

## CASE REPORT

Jean-Sébastien Raul,<sup>1</sup> M.D.; Antoine Tracqui,<sup>1</sup> M.D., Ph.D.; and Bertrand Ludes,<sup>1</sup> M.D., Ph.D.

# Homicide by Manual Occipitoatlantal Dislocation

**ABSTRACT:** Occipitoatlantal dislocation is usually seen as a fatal injury in traffic accidents and has rarely been reported as a consequence of a homicide. The authors report the case of a woman presenting a fatal occipitoatlantal dislocation, the circumstances of which pointed to a homicidal origin. Blood extravasation surrounding the muscles of the posterior part of the neck as well as abnormal mobility of the cranio-cervical joint was noted during autopsy; thus a complete dissection of this region was performed. This led to the finding of a fracture of the left occipital condyle and of the left superior articular facet of the atlas. This case clearly demonstrates the need to perform a large, systematic, posterior approach to the upper cervical spine, completed by the opening of the skull around the posterior fossa, when injury to the cranio-cervical junction is suspected. In these cases, the classic anterior approach gives poor information and poor dissection possibilities.

**KEYWORDS:** forensic science, manual, occipitoatlantal dislocation, homicide

Occipitoatlantal dislocations are rare events in the framework of homicidal deaths. The discovery of a blood extravasation in the muscles at the back of the neck is a common finding associated with these cases and must lead to careful examination of the upper cervical spine.

### Case Report

In July 1999, the body of a 29-year-old female prostitute and former drug addict under substitutive treatment by benzodiazepines and buprenorphine was discovered in an unlocked bicycle shed near garbage cans in the backyard of an apartment block. The corpse, wearing only a T-shirt, was lying in a prone position, face to the ground, the buttocks slightly raised exposing the external genital organs. The police suspected a sexual assault, especially since investigation of the scene of the crime excluded the possibility of a fall, either suicidal or accidental. In addition, the other clothes of the victim were found packed in the bicycle shed.

Close examination of the entire body found different ecchymosis and contusions located on the face, neck, and anterior part of the arms, legs, and trunk. No injuries could be found on the posterior part of the body. Two scratches, evoking nail marks, were located on the left part of the chin and on the upper left part of the neck (Fig. 1). Radiographic examination was considered normal.

During autopsy, a significant haematoma consistent with strong gripping was seen in the subcutaneous tissue of the upper part of the neck underlying the supposed nail marks. Although no injury could be seen during external examination of the back of the neck, dissection showed blood extravasation surrounding the suboccipital groups of muscles as well as the splenius capitis and semispinalis capitis muscles (Fig. 2). We therefore decided to continue the autopsy by performing a posterior neck dissection. Using a circular

electric saw, a complete cervical laminectomy was done, associated with a large occipital craniotomy. The bone incision extended laterally towards the mastoids with an upper limit close to the Protuberantia occipitalis exterior. We obtained a good exposition of all cerebellar and upper medullary elements for a better macroscopic examination. A small epidural hematoma was then discovered.

After opening the dura mater, a large subarachnoid hemorrhage located around the cervical medulla was exposed. The occipital craniotomy allowed us to have a good look at the cerebellar fossa where a small cerebellar subarachnoid hemorrhage was present, corresponding to blood diffusion from the cervical subarachnoid spaces. The skull was completely opened up afterwards, by extension of the former craniotomy. No subarachnoid hemorrhage could be seen on the brain's surface. The brain and cervical medulla were then removed and no vascular malformation of the vertebral and basilar arteries could be found.

Abnormal mobility of the cranio-cervical joint was noted; thus a complete dissection of this region was performed. This led to the finding of a fracture of the left occipital condyle and of the left superior articular facet of the atlas (Fig. 3). Blood extravasation was observed in the posterior atlanto-occipital membrane as well as in the left alar ligament.

Findings on the anterior part of the cervical spine were poor in comparison, consisting only in a 0.2-cm blood extravasation in the left atlanto-occipital ligament.

Further steps of the autopsy failed to reveal other traumatic lesions. Close examination of the genital organs could find neither sperm nor injury.

The histology of different parts of the brain stem appeared normal.

Toxicological analyses were performed on postmortem samples by immunochemical methods as well as by liquid chromatography coupled to diode-array or mass spectrometric detection (LC/DAD, LC/MS), and gas chromatography coupled to mass spectrometric detection (GC/MS). They showed a recent cannabis intake (blood THC, 11-OH THC and THC-COOH : 0.28, 0.34 and 3.62 ng/mL), an exposure to buprenorphine (blood buprenorphine

<sup>1</sup> Institut de Medecine Legale - 11, rue Humann, F-67085 Strasbourg Cedex, France.

