An unusual Hangman’s fracture: Description and surgical management

E. Morel\textsuperscript{b,∗}, B. Ilharreborde\textsuperscript{c}, F. Zadegan\textsuperscript{a}, L. Rillard\textsuperscript{a}, P. Guigu\textsuperscript{a}

\textsuperscript{a} Department of Orthopaedics and Traumatology, Beaujon Hospital, 100, boulevard du Général-Leclerc, 92118 Clichy cedex, France
\textsuperscript{b} Biomechanics Laboratory, Mayo Clinic, 200, First Street SW, Minnesota, Rochester, MN55905, United States
\textsuperscript{c} Children and Adolescent Department of Orthopaedics and Traumatology, Robert-Debré Hospital, Paris, France

Accepted: 26 March 2009

Summary  C2 pedicles, or "Hangman’s" fracture and "Tear-Drop" fracture, have until now been described as two distinct entities, the former caused by extension-distraction and the latter by compression-flexion mechanisms. The present clinical case combined these two fracture types of the second cervical vertebra (C2), without neurologic complication. Surgical management reduced and stabilized the lesions of the bone and of the mobile segment between C2 and C3. A right-side subhyoid presternocleidomastoid approach was selected, the main deformity lying between the body of the second and third cervical vertebrae.

© 2009 Published by Elsevier Masson SAS.

Introduction

Second cervical vertebra (C2) fractures, whether located in the body of the vertebra, the odontoid process, the posterior arch or the pedicles, have been exhaustively classified [1–4].

These systems are not merely descriptive but indicate causal mechanisms and enable the various lesions encountered in clinical practice to be classified.

The present case matches the classifications in terms of fracture-line location but differs in the displacement of the various fragments. This suggests that the mechanisms involved in the various categories may in some cases combine, giving rise to an unusual fracture.

Clinical case

A 20 year-old man, with no notable history, was referred to our department following a road accident: a head-on crash had ejected him from the car he was driving without seatbelt.

The exact trauma mechanism was hard to specify, as the patient presented with posttraumatic amnesia. On interview, his only complaint was violent pain in the cervical spine. Facial examination revealed only superficial abrasions on the brow and soil in the hair, with no significant ecchymosis. No other trauma was noted on the rest of the axial and peripheral skeleton.
X-ray and cervical spine scan disclosed both C2 pedicle ("Hangman’s") fracture and C2 "Tear-Drop" fracture (Fig. 1 and 2). As can be seen in Fig. 2, the fractures comprised of three fragments. One anterior fragment corresponded to the Tear-Drop fracture; the second, just posterior to the first, corresponded to the C2 vertebral body, in continuity with the odontoid process; the third corresponded to the posterior C2 arch, including the articular pillars. The joint surface ratios between C2 and C3 were normal, and the mobile segment lesion only involved the C2-C3 intervertebral disk anteriorly and the common anterior longitudinal ligament. The displacements were visible mainly in the coronal plane, the second fragment showing kyphosis of about 20° without antelistsis with respect to C3. The Hangman’s fracture showed little displacement on X-ray, as was confirmed by the scan (Fig. 1). The postero-inferior C2-body part was within the vertebral canal, displaced posteriorly with respect to C3 vertebral body (Fig. 2).

There being no signs of neurological abnormality, the cervical spine was immobilized by cranial Halo traction, firstly to stabilize the fracture, and then to obtain progressive reduction by external maneuver, with progressive extension of the cervical spine associated to continuous incremental axial traction up to 6 kg.

Failing to observe any reduction after 2 weeks’ of this treatment, surgical management was decided on.

A right-side subhyoid presternocleidomastoid approach [5] was adopted. The anterior common vertebral ligament was partially ruptured and the Tear-Drop fragment was detached from the C2-C3 intervertebral disk, which was also partially dilacerated. The fracture was reduced extemperaneously under video-fluoroscopy (Fig. 3), and the correction was stabilized by anterior plating. Autologus tricortical iliac crest bone graft was used to achieve inter body fusion. The Tear-Drop fragment was compressed between the anterior plate and the C2 vertebra body (Fig. 4).

On follow-up, the neurological profile was unchanged; the patient could stand as of postoperative day 4, with the cervical spine immobilized in a Halo corset for 3 months. Oral feeding could be resumed immediately, there being no pharyngeal or laryngeal symptoms. One month after removal

---

**Figure 1** Preoperative X-rays and CT scan. Frontal view, “open-mouth” procedure (A); lateral view, showing Tear-Drop fracture — white arrow, left side — and Hangman’s fracture — white arrow, right side (B); coronal CT scan (C) and axial view (D) showing protrusion of the postero-inferior C2 vertebral body part (C); fracture lines of the C2 hangman’s fracture — white arrow (D).

**Figure 2** Lateral X-ray, detailed view. The three different elements of the fracture are surrounded by a black dashed line. The ‘‘Tear-Drop”, on the left (1); C2 vertebral body center, attached to C1 vertebral body (2); posterior arch, right, attached to C3 body (3). Postero-inferior C2 vertebral body part (white spot) displaced posteriorly compared to anatomical normal situation: white spot is normally aligned on the white dashed line.
Figure 3  Peroperative view. X-ray control of the instrumented correction of the deformity. A Cobb periosteotome was used, through the C2-C3 disk space, after diskectomy.

of the Halo corset, the patient recovered normal pain-free cervical spine mobility, apart from the mobility loss due to the C2-C3 fusion (Fig. 5). A control scan at 4 months confirmed C2-C3 interbody fusion (Fig. 6).

