

**TECHNICAL NOTE****PATHOLOGY/BIOLOGY**

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## A Proposed Dissection Procedure for Vertebral Arteries in Forensic Pathology

**ABSTRACT:** Vertebral artery removing constitutes a significant forensic pathology challenge. Dissection techniques during head–neck autopsy are based on anterior approach, a difficult method, which is unable to assess the transverse part of the artery. This work presents an original and simple method for dissecting vertebral arteries by a posterior approach, opening the vertebroarterial canal through the spinal canal without any special equipment. Once the spinal cord is removed, the transversarium foramina are opened by an internal cut at the pedicle and an external cut at the transverse process. This enables us to visualize vertebral arteries in its entirety. The method improves both the examination of the upper extracranial segment of the vertebral artery and the neuropathological study when arterial injury is suspected. Applying this method routinely is both feasible and useful in suspected cases of vertebral artery trauma and could contribute to assess more precisely the actual incidence of this injury.

**KEYWORDS:** forensic science, autopsy techniques, cervical spine, neck injuries, neuropathology, vertebral artery injury

Recent studies emphasize the pathological importance of the vertebral artery and the necessity to routinely examine this vessel in all cases of fatal traumatic head and neck injuries, even in the absence of external physical evidence of trauma (1–4). However, this examination is often neglected because the relative inaccessibility of the vertebral arteries implies a significant difficulty in the dissection procedure, especially in the extracranial segment (5,6). The current work presents a simple procedure for dissecting vertebral arteries and discusses its advantages on the basis of existing methodologies. To test the method, vertebral arteries were removed bilaterally from unselected cadavers from the Forensic Pathology Service of the *Institut de Medicina Legal de Catalunya* and the *Unitat d'Anatomia i d'Embriologia* of the Medicine Faculty of the *Universitat Autònoma de Barcelona*.

### Technical Description

The method requires the use of normal dissection instruments, routinely used in hospital and forensic necropsies: oscillating saw (preferable straight blade), postmortem hammer and chisel, scalpel, toothed forceps, ordinary curved scissors, and flat end tweezers.

The body is placed in a prone position with a block placed under the chest, stretching the posterior neck structures. A midline skin incision is made from the external occipital protuberance to the upper thoracic spine. The skin and soft tissues are then dissected from the bone using scalpel and forceps and then reflected back to

expose as much as possible the posterior aspect of cervical spine. To allow the soft tissues to be folded back in a flap without retractors, it may be useful to make horizontal cuts mainly at the top and lower parts of this incision (Fig. 1a).

Once arches of the cervical vertebra are exposed, using oscillating saw, then perform a cervical bilateral laminectomy (Fig. 1b). Free the posterior part of the atlanto-occipital ligament, and turn with the forceps the laminae and spines to uncover the spinal canal (Fig. 1c). Transect and remove the cervical cord. Approach vertebroarterial canal by internal and external cuts (Fig. 2). It is important to be careful at this stage of the dissection to avoid structural damage. The internal cut is performed through the spinal canal and should be placed at the more anterointernal part of the pedicle, directing it outward and forward (Fig. 1d). The external cut should be placed between the anterior and the posterior tubercle of the transverse process and should be directed inward (Fig. 1e).

Toothed forceps are used to remove the pieces of bone and uncover the vertebroarterial canal, exposing the entire foraminal segment of the vertebral artery (Fig. 1f). After a detailed *in situ* examination of both vessels, these should be cut as far as possible from the prevertebralis to atlantic parts of the vertebral arteries (transverse foramina of the sixth cervical vertebra, and at the level of foramen magnum). The flat-end tweezers and curved scissors are then used to hold and remove the vertebral arteries from the vertebra. The further part of the intracranial segment can be removed while the brain is being removed by conventional cranial autopsy.

### Discussion

Although techniques by which the vertebral arteries are examined have been discussed in previous articles and books devoted to forensic pathology, demonstration of the vertebral artery injury still constitutes a significant forensic pathology challenge mainly

