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Atlanto-axial fixation in traumatic Atlanto-axial dislocation with odontoid process fracture

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Abstract

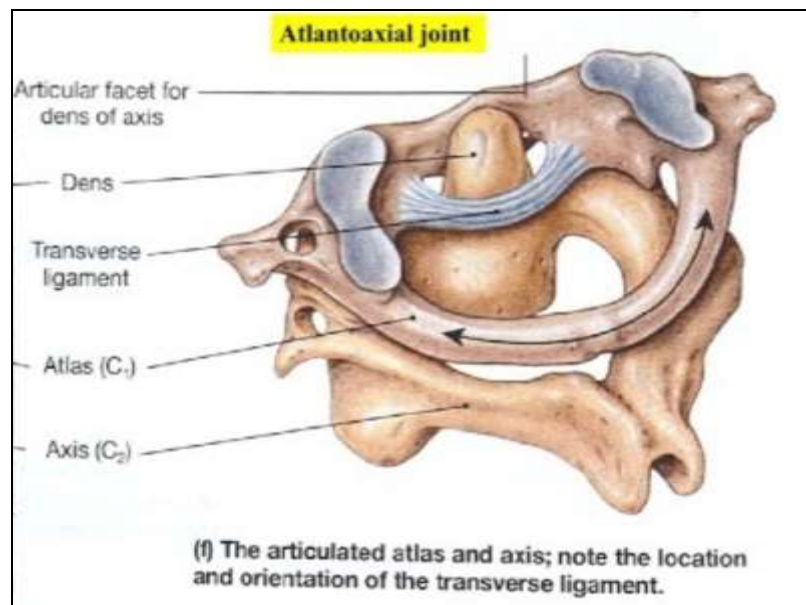
Atlanto-axial segment is made up of Atlas (c1) and axis (c2) vertebrae. This segment is responsible for rotational movement in the region of the cervical spine. Instability and damage to this segment can occur due to various reasons and can lead to abnormal motion with neurological consequences. Here we describe a case of 21 year old male with traumatic Atlanto-axial dislocation with odontoid process fracture with left upper limb weakness with gait instability treated with posterior vertebral fixation using pedicle screws with its clinical as well as radiological outcome.

Keywords: Atlanto-axial dislocation, rotational instability, posterior fixation, cord compression

Introduction

The Atlanto-axial articulation is a complex of three synovial joints, which join the atlas (C1) to the axis (C2).

- Lateral Atlanto-axial joints (2)
- Median Atlanto-axial joint



Bones

In all the vertebrae, cervical vertebrae are smaller in size than all the other vertebrae's to allow movements of head and to protect cranial nerves.

Occiput - base of skull which articulates with atlas

Atlas (C1) - 1st cervical vertebrae which is ring shaped having thick anterior and thin posterior arch without body.

Axis (C2) – 2nd cervical vertebrae having large vertebral body with odontoid process (dens) over which atlas rotates.

Ligaments

Nuchal ligament: it is a continuation of supraspinous ligament which attaches to the tip of spinous processes from C1-C7 and also provides attachment to the rhomboid and trapezius.

Occipito-atlantal ligament complex: 4 ligaments (anterior, posterior and 2 lateral) which connects occiput to atlas

Occipito-axial ligament complex: 4 ligaments (occipitotaxial, 2 alar and apical) connects occiput to axis

Atlanto-axial ligament complex: 4 ligaments (posterior, anterior and 2 lateral) connecting atlas to axis

Cruciate ligament complex: stabilises the Atlanto-axial joint

Transverse ligament: which connects lateral masses of atlas and anchors dens in place. Also acts as a posterior articulation of the atlanto-axial joint.

Anterior and Posterior longitudinal ligaments: these long ligaments run full length of the vertebral column which covers vertebral bodies and intervertebral discs.

Ligamentum Flavum: connects laminae of adjacent vertebrae.

Interspinous vertebrae: connects spinous processes of adjacent vertebrae.

Function

Atlanto-axial joint allows,

- 10-15 degrees of flexion/extension
- 30 degrees of axial rotation
- Minimal lateral flexion

