

Concomitant fracture of bilateral occipital condyle and inferior clivus: what is the mechanism of injury?

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Received: 11 July 2006 / Revised: 14 October 2006 / Accepted: 6 November 2006
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Abstract With the routine use of multi-slice high resolution computed tomography, increasing number of occipital condyle fractures have been reported in the last decade. The authors report a very rare case of bilateral occipital condyle fracture complicated by the fracture of the inferior clivus and discuss the possible mechanisms of injury.

Keywords Clivus fracture · Halo vest · Mechanism · Occipital condyle fracture · Trauma · Treatment

Introduction

Since the first description by Bell [3] in 1817, fractures of the occipital condyle remain to be a challenging entity for many radiologists, neurosurgeons and orthopedic surgeons. This is mainly due to variations in the clinical presentations and inability to detect the

fracture by routine X-ray examination in emergency room settings [2, 9]. In this report, we present an extremely rare case of a bilateral occipital condyle fracture complicated by the fracture of the inferior clivus and aim to discuss the possible injury mechanisms. The importance of careful investigation of the craniocervical junction integrity in all patients with high velocity head and cervical trauma is also stressed.

Case report

This 25-years-old male was admitted to emergency room following motor vehicle accident. On admission he found to have a Glasgow Coma Score (GCS) of eight, reactive pupils and respiratory distress. Radiological investigations revealed subarachnoid hemorrhage, right temporal contusion, right sided pneumothorax, lung contusion, and a right femur fracture. A detailed computed tomography (CT) scan of cranio-cervical junction revealed bilateral fracture of the occipital condyles and inferior clivus (Fig. 1). After immobilization by rigid collar, a chest tube was applied. Following the insertion of a right ventricular catheter, the patient was treated according to severe head injury protocol [5]. Eye opening and spontaneous movement of extremities was noted at posttraumatic seventh day.

After partial resolution of pulmonary problems, magnetic resonance imaging (MRI) of the cranio-cervical junction at posttraumatic ninth day revealed rupture of anterior atlantooccipital ligament and hematoma in anterior and posterior peridural area at dento-clival space with posterior bulging of tectorial membrane (Fig. 2). No signs of lower cranial nerve paralysis were observed in ENT examination. External

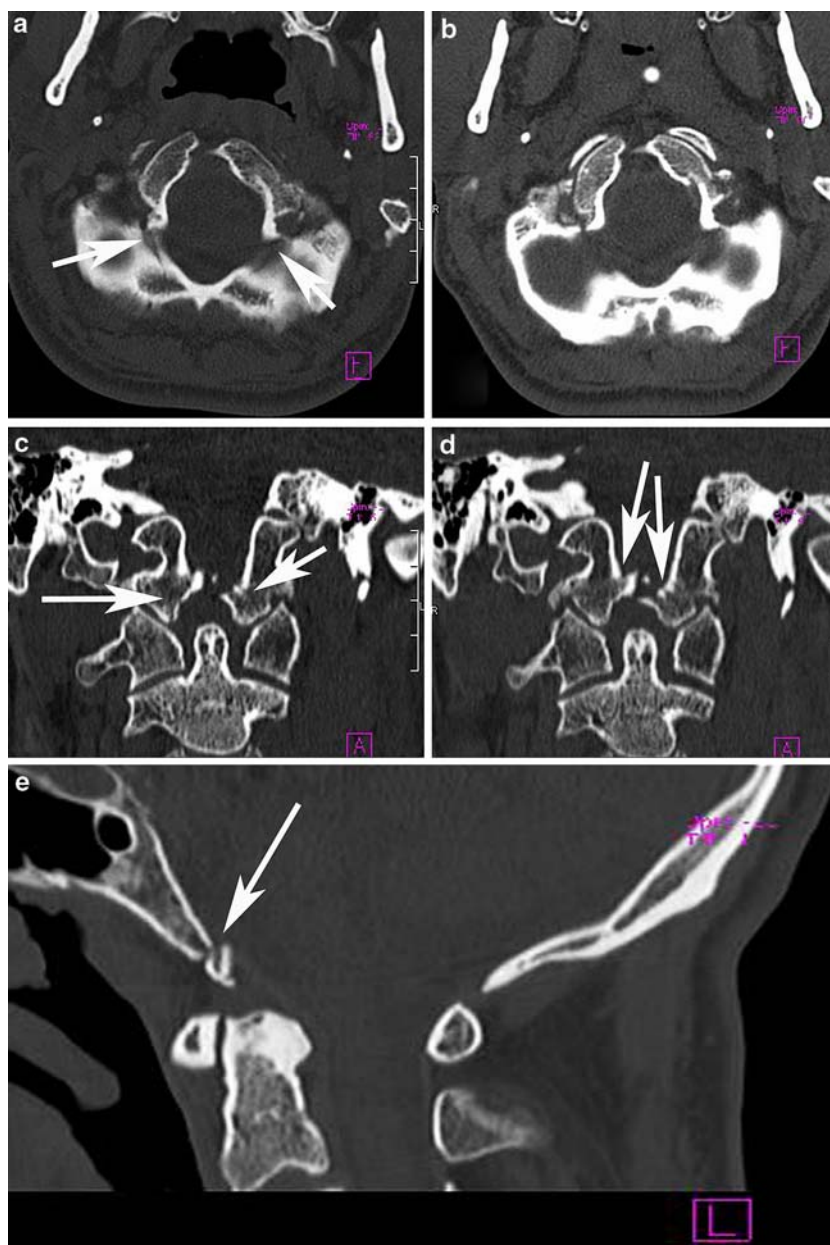
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Fig. 1 Axial CT (**a, b**) and coronal reconstruction CT (**c, d**) of craniocervical junction reveal bilateral occipital condyle fractures (*arrows*). Midsagittal CT reconstruction (**e**) shows fracture of the clivus (*arrow*)