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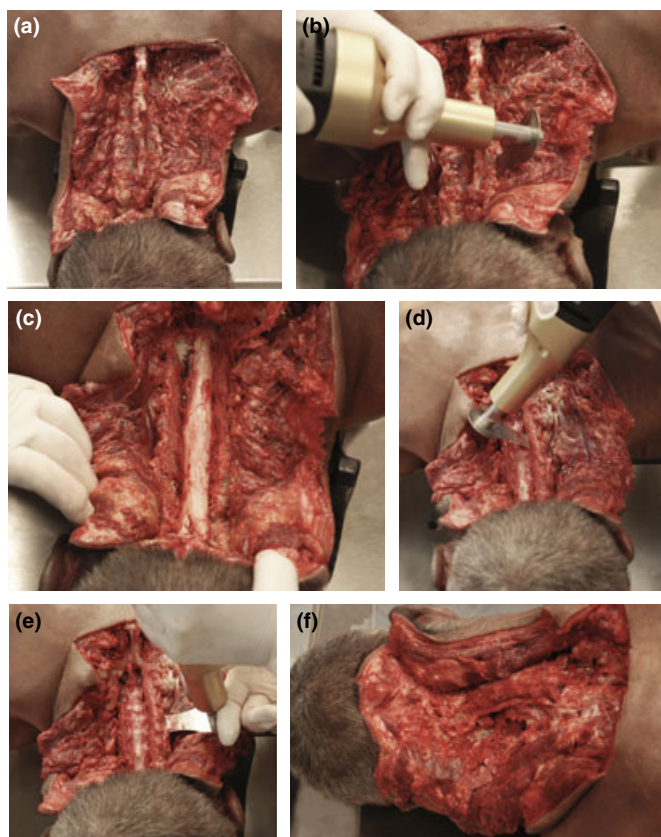


FIG. 1—Dissection procedure for vertebral arteries. (a) Exposing arches of the cervical vertebra. (b) Cervical laminectomy. (c) Uncovering of the spinal canal. (d) Internal cut is performed at the more anterointernal part of the pedicle. (e) External cut is performed between the anterior and the posterior tubercle of transverse process. (f) Left vertebral artery in situ.

because of the significant difficulty in the dissection of the neck. Postmortem angiography techniques have been widely proposed, even as a priority screening method before vertebral artery dissection (5). However, to undertake angiographic study is not always logistically possible, and vertebral artery evaluation may be complicated by vascular malformations, postmortem positioning during angiography, or technical errors (7). Additionally, angiography diagnosis does not exclude a later vertebral artery dissection. Several authors have proposed methods to remove and decalcify the cervical block (8–10). Disadvantages of these techniques are related with the decalcification process that is laborious and more time-consuming for a medico-legal investigation, extending the investigation by a number of weeks.

On the other hand, more suitable methods are those that allow immediate vertebral artery examination. These methods, such as the present procedure, remove the vertebral arteries during head-neck autopsy by opening the transversarium foramen (vertebroarterial canal) (7,11,12). Nevertheless, our method differs from those previously published in the way that vertebroarterial canal is dissected by posterior (rather than anterior) approach, being the neck dissection both quicker and easier comparatively with the anterior approach (10,13). Improvements to the procedures already published are related to the fact that the proposed posterior approach allows a very optimal exposition of the transverse part (segment V3) of the vertebral artery, a critical segment for the traumatic injuries that remain unobserved during the anterior neck approach (11,12,14). Additionally, given that our procedure approaches the vertebroarterial canal through spinal canal, it improves the

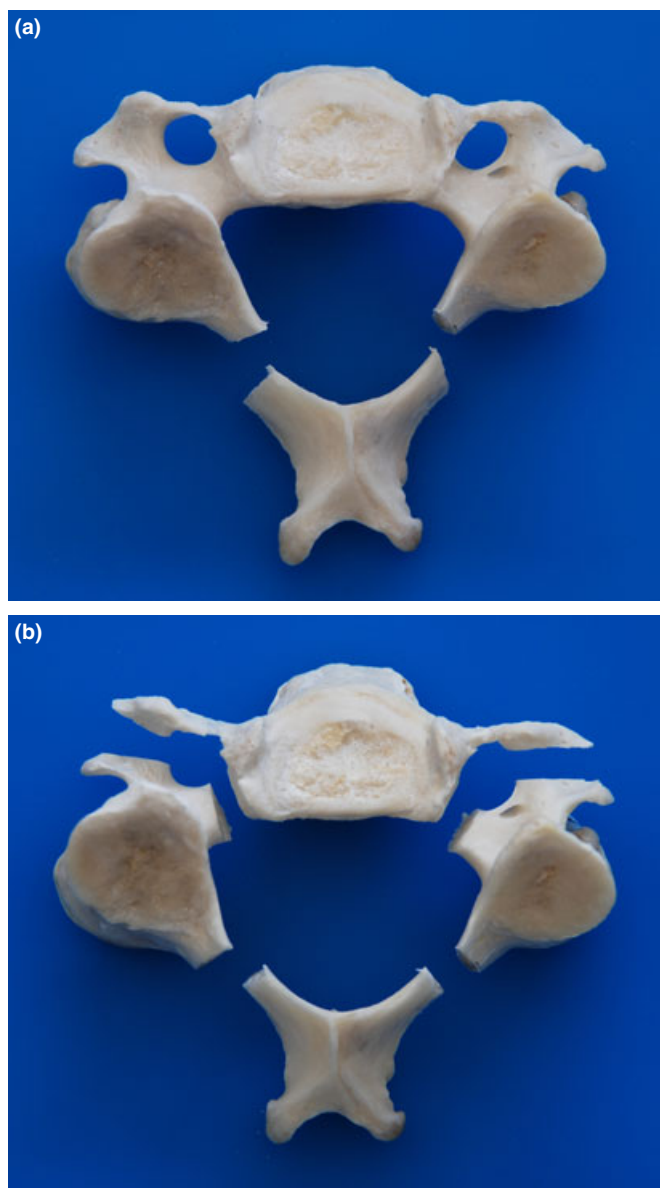


FIG. 2—Superior view of cervical vertebra. (a) Bilateral laminectomy. (b) In the same vertebra, vertebroarterial canal is opened by internal and external cuts.