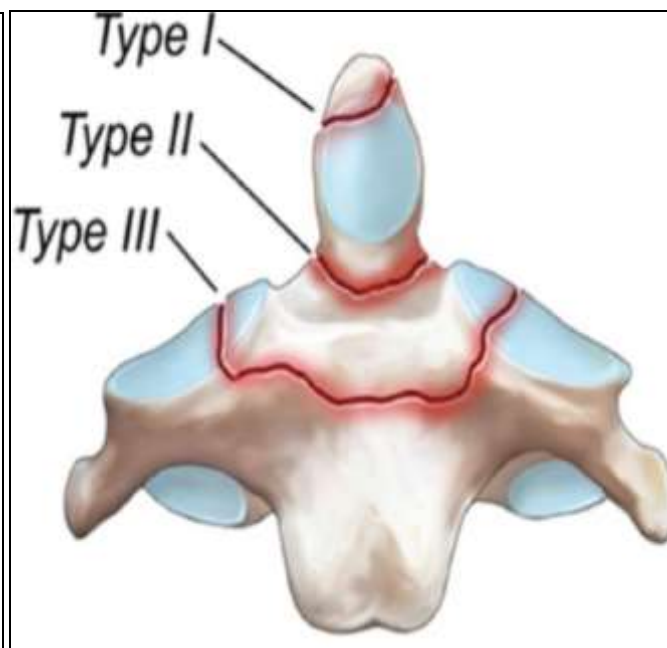
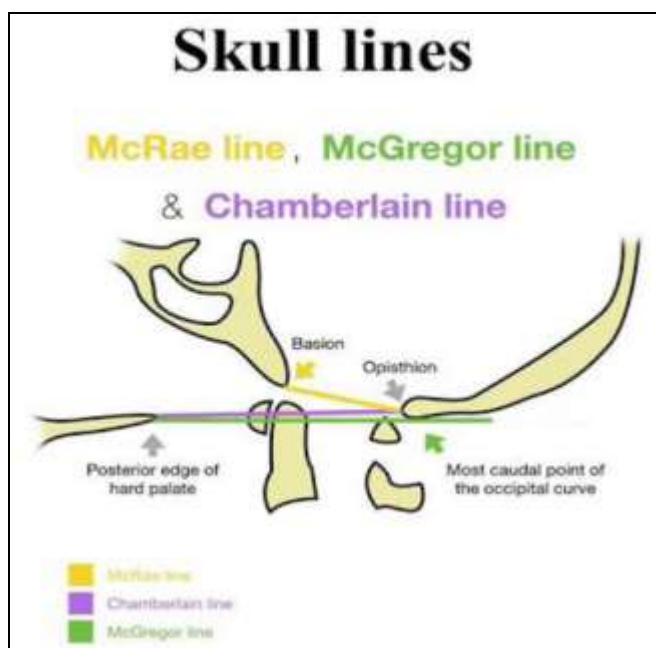
Parameters

- A. Predental space: it is a space between anterior arch of atlas and dens of axis. Beyond 3 mm is suggestive of dens fracture or disruption of transverse ligament.
- B. Chamberlain line: it is a line measured from dorsal lip of foramen magnum to the posterior portion of hard palate. Superior tip of odontoid doesn't exceed beyond this line. Beyond 5 mm extension above this line is abnormal.
- C. McGregor line: it is a modification of the chamberlain line and measured from posterior portion of hard palate to the lowest edge of mod line occipital surface.
- D. McRae line: it is measured from anterior margin of foramen magnum to the posterior border and odontoid tip should not cross this line.
- E. Anderson and D'alonzio classification for dens fracture

Type-I: Upper dens

Type-II: Base of dens

Type-III: Body of axis



Case description

21 year old male with complaint of neck pain with left upper limb weakness since 1 week which is due to road traffic accident. Post trauma Patient was unable to stand or walk with normal bowel and bladder function. Patient was taken to Government hospital in Uttar Pradesh where all the radiological investigations were done. MRI and CT scan of this patient have predental space of 7 mm which is suggestive of atlanto-axial dislocation and fracture of odontoid process

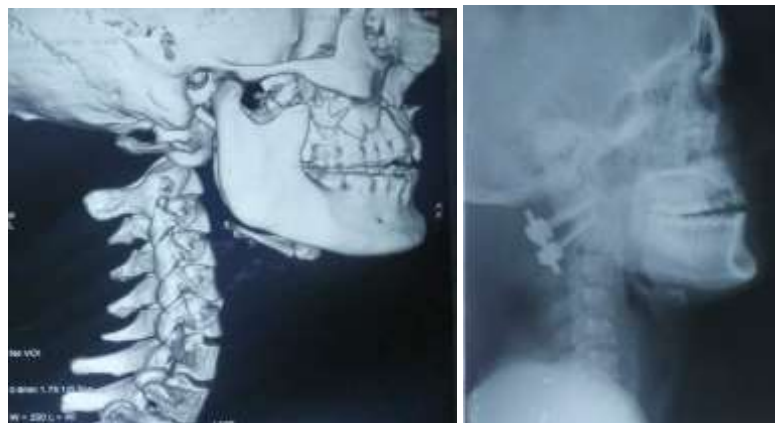
which caused compression over brainstem due to which patient developed weakness in left upper limb. When patient came to CHA tong insertion done and traction given then traction CT scan done for checking stability of Atlanto axial joint and patient was operated C1-C2 fixation with rod and screw fixation with posterior approach and after 2 days of surgery patient's neurology got improved and post operative ct scan done.



Pre-op CT.

Post-op CT

Pre-op MRI



Pre-op 3D CT

Post-op xray

Discussion

Traumatic C1/ C2 dislocation appears to be rare but possibly life-threatening entities of injury coming along with a high risk of vascular and neurological disorders due to vitally important structures present in this region [1-4]. Role of structures which contribute to dislocation is not completely understood.

