



CASE REPORT

Longitudinal atlantoaxial dislocation associated with type III odontoid fracture due to high-energy trauma. Case report and literature review

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Abstract

Introduction Traumatic upper cervical spine injuries are frequently associated with high-energy trauma. The potential injuries to vital organs associated to a possible neurological damage marks the severity of this pathology. The neurological structures can be affected by a primary injury, spinal cord, cranial nerves and spinal nerves; or secondary to a vascular compromise, mainly the vertebral arteries. The dislocation of the atlantoaxial joint causes an unstable cervical spine that could be often associated with fracture of the Atlas and Axis. Evidently, these have a high morbimortality rate.

Case presentation A young woman who suffered a severe polytrauma secondary to a motor vehicle collision was diagnosed with a sagittal plane atlantoaxial joint dislocation associated with a type III odontoid fracture, despite an adequate initial polytrauma management, the neurological damage was too critical, ultimately the decease of the patient.

Discussion The atlantoaxial joint dislocation is a rare condition of the upper cervical spine and is usually secondary to a high-energy traumatism. The disruption of the atlantoaxial ligaments originates the considered most unstable cervical spine lesion and with the highest mortality. Attributable to the kinetic the bone fracture of the Atlas and Axis are commonly related, specially the odontoid process. Early immobilization followed by surgical decompression and stabilization is primordial. Typically, these injuries have an ominous prognosis, that is aggravated if added a polytrauma affecting adjacent neurological structures and other vital organs.

Introduction

Traumatic injuries to the upper cervical spine are associated with high-energy trauma in young people, motor vehicle collisions being the most frequent. Among the injuries of the upper cervical spine, the atlantoaxial joint dislocation is rare and associated with high morbimortality rates. According to the kinetics causing the associated ligament impairment, numerous classifications have considered this to be the least frequent and the sagittal plane joint dislocation is considered the most unstable of all. Both secondary to the great instability produced by the disruption of the ligaments in atlantoaxial joint segment associated with the potential neurological and vascular damages [1–3]. It is

not uncommon for these cases to associate vertebrae damage at C1 and C2 levels, the odontoid fracture being the most common. Early diagnosis using neuroimaging techniques, and surgical treatment based on vertebral stabilization through C1-C2 fixation technique, are the key elements for managing of these injuries.

Case presentation

We present the case of a 43-year-old woman, with no relevant medical history, whom suffered a polytrauma in a high-energy traffic accident. During the prehospital phase, in the primary survey, the patient presented cardiopulmonary arrest followed by cardiopulmonary resuscitation manoeuvres for 8 min until primary stabilization. The airway and ventilation were managed with orotracheal intubation, followed with fluid therapy and inotropic drugs to maintain adequate blood pressure levels. The neurological survey revealed tetraplegia (ASIA-IS A), no response to any stimuli and bilateral mydriasis evidencing a Glasgow Coma

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Scale score 3. Further assessment showed deformity with external rotation of the right leg. In the hospital phase, urgent full body computed tomography (CT) scan was performed, showing signs of generalized hypoxic encephalopathy at the cranio-cervical level with poor differentiation of grey matter–white matter, type III odontoid fracture with anterior displacement of the odontoid process and atlantoaxial dislocation in the longitudinal plane (Figs. 1 and 2); in the thoracic portion were found transverse fractures of the first and third costal arches of the left hemithorax and bilateral pulmonary contusions; the abdomen showed a splenic rupture with a parasplenic haematoma and hemoperitoneum; in the extremities was identified a displaced fracture of the right femoral diaphysis. Emergency median laparotomy with splenectomy was performed, followed by external fixation of the right femur and subsequently was implanted an intraparenchymal intracranial pressure sensor, with initial readings of 14–16 mmHg. Throughout the procedures 3 blood bags were transfused, the patient maintained the haemoglobin level higher than 7 g/dl in the immediate postoperative period, which was followed in the intensive care unit (ICU). After 24 h in the ICU, the patient continued hemodynamically stable. A

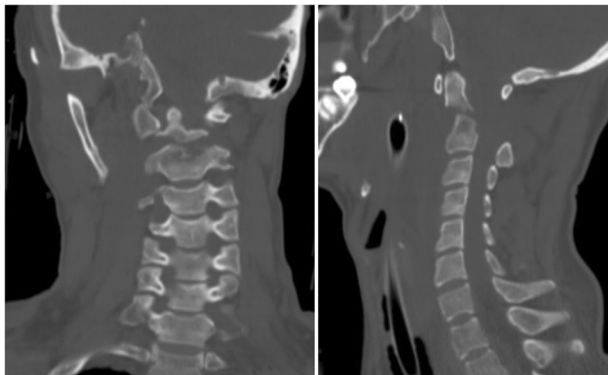


Fig. 1 CT-Scan reconstruction. Coronal plane (left) and sagittal plane (right) showing the atlantoaxial dislocation in the sagittal plane and type III odontoid fracture, which exhibits the rostral and ventral displacement in relation to the position of the Axis body.