Received 19 Oct. 2002; and in revised form 16 Jan. 2004; accepted 16 Jan. 2004; published 7 April 2004.



FIG. 1—Photograph showing a close-up view of the submental region. Note the two parallel scratches consistent with nail marks.



FIG. 2—Photograph taken after dissection of the subcutaneous tissue and muscles of the posterior part of the neck, showing a large hematoma located at the occipito-cervical junction.

and norbuprenorphine: 7.5 and 14.9 ng/mL) and the presence of two benzodiazepines (blood nordiazepam: 5020 ng/mL, blood oxazepam: 708 ng/mL).

### Discussion

The position of the victim's body, facing the ground and hidden near garbage cans in an isolated place, led the investigators to suspect a sexual assault. A fall from a nearby building could have been a possibility but was inconsistent with the size of the windows and the absence of outside fire escapes. A fall from the top of one of the buildings would have led to more serious injuries. Also, this could not explain why the victim's clothes were found in the shed.

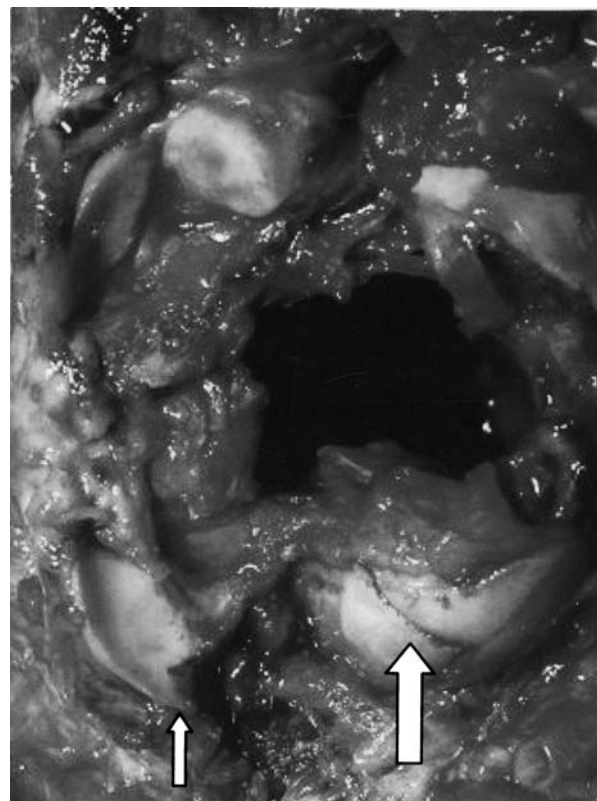


FIG. 3—Photograph taken after dissection of the occipitoatlantal joint. Note the fracture of the left occipital condyle (large white arrow) and of the left superior articular facet of the atlas (small white arrow).

Knowing that the victim was a prostitute was an additional reason to consider a sexual assault as likely.

Contusions and ecchymoses located exclusively over the anterior part of the body gave evidence of a struggle while the offender was trying to keep the victim on the ground as he was lying on her back.

The scratches found on the left upper part of the neck and on the chin associated with a subcutaneous hematoma could be the consequence of strong manual gripping of the head under the chin.

Postmortem radiography did not show the occipitoatlantal dislocation often reduced by the rigor mortis (1).

Our autopsy protocol includes systematic examination of the subcutaneous tissue of the posterior part of the body. In the present casework, this led to reveal blood extravasation in the muscles at the back of the neck. This is a common finding associated with occipitoatlantal dislocation, as described by Adams (1). Autopsy was continued by performing a posterior approach of the spine and skull, for which different techniques have been described (2,3). We preferred a “surgical” approach by performing a cervical laminectomy and a posterior skull opening which gives the possibility to extract the brain and the cervical spine as a whole.

The traumatic origin of the subarachnoid hemorrhage was assessed by the bone fractures and by the blood extravasation. To exclude any vascular malformation, close gross examination of the cerebral arteries, especially vertebral, cerebellar and basilar arteries, was performed showing no vascular malformation such as an aneurysm. Therefore the major subarachnoid haemorrhage discovered in the upper part of the posterior cervical spine and diffusing in the posterior fossa can be considered as of pure traumatic origin.