immobilization by Halo vest was performed then which remained for 12 weeks until the bony healing (Fig. 3).

Discussion

Routine use of multi-slice CT, resulted to an increase in the number of reported cases of occipital condyle fractures (OCFs) in the last decade [9, 11, 16]. Capuano et al. [6] in a review of literature found 11 reported cases between 1817 and 1974 and 225 cases up to 1999. High resolution reconstructed CT imaging is the gold standard technique in diagnosis and also provides precise data on degree of displacement of fractured

bone [7]. MRI, on the other hand, can be useful for the assessment of cord injury and soft tissue [2, 9, 10]. In the present case although MRI scans were able to show the intact tectorial membrane, the integrity of the anterior atlantooccipital ligament and the alar ligaments was impossible to assess due to presence of periarticular edema and hematoma. Since the atlanto-dental distance was in normal ranges, transverse ligament, the crucial component of the upper cervical ligamentous complex, was assumed to be intact.

In the most commonly used classification of OCFs, Anderson and Montesano [1] divided OCFs into three types according to the radiographic appearance and presumptive mechanism of injury. OCF Type 1 is



Fig. 2 Sagittal T1-weighted MR image showing the hyperdense lesion consistent with hemorrhage and periarticular edema located at craniocervical junction. Bulging of the intact tectorial membrane is noted (*arrow*)



Fig. 3 Coronal reconstruction CT performed 12 weeks after Halo immobilization shows medullary and cortical callus formation and nearly complete fusion (*asterisks*)

characterized by an impacted condyle fracture with comminution occurring as a result of axial loading. OCF Type 2 is described as a basilar skull fracture with extension into the condyle which is morphologically linear. OCF Type 3 is defined as an avulsion fracture at the insertion sites of alar ligaments.

Bilateral OCF with a concomitant clivus fracture is rarely encountered and underlying mechanisms have not been satisfactorily determined. Hyperflexion or hyperextension in association with distraction and axial

rotation and resultant avulsion fracture at the site of attachment of alar ligaments and tectorial membrane has been proposed [11–13, 15].