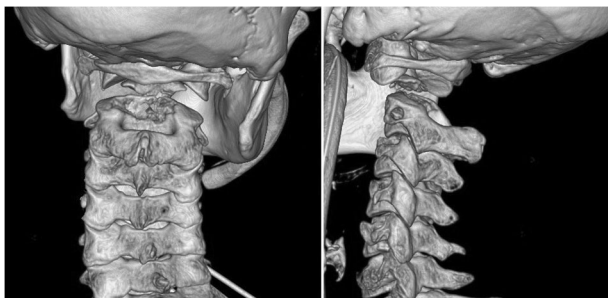


Fig. 2 CT-3D reconstruction. Atlantoaxial dislocation and type III odontoid fracture and the atlantoaxial gap in the sagittal plane.

control cerebral CT scan revealed no changes with grey matter–white matter de-differentiation neither the C2 displaced fracture. The patient was treated with sedation–relaxation measures, ventilatory support, and vasoactive drugs during the first 48 h, maintaining hemodynamic stability. After 72 h the sedation–relaxation was suspended but patient continued to show no neurological response, with bilateral non-reactive mydriatic pupils and cessation of brainstem reflexes. Finally, with this poor and unfortunate prognosis, given the precarious neurological and clinical situation of the patient, and in a consensual-consent with her family, it was determined to limit basic life support measurements, which led to the decease of the patient.

Discussion

Upper cervical spine injuries are generally associated with high-energy traumatism, such as motor vehicle collisions, sports accidents, accidental falls; increasing their incidence in elderly [4]. The atlantoaxial joint segment being the most vulnerable and where the majority of these fractures are located.

The traumatic C1-C2 joint dislocation is uncommon in adults, if this occurs it has a high life mortal threatening rate. This injury entails damage to many ligaments in this juncture that could be aggravated with the association of adjacent non-vital structures like bones or muscle injuries. The principal concern with this type of lesions lies due to the characteristic anatomical harmonious arrangement of the occipito-cervical junction, this body segment contains very delicate structures such as; nervous tissue, the spinal cord and the lower cranial nerves [1, 2, 5]; blood vessels, the vertebral arteries [3, 5] and the carotid arteries [6]. This disease has also been described as a congenital cranio-cervical fusion disorder [7].

Diverse classifications of the atlantoaxial joint dislocation have been described in the literature, these injuries are associated with a disruption of the anatomical structures such as bone fractures of the Atlas and Axis, at times affecting the arch of C1, the odontoid process and sometimes the articular facets [8–10]. However, an atlanto-occipital dislocation combined with an atlantoaxial dislocation has been described only twice in the literature and by the same medical centre [11].

Rotational atlantoaxial dislocations in the axial plane were classified by Fielding and Hawkins into four types [8]; type I, the odontoid process acts as a centre of rotation, with no displacement in the axial plane; type II, the centre of rotation is located laterally at the C1-C2 joint, which produces an anterior displacement in the sagittal plane of 3–5 mm in addition to rotation; type III there is a rotational

and anterior deviation greater than 5 mm with subluxation of both atlantoaxial joints and the type IV there is a posterior subluxation of both atlantoaxial joints, this last being described in rheumatoid arthritis.

White and Panjabi described five types of atlantoaxial dislocations; type A describes an anterior displacement of the Atlas on the Axis; type B is a posterior displacement; type C is a rotational dislocation of the Atlas with the Axis of the articular facets on one side, rotating and moving the Atlas anteriorly; type D is a rotational dislocation of the Atlas having as Axis the articular facets on one side, rotating and moving the Atlas posteriorly; and type E implies a rotation of the Atlas over the Axis, the pivotal Axis being the odontoid process [9].

