Case Report

Traumatic posterior atlantoaxial dislocation without related fractures of C1-C2

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Abstract

Posterior dislocation without any associated fracture of odontoid is exceedingly rare and only 11 cases have been reported so far. A 32 year old male presented with pain, stiffness in neck, difficulty in breathing, associated lacerations on face and deformity of mandible and inability to open mouth. His plain radiographs, CT scan, MRI demonstrated a posterior dislocation of the atlas with respect of axis and a flake of bone from odontoid process on CT scan. He was successfully managed by closed reduction, C1C2 lateral mars pedicular screw stabilization and inter facetal fusion with synthetic bone graft substitute. At 10 months followup he had lost only 30° cervical rotation. The case is reported in view of rarity and to discuss the treatment rationale.

Key words: Posterior atlantoaxial dislocation, posterolateral pedicle fixation, transverse ligament, traumatic

Introduction

The posterior atlantoaxial dislocation is usually associated with a fracture of the odontoid process, rupture of the transverse ligament, or a congenital anomaly.[1] This injury occurs following high-velocity trauma. Posterior dislocation without any associated fracture of odontoid is exceedingly rare, with only 11 cases reported so far to the best of our knowledge.[2-12] We present posterior atlantoaxial dislocation without odontoid process fracture or neurological deficit.

Case Report

A 32 year old man presented with pain and stiffness in the neck, difficulty in breathing associated with lacerations on face and deformity of mandible with inability to open the mouth following trauma. He was travelling in a car which was hit to a parked lorry from the side. There was no history of unconsciousness or signs of head injury. The neurological examination showed no apparent neural deficit. Emergency tracheostomy was performed.

On secondary survey, the patient was well oriented to time and space with no evidence of concomitant chest, abdominal or head injuries except laceration on his face with fracture of mandible. The flexion/extension and rotation of the neck, along with opening of mouth were restricted. The patient did not have any signs of generalized ligamentous laxity.

Radiographs of the cervical spine demonstrated a posterior dislocation of the atlas with respect to the axis [Figure 1] with no evidence of fracture. The C7 vertebra was not visualized due to overlap of the shoulders. Magnetic resonance imaging (MRI) [Figure 2] of the cervical spine demonstrated no cord compression or intramedullary cord signal abnormality at the level of the atlantoaxial dislocation. The membrana tectoria/apical and transverse ligament at lateral attachment of dens was torn. Superior transverse ligament was found intact. Computed tomography (CT) of the spine showed anterior displacement of C2. The dens was situated anterolateral to the anterior arch of C1 with facet joint dislocation of C1-C2. There was diffuse prevertebral soft tissue shadow seen from C1 to C4 level. A tiny fracture fragment seen adjacent to odontoid process. Atalanto-occipital joint appeared normal. Body and posterior arch of C2 appeared normal. Occipital condyles and rest of visualized cervical spine appeared normal. Comminuted displaced fracture was seen involving the angle and ramus of mandible on the right side.

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Closed reduction on skeletal traction under anesthesia was attempted with help of image intensifier [Figure 3a] and neurological monitoring by Wong three-step method.[7]

Figure 1: X-ray of cervical spine lateral view showing posterior dislocation of C1 with mandibular fracture

Figure 2: T2W MRI midsagittal view showing signal changes with no cord edema

Distraction phase

Traction is applied in slight flexion to keep C1 ring apposed to posterior odontoid.

Realignment phase

The C1 ring has slipped back over the odontoid but is displaced too far forward because of slightly excessive flexion angle of traction.

Release phase

Traction is changed to slight extension, allowing the C1 ring to come closer to anterior odontoid. Traction is then released over several hours.

The attempt of closed reduction failed. We had to proceed for open reduction with posterior stabilization and fusion [Figure 3b].

Operative Procedure

Under general anesthesia (GA), with the patient in the prone position, an incision was made in the midline from the external occipital protuberance inferiorly for 6-8 cm. The wound was deepened in line with the skin incision by incising the fascia and nuchal ligament in the midline of the neck, cutting down onto the large spinous process of C2. This fascial incision was extended distally onto the spinous process of C3 and then proximally onto the tubercle of C1. It was continued proximally, cutting down onto the external occipital protuberance. The facetal joints of C1-C2 and C2-C3 were exposed; Apical, alar, cruciate and posterior longitudinal ligament were torn, then under image intensifier, lateral mass pedicular screws were put and interfacetal fusion using synthetic bone graft substitute was done. Wound was closed in layers. The cervical spine was kept immobilized in a rigid cervical collar for an additional 3 months with no deterioration of neurology status [Figure 4a-c]. At followup, he had lost only 30° of cervical spine rotation. Flexion extension radiographs did not show instability at the C1-