Trauma doesn't necessitate neurovascular complications due to relatively wide bony spinal canal at C1-C2 level. Distraction injuries, however, may lead to distortion as well as to rupture of the spinal cord depending on the force applied. Accompanying vascular injuries affect the vertebral artery commonly, but may involve the carotid arteries as well [3]. Especially patients, who present a 'high-riding' variant of the vertebral artery, are at risk of vessel dissection or rupture, due to decreased limitation provided by bony structures.

As these types of injuries come along with a high grade of instability causing consequential disorders possibly, understanding of the injuries' morphology is of essential importance, in order to set the correct diagnosis and to apply the appropriate treatment.

Based on recommendations and cases presented in the literature as well as on our present results we conclude that in cases of high-energy trauma as well as in cases of low-energy trauma in older patients it appears to be highly necessary to perform CT imaging after trauma. If atlantoaxial dislocation is diagnosed, angiography is essential. Although direction of atlantoaxial dislocation may lead to the knowledge about all injured structures, MRI has to be performed, in order to visualize injured structures clearly. Moreover, MRI

presentation may give evidence about spinal cord injury [3, 10]. Regarding treatment of atlantoaxial dislocation, there is consensus that reduction has to be performed as soon as possible in all cases, in order to prevent residual instability and development of permanent deformity. To date it is known that time to reduction correlates with the recurrence of dislocation recurrence and failure of reduction [4]. Afterwards, immobilization and rigid fixation are necessary due to the high, residual instability. Wise *et al.* described one case of solitary rotatory atlantoaxial dislocation caused by ligamentous injury, which they treated successfully using brace immobilization. Fielding proposed conservative treatment using brace immobilization for rotatory dislocations of C1 and C2 as well. A close-mesh follow-up, including functional imaging is necessary, in order to prove the treatment's success and to prevent ongoing atlantoaxial instability in the long-term [4, 11].

Most authors, however, prefer surgical stabilization in adult lesions due to the residual instability after reposition of the facet joints, as do we [8, 12]. As rupture or dislocated bony avulsion of the transverse atlantal ligament appears to be clear indicators for the need of surgical stabilization, horizontal atlantoaxial dislocations as well as dissociations have to be treated surgically performing atlantoaxial instrumentation according to the recommendations of Dickman and Kandziora [13, 14]. Moreover it is known that there is a need of surgical intervention, if a fracture of the odontoid process and a rupture of the transverse atlantal ligament are combined [15]. As shown in the present cohort, surgical management appears to come along with good outcome.

Some authors favored performing closed reduction and fixation using a halo fixator. This method, however, failed in three cases. Lenehan *et al.* published a case in which closed reduction using a halo fixator failed in a patient suffering from C1/C2 lateral dislocation with fracture of the odontoid process [12]. Przybylski *et al.* reported about a 35-year-old man suffering from vertical atlantoaxial dislocation with additional type III odontoid fracture. The authors pointed out that atlantoaxial dissociation increased in the further course despite stabilization with halo fixator. Therefore they concluded that this method does not eliminate the vertical instability as it boosts it to the contrary. This method, however, is advantageous, if the treatment is delayed or the dislocation is not correctly reduced in the first step.

Several methods are known in order to run surgical fixation of C1 and C2. Transarticular fixation using Magerl's method and C1 mass with C2 transpedicular screw fixation according to Goel and Harms are commonly used resulting in satisfying long-term results [1, 16]. Other screw constructs for atlantoaxial fixation include Wright's C1 lateral mass and C2 translaminar screw construct or the C1 lateral mass and C2 pars screw construct [17]. Du *et al.* performed a meta-analysis of biomechanical testing of these atlantoaxial fixation techniques, which show good to excellent fusion rates in the literature. The authors concluded that all of these fixation techniques provide significant stabilization of axial rotation, flexion, and extension. Instrumentation constructs between lateral masses of C1 and translaminar screw placement at level C2, however, did not provide significant stabilization of lateral bending [18].

From our point of view Goel's and Harms's technique is advantageous in comparison to the transarticular fixation in atlantoaxial dislocation. Firstly, the risk of relapsing dislocation may increase intraoperatively if a screw is inserted as the atlas is possibly pushed away. Secondly, especially in young patients, further violation of the facet joints has to be avoided in order to remove implants after consolidation. Findings of Lee *et al.* support our experience that C1 mass and C2 transpedicular screw fixation is beneficial compared to transarticular fixation regarding the consolidation rate [19]. In patients presenting with high-riding vertebral artery, however, other fixation techniques are advantageous [18]. If there is a dissection of the vertebral artery, the patient has to get therapeutic anticoagulation by warfarin or phenprocoumon.

Conclusion

Here by, this is concluded that C1-C2 fixation is a treatment option in patient with traumatic Atlanto-axial dislocation with odontoid process fracture. Patient shows significant improvement clinically as well as radiologically without any significant increasing chances of immediate and early post operative complications.

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