CASE REPORT

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Complications of Cervical Manipulation: A Case Report of Fatal Brainstem Infarct with Review of the Mechanisms and Predisposing Factors

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ABSTRACT: Medical and surgical complications of chiropractic manipulation occur infrequently in relation to the number of procedures performed. These complications include intracranial hemorrhage, spinal cord injuries, trauma to the carotid and vertebral arteries, and vertebral-basilar distribution infarction. This is a report of a case of vertebrobasilar infarction following chiropractic manipulation leading to a comatose state within 1 h following the manipulative procedure. This case report should alert the forensic pathologist to the possibility of cervical manipulation as a cause of acute brainstem infarction, and the mechanism and the predisposing factors to injury should be reviewed. The importance of careful autopsy technique and use of postmortem arteriographic techniques are emphasized.

KEYWORDS: pathology and biology, brain, central nervous system, chiropractic

Case Report

A 51-year-old construction executive consulted a chiropractor for relief of recurrent neck pain. He had no previous significant medical history and had sought chiropractic cervical manipulation on numerous occasions in the past for a similar complaint. Following one such manipulation, he returned to his place of work where he complained of nausea, vertigo, tinnitus, and visual blurring. Approximately 30 min following the manipulation he was notably ataxic, collapsed, and became semicomatose. Following transportation to an emergency facility, he was noted to have ophthalmoparesis with bilateral lower limb ataxia and cerebellar dysarthria. Approximately 1 h following the manipulation, he became comatose, and a subsequent computerized axial tomography (CAT) scan examination confirmed a cerebellar-brainstem infarct accompanied by herniation and acute compression of the central aqueduct and ventricular dilatation. The patient was declared brain dead, and life support systems were terminated.

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A postmortem arteriogram using a direct cut down of the supraclavicular fossa was performed and suggested compression of the right vertebral artery at the level of the atlantooccipital junction and revealed a diffusely hypoplastic left vertebral artery (Fig. 1).

An autopsy including a postmortem examination of the upper vertebral-basilar artery distribution was performed with adequate exposure obtained by using a posterior midline, cervical approach with lateral extension of the superior margin. An area of perivascular hemorrhage was identified overlying the right vertebral artery at a point just proximal to the atlantooccipital ligament along the dorsal aspect of the first cervical arch. Serial microscopic sections of the excised vessel demonstrated perivascular hemorrhage with extravasation of red cells into the media and adventitial tissues. This hemorrhage was consistent with a shearing injury of the small arteries constituting the vasa vasorum (Fig. 2). The left vertebral artery was diffusely hypoplastic throughout its course with a diameter of approximately 25% of the right (Fig. 3). The entire cerebellum and brainstem region showed autolysis with extensive softening and discoloration. There was evidence of dilatation of the central aquaduct and ventricular system secondary to acute compression from massive brain swelling.

Discussion

Since the inception of the chiropractic profession in 1895, relatively few complications of cervical manipulation have been reported [*1*]. However, the literature does substantiate that