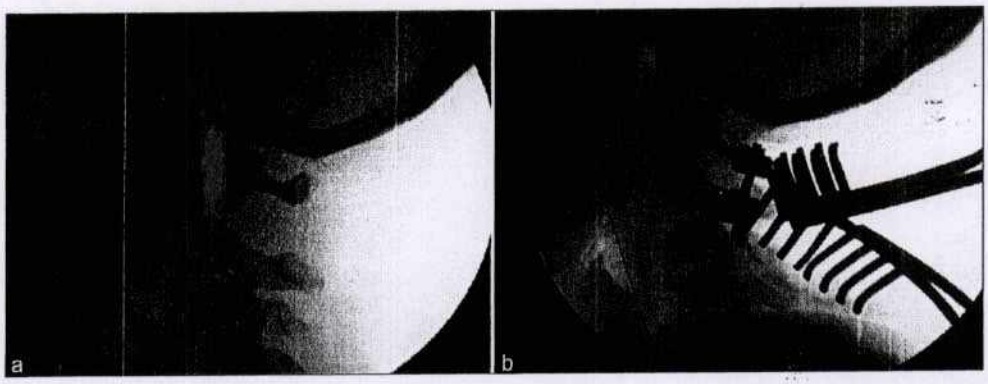

Figure 3: Fluoroscopic lateral view of cervical spine showing (a) controlled intraoperative closed reduction under image intensifier (b) Intraoperative image intensifier images of posterolateral pedicle screw fixation

C2 complex at the final followup of 10 months. An open mouth view with manual cervical traction did not show any distraction at the C1-C2 joint.

Discussion

Isolated posttraumatic atlantoaxial subluxation is a rare injury.[13] Nontraumatic anterior atlantoaxial subluxation is far more frequent in cases of rheumatoid arthritis, connective tissue disorders, and variety of congenital anomalies including Down's syndrome. Posterior displacements of 5-10 mm can develop after isolated transverse ligament rupture; further separation of C1 and C2 without fracture or rotation requires disruption of the apical, alar, cruciate, and posterior longitudinal ligament[14] or inefficiency of the alar.

The rarity of this dislocation is largely due to the stable configuration of the atlantoaxial complex. The odontoid process interlocks in the osseo-ligamentous ring formed ventrally by the anterior arch of the atlas and dorsally by the transverse ligament. Thus, the ring is weaker dorsally and commonly allows anterior dislocations.[16] However, with posterior dislocation, trauma tends to cause enough displacement to produce major cord damage with immediate death or posterior dislocation without fracture of the odontoid. This event may occur more frequently in fatal accidents, and lesion at this level might well be missed in a routine radiology and postmortem examination.[17] So, posterior dislocation without fracture may occur more frequently than reported.[18]

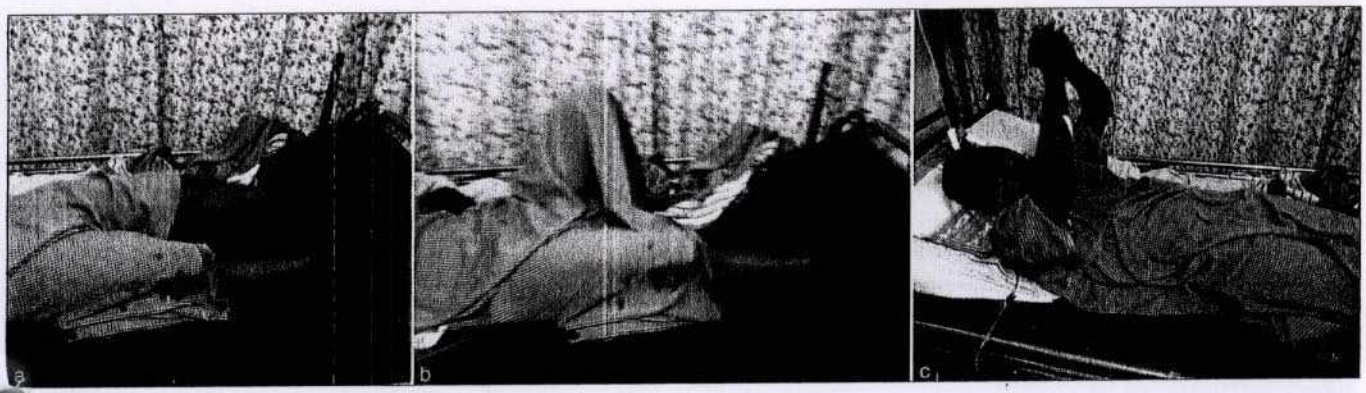

Figure 4: Clinical photograph (postoperatively) showing (a) Active movement of left lower limb (b) Active movement of right lower limb (c) Active movement of both upper limbs

