension (Figure 1A). The right C1-C2 facet joint distance measured 4.5 mm (normal is less than 3 mm)[4] (Figure 1B). The patient was initially stabilized

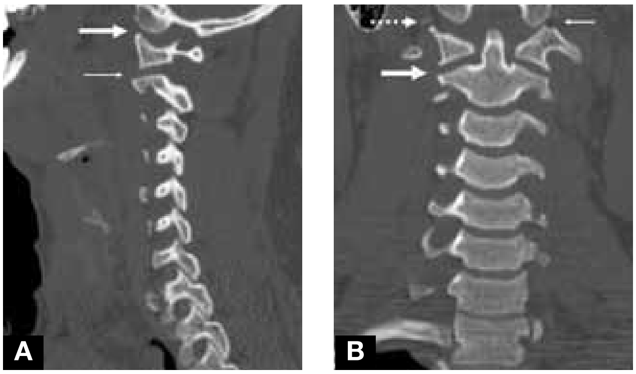

Figure 1. **Case 1—(A) Sagittal computed tomography scan. The thick arrow demonstrates diastasis of the occiput on C1 with anterior translation of the occiput. The thin arrow denotes widening between C1 and C2 of 4.5 mm and posterior translation of C2 on C3. (B) The dashed arrow denotes widening of the right occiput on C1 with a small bony avulsion fracture. The thick arrow denotes subtle widening between C1 and C2 on the right side. The thin arrow demonstrates subluxation and decreased space between the occiput and C1.**

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Figure 2. Case 1—Postoperative radiograph at 2 years demonstrating posterior occiput–to-C2 segmental fixation and a solid fusion mass.

Figure 3. Case 2—Preoperative radiograph showing widening of the C1-C2 intraspinous distance, which measures 21 mm.

in a cranial halo and vest. He demonstrated no motor deficits in his bilateral upper and lower extremities. He was able to breathe on his own above the ventilator.

Previous literature has documented the instability of atlanto-occipital dissociation injuries. Definitive treatment is with open reduction, posterior occipital-cervical arthodesis, and segmental fixation from the occiput to C2. In this case, a standard posterior cervical approach was used to expose the caudal aspect of the occiput and the cervical spine. At surgery there was gross disruption of the ligamentum flavum between C1 and C2 and between the occiput and C1. The C1 ring was grossly unstable. Bilateral C2 pedicle screws were placed with fluoroscopic guidance. A titanium occipital plate was applied to the base of the occiput and attached with 12-mm keel screws. Two 3.5-mm titanium rods connected the occipital plate to the C2 pedicle screws. Compression facilitated the reduction. A thorough decortication was performed. Both tricortical structural allograft and rhBMP-2 on an absorbable collagen sponge (InFUSE™, Medtronic Sofamor Danek USA, Memphis, Tenn) were added to facilitate fusion. After a prolonged hospital course and a number of non-spinal surgeries, the patient was discharged to an inpatient rehabilitation center. At 2-year follow-up, the patient maintains excellent alignment, with radiographic evidence of a solid arthrodesis (Figure 2). In addition, the patient had minimal cervical pain, was able to ambulate although with limitations due to the surgical arthrodesis of his hip, and could perform all activities of daily living without assistance.

Case Report 2

A woman in her late 50s was involved in a motor vehicle collision and presented to our emergency department with acute neck pain. The patient had no motor or sensory deficits upon her initial physical exam. Her cervical spine was temporarily stabilized with a rigid cervical collar. Radiographs of her cervical spine were limited because of her body habitus but revealed a widened C1-C2 intralaminar distance of 21 mm (Figure 3). On 3-dimensional CT scan of her cervical spine, a nondisplaced odontoid fracture, widening of the intralaminar space between C1 and C2, and widening of the left facet between C1 and C2 were noted (Figure 4). The left C1-C2 facet joint distance measured 5 mm, confirming our diagnosis of C1-C2 dissociation. Atlanto-occipital dissociation was also suspected because the right occipital condyle was 4 mm anteriorly translated with respect to C1. A magnetic resonance imaging (MRI) scan was obtained for further evaluation, and it revealed ligament disruption, subluxation, and diffuse edema between the occiput and C1 and also C1 and C2 (Figure 5).

The patient underwent open reduction and posterior occipital-cervical arthodesis, with segmental fixation from the occiput to C3. Gardner-Wells tongs with 5 lb of axial traction were applied at the start of the procedure. A standard posterior cervical approach was used to expose the upper cervical spine. A collection of cerebrospinal fluid was noted in the subcutaneous tissue, indicating a traumatic dural tear. After exposure of the upper cervical spine, significant instability was noted at both occiput-C1 and at C1-C2. Significant vertical instability was noted between C1 and C2. The dural tear was repaired. Lateral mass screws were then placed in C3. Given the aberrant course of the vertebral artery both in C1 and C2, lateral mass screw fixation in C1, pedicle screw placement in C2 and transarticular C1-C2 screw placement were contraindicated. The surgical construct consisted of an occipital plate, C3 lateral mass screws, C2 sublaminar hooks, and C1-C2 sublaminar wires. Compression between the occiput and C2 facilitated the reduction, and two 3.5-mm titanium rods helped stabilize the construct. Decortication, insertion of tricortical structural allograft, and addition of rhBMP-2 on

Figure 4. Case 2—Cervical sagittal computed tomography scan. The thin arrow denotes very subtle widening of the posterior aspect of the occiput on C1. The thick arrow demonstrates increased widening of the C1-on-C2 joint space.