The mechanism leading to this occipitoatlantal dislocation could have been a strong left rotation of the neck associated with hyperextension. This hyperextension-distraction mechanism has been described by Bucholz and Burkhead (4). These authors often found, as we did, dislocations associated with injuries to the submental region. Traumatic occipitoatlantal dislocation is associated with an extremely high mortality rate: 19% to 35% of patients dying of cervical spine injuries have been found at postmortem examination to have such dislocations (5,6). The improvement of on-scene resuscitation and transportation by medical service units has increased the number of survivors.

This injury is more commonly seen in children than in adults and results mainly from motor vehicle accidents (4).

As relatively little rotation occurs in the atlanto-occipital articulation, forced rotation at this level may cause significant disruption of the supporting capsular and ligamentous structures, resulting in subluxation or pure dislocation (7). As a result of the intrinsic strength of these ligaments, fractures at the base of their attachments usually occur before ligamentous disruption (8,9).

Histological analysis of the scratch sample confirmed its pre- or per-mortem origin, providing another argument for our physiopathological hypothesis. No injury to the brain stem could be noticed histologically. Neurogenic shock is the most frequent mechanism to explain the lethality of occipitoatlantal dislocation (1). The association of an occipitoatlantal dislocation with a subarachnoid hemorrhage of the cranio-cervical junction is a frequent finding (10). Given that the subarachnoid hemorrhage was located around the cervical medulla and did not extend over the entire brain, we believe that death occurred shortly after the cervico-occipital trauma.

Toxicological findings were consistent with the drug substitution treatment taken by the victim and could have altered her ability to react to an assault.

When such injuries are suspected, we feel it useful to perform a posterior approach associating a large occipital craniectomy and a complete cervical laminectomy. This helps to keep the subarachnoid hemorrhage in place and to save all the important vascular elements, giving the opportunity to discuss the traumatic or nontraumatic origin of the subarachnoid hemorrhage. Brain extraction should follow the opening of the cerebellar and cervical dura mater while the body is still lying in a prone position. The search for a traumatic bone injury should be made by opening systematically both the occipitoatlantal and the atlanto-axial joints.

## Conclusion

This case of homicide by manual occipitoatlantal dislocation clearly demonstrates the need to perform a large, systematic, posterior approach to the upper cervical spine, completed by the opening of the skull around the posterior fossa, when injury to the cranio-cervical junction is suspected. The classic anterior approach gives poor information and poor dissection possibilities.

This posterior approach should be carried out carefully and systematically in the case of suspected injury to the occipito-cervical joints, as it appears to be the most relevant technique to use and can certainly help in understanding most of the traumatic mechanisms involved in such injuries.

## References

1. Adams VI. Neck injuries: I. Occipitoatlantal dislocation—a pathologic study of twelve traffic fatalities. *J Forensic Sci* 1992;37(2):556–64. [[PubMed](#)]
2. Sohn D. Removal of the spinal cord in continuity with the brain at autopsy. *Am J Clin Pathol* 1972;58(5):596–7. [[PubMed](#)]
3. Berzlanovich AM, Sim E, Muhm MA. Technique for dissecting the cervical vertebral column. *J Forensic Sci* 1998;43(1):190–3. [[PubMed](#)]
4. Bucholz RW, Burkhead WZ. The pathological anatomy of fatal atlanto-occipital dislocations. *J Bone Joint Surg Am* 1979;61(2):248–50. [[PubMed](#)]
5. Alker GJ, Jr, Oh YS, Leslie EV. High cervical spine and craniocervical junction injuries in fatal traffic accidents: a radiological study. *Orthop Clin North Am* 1978;9(4):1003–10. [[PubMed](#)]
6. Bohlman HH. Acute fractures and dislocations of the cervical spine. An analysis of three hundred hospitalized patients and review of the literature. *J Bone Joint Surg Am* 1979;61(8):1119–42. [[PubMed](#)]
7. Montane I, Eismont FJ, Green BA. Traumatic occipitoatlantal dislocation. *Spine* 1991;16(2):112–6. [[PubMed](#)]
8. Dvorak J, Panjabi MM. Functional anatomy of the alar ligaments. *Spine* 1987;12(2):183–9. [[PubMed](#)]
9. Sherk HH. Lesions of the atlas and axis. *Clin Orthop* 1975;109:33–41. [[PubMed](#)]
10. Przybylski GJ, Clyde BL, Fitz CR. [Craniocervical junction subarachnoid hemorrhage associated with atlanto-occipital dislocation](#). *Spine* 1996;21(15):1761–8. [[PubMed](#)]

Additional information and reprint requests:

Jean-Sébastien Raul, M.D.  
Institut de Médecine Légale  
11, rue Humann, 67000 Strasbourg  
France

E-mail: Jean-Sebastien.Raul@iml-ulp.u-strasbg.fr