Meyer describes the atlantoaxial dislocations in three categories, taking into account the injury mechanism, the radiological findings and the instability secondary to the ligamentous injuries [10]. The type I would be the atlantoaxial rotary dislocation, in which the injury to the alar ligaments and the affected joint capsules are a constant, being the least unstable type. The type II corresponds to an anterior-posterior atlantoaxial dislocation, sometimes combined with a slight degree of anterior sagittal rotation of C1 over C2, this injury has a more serious implication because of the ligaments that are affected, the alar and apical ligaments of the odontoid process as well as the transverse ligament of the Atlas and the tectorial membrane. The type III is an atlantoaxial distraction dislocation, that is seen in both sagittal and coronal planes, this is the most unstable type since not only the ligament elements and joint capsules are affected, but also muscle tears are associated. All three types can have concomitant bone fractures; articular facet, Atlas arch and odontoid process fractures have been described, predominantly in the type II and type III according to the Anderson and D'Alonzo classification [12].

As for the diagnosis, it is recommended that imaging studies are performed on patients who have suffered a high-energy traumatism and in elderly patients that have experienced a minor trauma but present with symptoms of continuous neck pain, functional impotence or any kind of neurological symptoms. Simple radiology studies are not sufficient since they have a high rate of false-negative interpretations, for this reason, it is essential that at the very beginning of the suspected diagnosis of an atlanto-occipital or atlantoaxial dislocations injuries a CT scan is performed extended with a CT-Angiography given the surrounding vital vessels in this portion of the body. This study has a double purpose, diagnostics and in case of finding any type of injury that needs an urgent or emergent surgery, it can be promptly and more accurately assessed by the surgeon [3]. A further and more precise step on the diagnosis, in case of positive findings, a magnetic resonance imaging (MRI) study will provide an assessment of any associated nerve

tissue damage, ligament injuries and vascular structures, the latter by means of MRI-Angiography sequences [13].

Traction manoeuvres are strongly discouraged considering the fatal neurological complications [1, 14] that can cause an increase dislocation with an iatrogenic distraction over a debilitated ligament or any movement of fractured bones in the Atlas and Axis [15]. After an accurate identification of the cervical injury, if there is an indication for this treatment, which are basically the injuries caused only by distraction and hyperextension kinetics with damage limited solely to ligament structures and joint capsules [16].

The recommended treatment is surgery by posterior C1-C2 fixation, either by the Magerl transarticular fixation technique [17] or by the Harms-Goel lateral Atlas and transpedicular Axis mass fixation technique [18]. Surgical fixation provides and adequate stabilization in flexion-extension and rotation of the cervical spine is achieved.

Some authors recommend the Harms-Goel technique over the Magerl technique since the latter can increase the distraction of the Atlas with the introduction of the screw and, in addition, it allows to maintain the integrity of the joint capsule with the possibility of removing the fixation once the osteo-ligament injuries have been consolidated [10, 19].

Anterior transarticular C1-C2 fixation using the Vaccaro technique [20] is also an option to consider in some cases, as long as the vertebral dislocation and other associated bone injuries are reducible, such as a fracture of the odontoid process [21]. In case of associated vertebral artery injury, it should be treated with anticoagulant therapy [3].

In our case, the patient had major injuries to her thorax, abdomen, and lower extremities, which led to a state of hypovolemic shock, requiring emergent laparotomy. Likewise, her neurological status did not show improvement despite the intensive treatment, and she remained in a non-reactive coma, possibly due to the nerve-vascular injuries associated with the trauma itself as well as secondary hypovolemic hypoxia. Due to the mentioned, the patient died a few days after the severe polytrauma; being impossible to carry out new radiological studies of the cervical spine, neither any surgical treatment of the cervical lesion.

The atlantoaxial dislocation is a very unusual and complex traumatic injury that compromises the upper cervical spine. High-energy traumatisms are associated with young adults meanwhile the elderly patients can be afflicted by a low-energy trauma. This injury leads to a disruption of very important set of ligaments that are commonly associated with bone injuries of the Atlas and Axis, the most frequent portion damaged is the odontoid process. Likewise, given the high risk for primary or secondary injuries of the nerve and vascular structures, these lesions have a high morbimortality rate. Type III atlantoaxial joint dislocation produces distraction with longitudinal displacement of both

vertebrae, causing the least frequent kind of dislocation in the cervical spine but the greatest structural instability of this portion. The prehospital phase assessment with the ABCDE systematized approach, prioritizes the airway in which the health providers first ensure stability of the cervical spine for further manoeuvres, then the circulatory system with the control of any haemorrhage if necessary, followed by examination of any deficit in the neurological sphere and finishing the primary assessment with a full-body exposure and protection of any potential environmental hazards. In the hospital phase, with a hemodynamical stable patient, the medical team pursues any further non-visible injuries with the use of the radiological studies, among others, a cerebral and cervical spine CT or MRI. In the case of longitudinal atlantoaxial joint dislocation, is recommended the surgical treatment using the technique of C1-C2 fixation.

Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

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