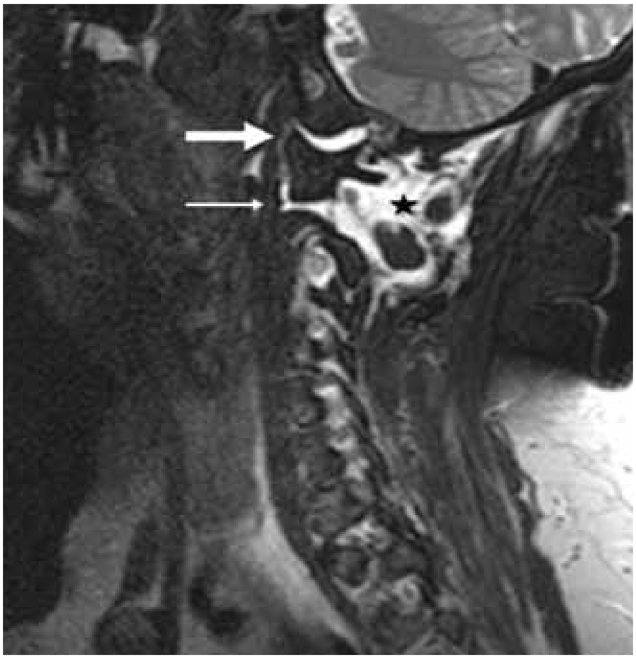

Figure 5. Case 2—Preoperative sagittal T_2-weighted magnetic resonance image. The thick arrow denotes increased fluid on the occiput-C1 joint. The thin arrow represents increased fluid between C1 and C2. The star denotes diffuse edema in posterior ligaments, suggesting ligamentous injury.

Figure 6. Case 2—Postoperative radiograph showing maintained reduction, segmental fixation from occiput to C2, and progression of arthrodesis to fusion.

an absorbable collagen sponge (InFUSE) were carried out in order to facilitate a fusion. The wound was closed in standard layered fashion. After a short hospital course, the patient was transferred to an inpatient rehabilitation facility, and her neck was immobilized in a Miami J cervical collar (Ossur Trauma & Spine, Paulsboro, NJ) for 8 weeks. At 2½ years after surgery, she remained neurologically intact and had minimal pain. Her radiographs at 2½ years revealed excellent sagittal alignment, with maintained reduction, and radiographic progression to fusion (Figure 6).

Discussion

The incidence of craniocervical dissociative injuries is unknown. Because of the rarity of these injuries, and because most patients expire prior to evaluation, only a handful of case reports have been documented in the literature.[17] We have described 2 cases of combined occiput-C1 and C1-C2 subluxation in patients who have survived injury.

The mechanism of injury in these patients, both of them treated at our institution, was most probably a deceleration that caused a hyperextension-flexion injury. Hamai and colleagues[18] described a similar though somewhat more extreme case of traumatic atlanto-occipital dislocation with atlantoaxial subluxation that they felt was principally due to a hyperextension-flexion injury during a motor vehicle accident. Other case reports of survivors of craniocervical dissociative injuries have shown that a majority of these injuries occur as a result of a sudden vehicular deceleration or in pedestrians struck by a motor vehicle.[3,10,18]

Traynelis and colleagues[13] developed a classification system for occipitocervical subluxations and dislocations that was based on the direction of displacement. Type I injuries are anterior translocations of either unilateral or bilateral occipital condyles in relation to the C1 lateral masses. This is the most common type of occipitocervical subluxation. Type II injuries are defined as vertical displacement of the occipital condyle greater than 2 mm.

These injuries can also occur at the atlantoaxial articulation. Type III occipitocervical dissociation is manifested by a posterior translation usually with associated atlas fracture. Both of our patients had a type I anterior subluxation of the occipital condyle relative to the C1 lateral mass with concurrent vertical displacement of the C1 lateral masses relative to the C2 lateral masses. When this classification system is applied, our 2 patients, to the best of our knowledge, are unique in the literature.

Although the alar ligament and the tectorial membrane were found to have been involved in both cases, the instability in these cases implies other ligamentous injury, including the gross disruption noted in the ligamentum flavum between C1 and C2 and between the occiput and C1, as seen in our first case. Sometimes this injury is associated with a traumatic dural tear such as in our second case. One needs to be especially careful in appreciating the course of the vertebral artery in the process of establishing safe mechanical stabilization of these injuries.

In both of our patients, the atlas-dens interval and lateral atlas-dens interval were normal. Therefore the transverse atlantal ligament was felt to be intact. Wackenheim's line, Powers ratio,[11] Harris lines,[19] and the X-line method of Lee and colleagues[20] have all been described as accurate tools with which to initially assess a patient for altanto-occipital dislocation. However, Powers ratio is not reliable for subtle subluxation, posterior atlanto-occipital injuries, or rotational atlanto-occipital injuries. Wackenheim's line, Powers ratio, Harris lines of dens-basion interval, and posterior axis line to basion were normal in our 2 patients. Both patients did meet the criterion of having occipital condyle–to-atlas displacement of greater than 2 mm. One of our patients met the criterion of the X-line method described by Lee and colleagues.[20] This is not an uncommon occurrence, as many previous documented case reports do not meet the criteria of these radiographic assessments. One must be acutely aware of the patient's history regarding type of accident and the findings of the physical exam and also have a high index of suspicion because of the often incomplete diagnostic findings. The findings of revealed ligament disruption, subluxation, and diffuse edema between the occiput and C1 and also C1 and C2 were only appreciated with full examination of both condyles on MRI with sagittal reconstruction, as opposed to radiographs or even MRI coronal or axial cuts.

In summary, the purpose of this paper is to alert orthopedic and emergency room physicians to be cognizant of the subtle findings that can easily be missed in these rare but eminently treatable patients with these combined injuries as evidenced by the favorable outcome of our 2 patients.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award.