Unilateral avulsion fracture of the occipital condyles might well be explained with lateral bending, rotation or both. However, there are authors who have stressed the need for further studies elucidating the real mechanisms of injury especially for Type III OCFs [17]. This issue is also important for bilateral OCFs. For instance, the distraction forces which causes straining of the alar ligament and the subsequent avulsion fracture on one side does not cause straining on the opposite alar ligament thus, we believe the proposed mechanisms are deficient in explaining the mechanism in bilateral condyle fractures. Furthermore concomitant clival fracture in bilateral OCF cases cannot be explained with the current proposed mechanisms.

In our opinion, the mechanism of injury in bilateral OCF fracture is pure axial loading and compression which is the proposed mechanism for Type I OCF. With such an injury, both occipital condyles may have been impacted, leading to their fracture and displacement. Likewise, the fracture of the clivus may also be explained by the same mechanism. An axial impact to the vertex may have caused compression of the cranial base and vertebral bodies so that the clivus is pushed downwards towards the anterior tubercle of C1, leading to its fracture. Since the mechanism of injuries are discussed mainly on theoretical basis further studies are needed for eliciting the true reasonable causes for OCFs.

Treatment of OCFs is based on immobilizing the craniocervical junction either with external devices or surgically. However, there are no widely accepted treatment guidelines [9, 14]. Although successful treatment of bilateral OCFs with cervical collar has been reported [4] more rigid fixation is warranted if a concomitant clivus fracture is identified.

According to our knowledge, apart from the present report, there are only five cases reported previously [8, 12–15] (see Table 1). The first reported case of bilateral OCF with extension to clivus by Jones et al. [13] was quadriplegic and treated by posterior fusion procedure at the fourth week of his admission. A similar case reported by Tanabe et al. [15] was treated with halo brace for 16 weeks. Fuentes et al. [8] reported successful treatment with posterior C1 laminectomy without fusion. Imamura et al. [12] surprisingly reported occipito-cervical instability in their autopsy case in spite of intact transverse and alar ligaments and the tectorial membrane. Maughan et al. [14] recently reported their patient treated by a new technique of occipito-C1 fixation rather than the typical surgical method of occipito-C2 or below fixation. Another re-

Table 1 The summary of the bilateral occipital condyle + clivus fracture cases reported in the literature

Author	Age/sex	Neurological deficit on admission	Type ^a	Treatment
Jones [13]	43/M	Quadriplegic, loss of DTR in upper limb	III–III	Surgery (Oc fusion) (4 weeks)
Tanabe [15]	38/M	Bilateral CN VI, left CN IX and X palsy, upper limbs paretic, crossed sensory loss	III–III	Halo (16 weeks)
Fuentes [8]	47/F	Tetraparetic, left CN VI	I–III	Surgery + hard collar (12 weeks)
Imamura [12]	25/M	Severed medulla oblongata, torn basilar artery	III–III	Autopsy
Maughan [14]	31/F	Neurologically intact	III–III	Surgery (occiput-to-C1 fusion)
Present case	25/M	Neurologically intact	– ^b	Halo (12 weeks)

^a OCF type according to Anderson and Montesano classification

^b If the mechanism of injury (axial loading) is concerned, Type I should be the appropriate type, however no comminution was detected in both condyles

ported occurrence of a rare combination of an avulsion of both the right occipital condyle and clivus and a fracture of the left lateral mass of the atlas was treated with a cervical collar [11]. In the present case, due to systemic problems, a rigid cervical collar was considered sufficient for cervical immobilization in a patient under sedation. However, after partial resolution of the pulmonary problems a Halo vest is immediately applied for rigid fixation. After the documentation of bony healing, Halo vest is removed.

Conclusion

In this report, a rare variant of bilateral OCF with extension to inferior clivus is presented. Diagnosis is made by high-resolution multi slice CT examination of cranio-cervical junction. MRI may have a limited value in showing the functional integrity of the upper cervical ligamentous complex due to presence of periarticular edema and hematoma.

The mechanism of injury suggested for OCFs are largely based on rational theoretical analysis and may be insufficient in explaining bilateral OCFs and a concomitant clivus fracture. In cases where the transverse ligament integrity is considered intact, external immobilization may be sufficient for maintaining stabilization. In the present case satisfactory results were obtained after 12 weeks immobilization with Halo vest.

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