Discussion

Surgeons have long been interested in superior cervical spine fracture, one of the first publications on the subject dating back to October 1888, when J.J. de Zouche Marshall [6], a British prison surgeon, wrote an article on judicial hanging with a view to "humanizing" the process by ensuring instantaneous death. He had observed that, when the knot of the noose was positioned under the prisoner's chin, death was both sure and quick; he therefore described a device to maintain the knot under the chin and obtain violent hyperextension of the superior cervical spine — the positioning of the knot having hitherto apparently been left up to the executioner.

Fracture secondary to this kind of trauma was not known at that time: only in 1913 did Wood-Jones [7] publish a precise description of the bone lesion most frequently encountered in hangings using a procedure similar to Marshall's: second cervical vertebra pedicle fracture, separating the vertebral body, which remained joined to the atlas, from the posterior arch, which remained joined to the third cervical vertebra.

The name "Hangman's fracture" comes from Schneider et al. (1965) [3] who, on the basis of Wood-Jones' studies and their own observations of road accidents, reported

Figure 4  Postoperative X-rays. Left side, frontal view, and right side, lateral view, showing interbody fusion with iliac crest bone grafting, anterior C2-C3 plate, and reduction of initial kyphosis.
a similarity between the fractures found secondary to hanging and fractures found in their own patients (mainly road-accident victims). The term was taken up by most English-language authors, although Garber had, in 1964 [8], coined the term of axial ‘‘traumatic spondylolisthesis’’, on the basis of an eight-case series systematically exhibiting anterior displacement of the axial body on lateral X-ray. However, even if the name changes from author to author, the mechanism is always the same: sudden hyperextension of the head and superior cervical spine associated with distraction beyond physiological limits.

The first review of the literature on the topic was by Williams et al. in 1975 [9], covering eight publications, of which the largest series numbered 12 cases.

Then, in 1981, Effendi et al. [2] put forward the first classification scheme for C2-pedicle fractures, based on X-ray analysis of 131 cases. This three-grade classification, in terms of fracture displacement and especially spondylolisthesis of C2 onto C3, has provided a basis for recommendations as to orthopedic or surgical management according to the respective instability of the various types described.

In parallel to this, Schneider, in 1956 [4], first described the ‘‘Tear-Drop’’ fracture, in the inferior cervical spine, resulting, he said, from axial compression and defined as the association of two simultaneous but distinct lesions: detachment of a tear-drop-shaped antero-inferior fragment from the vertebral body concerned, and sagittal displacement of the rest of the vertebral body, characterized by local kyphosis and protrusion of the postero-inferior part of the vertebral body into the canal. Schneider himself did not describe this type of fracture in the case of the C2 vertebra.
An unusual Hangman’s fracture: Description and surgical management

In terms of Benzel’s classification of C2 vertebral body fractures [1], the present case is of type I, with a frontal fracture line to the vertebral body near to the pedicles. Although Benzel considers the presence of an associated Tear-Drop fragment to be classical, the mechanism involved in type I is, according to him, one of extension and compression, generally inducing lordotic rather than the kyphotic vertebral body displacement found in the present case. Postero-inferior C2 protrusion into the canal is, moreover, unusual in type I fracture. And finally, the fracture line in the present case was too posterior to count as a vertebral body fracture as such (Fig. 1).

Thus, in the present case, two entities hitherto described separately were associated: a Hangman’s fracture of the C2 pedicles, thought to result from sudden hyperextension, and a Tear-Drop fracture of the same vertebra, classically caused by axial compression.

It is obviously difficult to say to what extent each mechanism contributed to the lesions observed; but it is interesting to note that the Hangman’s fracture, by separating the vertebral body from the posterior arch, no doubt contributed to the kyphosis of the C2 body onto C3. Moreover, on Effendi et al.’s classification [2], C2 kyphosis in type II fracture is systematically associated with sagittal displacement — i.e., spondylolisthesis of C2 onto C3 — which was not the case in our patient.

Thus, in terms of fragment displacement, the present case is somewhat different from the usual classifications and previously reported cases [1–4,8,9].

Management took account of the following parameters:

- the patient’s age;
- the absence of neurologic signs;
- the lack of concrete clinical data as to the long-term evolution of this type of deformity;
- the local kyphosis of C2 onto C3;
- the presumed C2-C3 mobile segment lesion, previously described [10,11] and certainly present in our patient even though unconfirmed on MRI due to Halo-induced artifacts;
- the failure of progressive traction/extension to obtain correction.

We opted for surgical management to correct the kyphosis of the C2 vertebral body onto C3 and stabilize the trauma zone in the ‘most physiological’ position possible. An anterior approach seemed best suited to these two objectives.

The surgical timing, however, should no doubt be revised when external maneuver fails to achieve reduction. Operating 3 weeks after the accident, with consolidation already under way, reducing the displacement was tricky, even after C2-C3 diskectomy. This should be taken into account, as it lengthened the operation and, most critically, required instrumental maneuvers in the vicinity of the CNS (Fig. 3).

Conclusion

The present clinical case indicates that a complex mechanism of superior cervical spine extension and associated axial compression is possible, giving rise in one and the same vertebra to two distinct entities — Tear-Drop and Hangman’s fractures — hitherto considered distinct. Management was essentially aimed at restoring anatomic ratios approximating normal cervical lordosis as closely as possible.

Conflict of interests

For all of the authors, no conflict of interests.

References