An uncommon C1 fracture with longitudinal split of the transverse ligament

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Abstract We present a unique variant of C1 fracture, which, at the best of our knowledge, has never been previously reported. This lesion consists in a lateral mass atlas fracture with a longitudinal separation of the transverse ligament that remains functionally preserved. We considered this lesion to be stable and treated the patient conservatively with good recovery. Even if many classifications of atlas fractures have been proposed, none of them ever described this uncommon variant. We debate about biomechanical aspects and therapeutic implication of the reported case.

Keywords Atlas fracture · Transverse ligament · Cervical instability · Cervical spine injury

Case report

A 42-year-old male is admitted to our emergency department after falling down the stairs provoking a cervicothoracic trauma. The dynamics of the accident had consisted in a fall from a staircase of around ten steps with

receipt on the head. At admission the patient is awake and conscious; initial neurologic examination identifies no major disorder. Plain X-ray imagery of the cervical spine is non-conclusive. A total-body CT scan, including cerebral and cervical imagery, is performed showing a non-dislocated Anderson–Montesano type 1 fracture [1] of the right occipital condyle, a fracture of the atlas involving the right lateral mass and a congenital non-fusion of the anterior and posterior arches (Fig. 1). Other findings are a burst-fracture of the fourth thoracic vertebra and costal fractures of the second and eleventh rib on the right. The radiological examination is completed with a cervical MRI showing the massa lateralis fracture and a longitudinal separation of the transverse ligament (Fig. 2) which is separated lengthwise but its fibers are still intact (Scheme 1). No sign of atlantoaxial dislocation is evidenced.

The fracture of the fourth thoracic vertebra is an unstable type B lesion and is stabilized surgically with a posterior spondylodesis. The C1 fracture is considered to be stable because of the functionally intact transverse ligament and treated conservatively by rigid collar immobilization during 3 months.

The postoperative clinical course is uneventful and the patient is discharged from the hospital after 23 days. After 3 months the mobility of the cervical spine is re-established with the aid of physiotherapy.

Five months after the trauma, a cervical CT scan shows the recovering fracture of the lateral mass and no evident lesion of the ligament (Fig. 3).

Discussion

Fractures of the atlas occur in 2–13% of cervical spine injuries and represent 1–2% of all vertebral fractures [9].

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Fig. 1 Transverse CT-scan image showing the fracture of the right lateral mass of C1 and the anterior non-fusion (a). On the *right* the posterior non-fusion is evidenced (b)

Fig. 2 Transverse MRI showing the transverse ligament split lesion

Scheme 1 Schematic drawing describing the atlas fracture and transverse ligament lesion

Often injuries of the first cervical vertebra are caused by high-energy traumas and are accompanied by other cervical lesions, most commonly dens fractures. Neurologic

Fig. 3 5 months post-treatment transverse CT-scan showing the fracture consolidation in progress and an intact transverse ligament

disorders are rare in isolated atlas fractures, and mostly due to concomitant injuries, but cases of caudal brain nerve disorders or hyposensitivity of nerve occipitalis major are also reported [5, 11]. Rarely vertebral artery lesions are associated with isolated C1 fractures [8].

Jefferson [6] first completely described in 1920 and gave name to an anterior and posterior arch fracture of the atlas. He already hypothesized about the trauma-mechanism: The atlas ring structure is driven apart by axial compression, because the vector of force is distributed centripetally on the convex surface of the axis.

The mainly used classification system for atlas fractures is the strictly bone-focused Gehweiler classification [4] distinguishing isolated and combined arch fractures, massa lateralis and processus transversus fractures. The present case would be classified as a Gehweiler type IV fracture which is infrequently reported in the literature [6, 7].

As concomitant lesions of the transverse ligament are important for C1-C2 stability they should be searched and visualized by MRI [2]. The Dickman classification system

Scheme 2 Dickman classification of atlas and transverse ligament lesions. Type I lesions consists in central (a) or lateral (b) transverse ligament interruptions; type II lesions are associated with lateral mass comminuted fracture (a) or with the avulsion of the transverse ligament insertion (b)

[3] is focused on these types of transverse ligament injuries (Scheme 2). It distinguishes its complete ruptures (type I) from the bony avulsions of its atlantal insertion (type II). There are two subtypes of the latter: type IIa is characterized by a concomitant lateral mass fracture, whereas type IIb is an isolated tubercle avulsion-fracture.

In contrast to this, the present case is a lateral mass fracture with an uncommon lengthwise ligament split. To our knowledge, no classification has ever described the anatomic and biomechanical character of this pathological finding. We propose to add this entity to Dickman's classification as Type III, a benign transverse atlantal ligament injury which is associated to a lateral mass fracture. Following White and Panjabi criteria [10], no C1-C2 instability is present, as no augmentation of atlas ring diameter, any neurologic deficit and no complete discontinuity of transverse ligament may be found.

From a biomechanical point of view, in the reported case, the vector of traumatic force seems to be axial compression with inclination to the patient's right side as the concomitant unilateral occipital condyle fracture suggests. We hypothesize that the non-fused anterior and posterior arches might contribute to more flexibility of the ring structure of the atlas making a single fracture of the lateral mass with a ligament split lesion possible.

Conclusion

We postulate that this form of lesion of bony and ligamentous structures of the first cervical vertebra, which has not been described before, is distinct from all other classified entities because of its anatomic feature and benign character towards C1-C2 stability.

The presumed mechanism of fracture is axial compression with higher impaction on the right lateral mass. The non-fused atlas arches could explain the more flexible reaction of the ring, allowing an isolated massa lateralis fracture with a longitudinal split lesion of the transverse ligament.

Conflict of interest None of the authors has any potential conflict of interest.

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