Table 1: Details of previously published case reports

Case no.	Reference	Age (years)	Sex	Mode of injury	Facial lacerations	Neural deficit	Reduction	Internal fixation	Late instability	Follow up
1	Haralson[2]	30	Male	Polytrauma RTA	+	No	Closed reduction	Posterior wiring at 6 weeks	-	1 year
2	Sassard[3]	20	Female	Polytrauma RTA	+	Mild	Closed reduction	No	No	10 years
3	Patzakis[4]	37	Male	Polytrauma RTA	+	No	Closed reduction	No	No	3 years
4	Fox[5]	65	Male	RTA	NA	Transient quadriplegia	Open reduction	Transoral odontoidectomy and posterior fixation	-	NA
5	Jamshidi[6]	22	Male	RTA	+	No	Closed reduction	Posterior cervical wiring	-	NA
6	Wong[7]	23	Male	RTA	NA	No	Closed reduction	Posterior cervical wiring!	-	7 years
7	Sud[8]	38	Male	Polytrauma RTA	NA	Upper limb weakness	Open reduction*	Partial odontoidectomy and posterior fixation[§]	-	3 months
8	Yoon[9]	64	Male	Polytrauma RTA	+	Mild	Open reduction	Transarticular screw fixation[#]	-	6 months
9	Neumann[10]	22	Male	Polytrauma RTA	+	No	Closed reduction	No	No	2 years
10	Ping Zhen[11]	44	Male	Earthquake	+	No	Open reduction	Partial odontoidectomy and posterior fixation	No	NA
11	Jiang[12]	48	Male	RTA	+	No	Open reduction	Transoral odontoidectomy and posterior fixation	No	21 months
12	Our study	32	Male	RTA	+	No	Closed reduction	Posterolateral pedicle screw fixation with fusion	No	9 months

Polytrauma indicates patients with associated appendicular skeleton injuries, RTA=Road traffic accident, NA=Data not available, *Secondary to brachial plexus injury, #Without trial of closed reduction, §Closed reduction unsuccessful, INonanatomical reduction and residual instability following closed reduction

Older patients with extensive degenerative disease within the cervical spine are probably far less tolerant of such an injury due to the presence of osteophytes and other degenerative phenomena.[19] Thus, it is possible that most patients surviving such injury might be relatively young [Table 1].

Although the mechanism of the posterior atlantoaxial dislocation without a fracture of the odontoid is not proved by clinical or experimental studies,[10,19] the pattern of injury is consistent with a high-grade hyperextension mechanism, as described by Haralson and Boyd.[2] This is supported by the fact that most of the reported cases are associated with facial injuries following the road accidents[19] [Table 1] and this is applicable to our case too.

One of the authors speculated that their patient was struck from behind while the cervical spinal muscles were relaxed. The force of the collision applied to the trunk caused the body to be thrown forward at a greater velocity than that caused to the head. This resulted in extreme hyperextension of the atlantoaxial joint.[8]

In most of these patients, rupture of the transverse ligament with anterior atlantoaxial dislocation without fracture could be diagnosed indirectly on radiographs with an atlanto-dental interval of 5 mm or more.[11] These radiographic measurements are reliable only when the odontoid process is intact and attached to the C2 body, and may be misleading depending on the head position; flexion/extension views are not advisable in a patient with an acute neurological injury.[8]

Dickman *et al.* first reported that such ligamentous injuries can be directly seen on MRI.[11] MRI provides a sensitive method of detecting the integrity of the transverse ligament, which may have a bearing in future treatment of such injury. Compromised transverse ligament on MRI strongly suggests internal fixation.[19] What we intend to say is that most of these injuries are without associated fracture. So, on MRI, we look out for transverse ligament injury, which indicates the need for surgery as nonoperative management will lead on to late instability. MRI also affords a more sensitive method to assess the degree of cord compression, soft tissue injuries such as hemorrhage, disc herniation, and nerve impingement.