neuropathological study. In this sense, several studies have shown that vertebral artery trauma is often associated with other neck injuries such as vertebral fractures, spinal hematoma, or spinal cord injury (1,14–16).

Moreover, in contrast to the dissection purposed by Bromilow and Burns (11), our method requires no special instruments to open transversarium foramen; in fact, it uses instruments routinely applied in hospital and forensic necropsies. We consider that instrument availability for vertebral artery dissection cannot be an additional limiting factor in cases when vertebral artery examination is necessary. Although the use of oscillating saw may leave small bony particles in the tissues adjacent to the vessel, visible on histological section, no necropsy-induced structural damage has been noted on histopathological examinations.

In summary, this work presents an original and simple method to remove the vertebral arteries, suitable for hospital and forensic necropsies, without any special equipment. The method improves

both the examination of the upper extracranial segment of the vertebral arteries and the neuropathological study when arterial injury is suspected. The technique preserves the carotid system; therefore, it does not interfere significantly with embalming procedure. Applying this method routinely is both feasible and useful in suspected cases of vertebral artery trauma and could contribute to know more precisely the true incidence of this injury.

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#### **References**

1. Kasantikul V, Ouellet JV, Smith TA. Head and neck injuries in fatal motorcycle collisions as determined by detailed autopsy. *Traffic Inj Prev* 2003;4(3):255–62.
2. Kaiser Ch, Schnabel A, Berkefeld J, Bratzke H. Traumatic rupture of the intracranial vertebral artery due to rotational acceleration. *Forensic Sci Int* 2008;182(1-3):e15–7.
3. Kim YK, Schulman S. Cervical artery dissection: pathology, epidemiology and management. *Thromb Res* 2009;123(6):810–21.
4. Lee CK, Gray L, Maguire J. Traumatic vertebral artery injury: detailed clinicopathologic and morphometric analysis of 6 cases. *Am J Forensic Med Pathol* 2009;30(2):134–6.
5. DiMaio VJ, DiMaio D. Trauma to the skull and brain: craniocerebral injuries. In: Geberth VJ, series editor. *Forensic pathology*, 2nd edn. Boca Raton, FL: CRC Press, 2001;147–85.
6. Palomo JL, Ramos V, Palomo I, López A, Santos IM. Patología forense y neurología asociada de los traumatismos craneoencefálicos: estudio práctico. *Cuad Med Forense* 2008;15(52):87–118.
7. Reichard R, Dolinak D, Guileyardo D. Delayed rupture of a vertebral artery as an uncommon cause of fatal subarachnoid hemorrhage. *Am J Forensic Med Pathol* 2002;23(4):394–7.
8. Hutchinson EC, Yates PO. The cervical portion of the vertebral artery. A clinico-pathological study. *Brain* 1956;79(2):319–31.
9. Vanezis P. Techniques used in the evaluation of vertebral artery trauma at post mortem. *Forensic Sci Int* 1979;13(2):159–65.
10. Sheaf MT, Hopster DJ. The nervous system. In: Sheaf MT, Hopster DJ, editors. *Post mortem technique handbook*, 2nd edn. London, UK: Springer, 2005;282–318.
11. Bromilow A, Burns J. Technique for removal of the vertebral arteries. *J Clin Pathol* 1985;38(12):1400–2.
12. Aggrawal A, Setia P. Vertebral artery dissection revisited. *J Clin Pathol* 2006;59(9):1000–2.
13. Gisbert JA, Verdú FA. Autopsia medico-legal. In: Gisbert JA, editor. *Medicina legal y toxicología*, 5th edn. Barcelona, Spain: Masson, 1998;219–43.
14. Rommel O, Niedeggen A, Tegenthoff M, Kiwitt P, Bötel U, Malin J. Carotid and vertebral artery injury following severe head and cervical spine trauma. *Cerebrovasc Dis* 1999;9(4):202–9.
15. Pötsch L, Bohl J. Traumatic lesion of the extracranial vertebral artery—a note-worthy potentially lethal injury. *Int J Legal Med* 1994;107(2):99–107.
16. McCormick MT, Robinson HK, Bone I, McLean AN, Allan DB. Blunt cervical spine trauma as a cause of spinal cord injury and delayed cortical blindness. *Spinal Cord* 2007;45(10):687–9.

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