In our case, CT [Figure 5a, b] and MRI [Figure 2] showed avulsion of the transverse ligament with no evidence of odontoid process fracture. Axial CT scan revealed the odontoid peg lying ventral to the anterior arch of the atlas with intact anterior arch of the atlas [Figure 5a, b], and three dimensional CT reconstructions [Figure 5c] clearly revealed posterior atlantoaxial dislocation with atlantoaxial rotation. Although the possibility of injury to the alar ligaments has been suggested by Willauschus *et al.*,

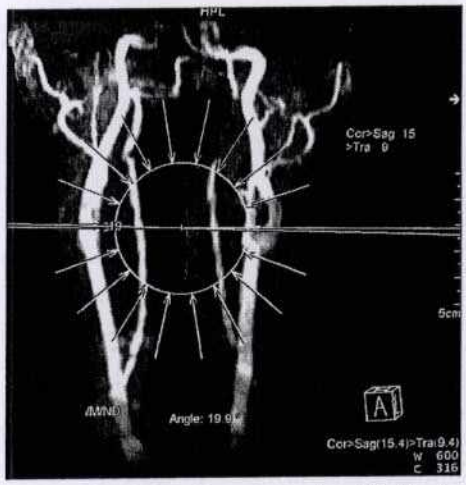

Figure 6: Preoperative MR angiogram to rule out kinking/insufficiency of vertebrobasilar artery

Figure 5: CT of cervical spine (a) Sagittal section showing posterior dislocation of C1 with respect to C2, (b) Coronal section spine showing anterior displacement of C2 and the dens is situated anterolateral to the anterior arch of C1 with facet joint dislocation of C1-C2 (c) 3D reconstruction of cervical spine showing C1-C2 dislocation (peroperatively)

we could not demonstrate this. MR angiogram [Figure 6] showed adequate vertebral artery flow, which may be helpful in suspected vertebrobasilar insufficiency[19] (we expected kinking of vertebral arteries due to such magnitude of displacement).

Neurological deficits are invariably present even in patients with dramatic displacement and atlantoaxial widening.[8] All previously reported cases had either mild or no neurological deficit [Table 1]. If the initial distraction of the C1-C2 complex does not cause a neurological deficit, then a significant amount of displacement can be tolerated in this region owing to the large size of the spinal canal.[2]

A skeletal study has demonstrated that posterior dislocation without fracture of the odontoid reduced the canal area to 36%, which is sufficient to avoid cord compromise,[14,20] and the extra free space also allows a margin of error during reduction.[7] These findings are consistent with Daly's rule of thirds.[2] Thus, patients actually seen in clinical practice are probably those who have escaped a severe distraction injury to the spinal cord. Therefore, a high index of suspicion is required, especially in patients who have concomitant head injuries and altered mental state.

There is no clear consensus on the treatment of these rare injuries. Possible techniques for reduction include closed manipulation under skull traction, and open decompression and reduction. Also, most authors of previous studies have favored closed reduction by manipulation and skull traction[2-4,6,7,10,12] under GA with fluoroscopic control and continuous spinal cord monitoring[7,10,18] to avert the neurologic risks of traction and manipulation. This manipulation is highly technically demanding and has its own risk. Many centers have poor infrastructure for fluoroscopic control and continuous neurological monitoring. Yoon *et al.* in their study adopted an operation-assisted reduction to avoid over-distraction of the spinal cord,[9] since it is difficult to judge the amount of traction which may lead to death due to over-distraction of the C1-C2 complex.[21,22] Flexion/extension maneuver, adopted for the odontoid process to slip back into the osteo-ligamentous ring of atlas, also has a great potential to injure the spinal cord. Wong *et al.* has described three phase reduction where initial traction is applied in slight flexion followed by realignment phase where a ring has slipped back over odontoid and release phase. Where traction is changed to slight extension to allow C1.

An intact transverse ligament probably provides the atlantoaxial complex with sufficient stability following reduction of the odontoid peg into the osseo-ligamentous ring.[2,10] The failed cases should be managed with open decompression and reduction.[10] Posterior surgical fusion is usually necessary because of residual instability of C1-C2 or incomplete reduction. With this understanding of complications in closed reduction, primary open decompression and reduction was not indicated.[10]

The choices for posterior fixation include wiring techniques and screws' construct.[23] Biomechanical data support the use of C1-C2 pedicle screws as they afford greater stiffness, and high fusion rate can be achieved without the need for postoperative halo vest immobilization in the screws system. In our patient, the stability of the upper cervical spine was restored with closed reduction and posterior stabilization, as expected, since the transverse ligament was torn.

In conclusion, most of the posterior atlantoaxial dislocations without odontoid fracture usually present without a significant neurological deficit. Also, closed reduction under fluoroscopic guidance is usually successful and safe. Intact transverse ligament dictates nonoperative or surgical line of management of such dislocations. Surgical fusion may be necessary in cases with documented transverse ligament ruptures or in those with demonstrable late instability on flexion/extension radiographs.

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