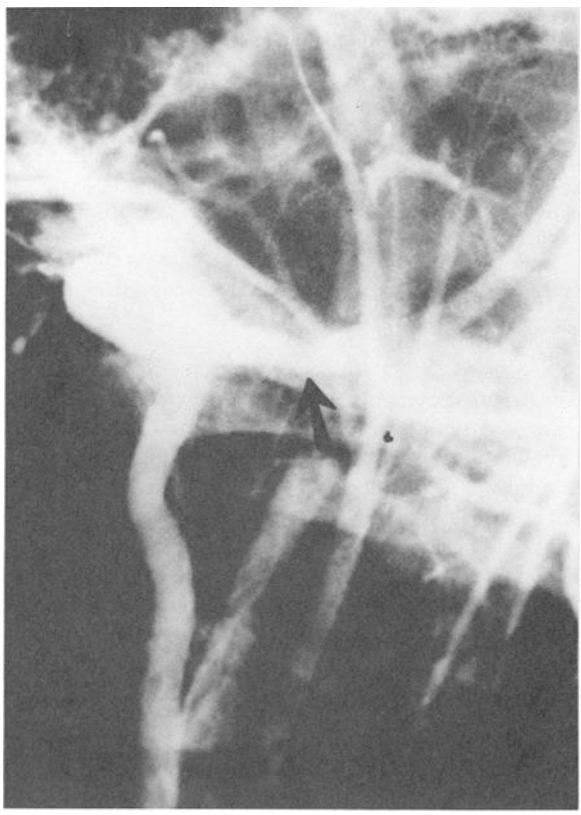

FIG. 1—*The postmortem arteriogram of the right vertebral artery demonstrates an area of irregular compression suggestive of dissection as the vessel penetrates the dura above and medial to the first cervical vertebral body* (arrow).

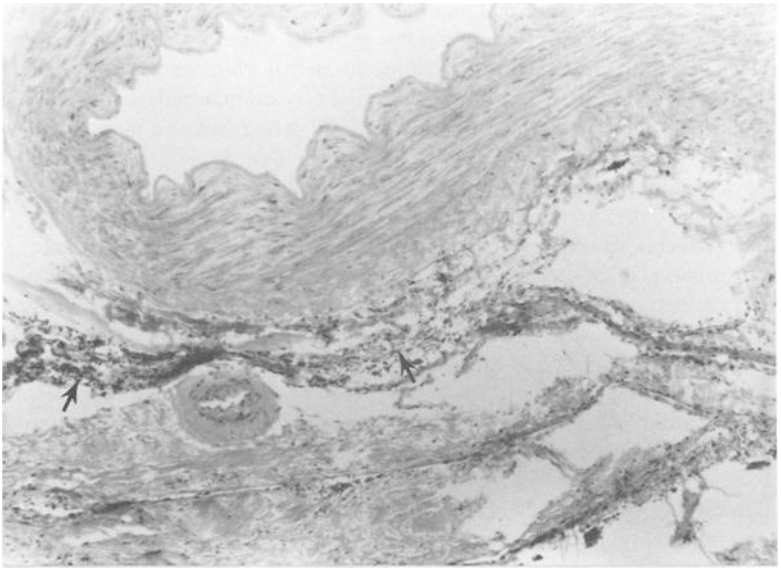

FIG. 2—*The resected right vertebral artery shows acute hemorrhage* (arrows) *with dissection of the adventitial tissue of the vasa vasorum.*

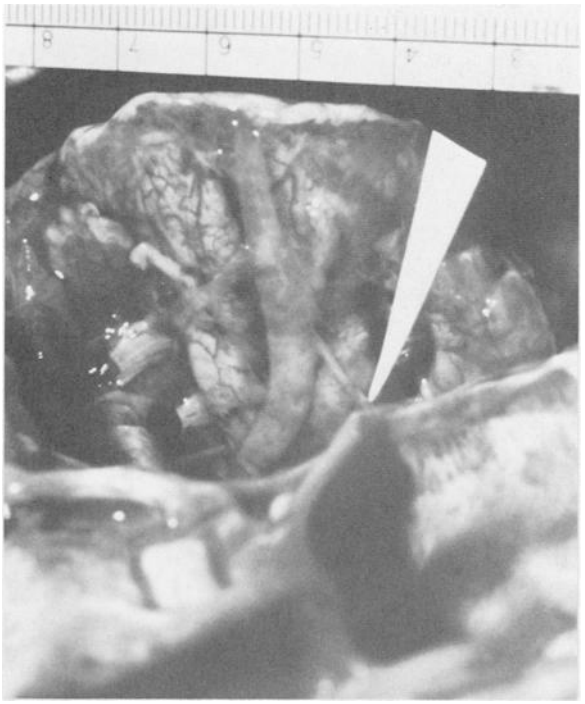

FIG. 3—*The in situ photograph demonstrates the marked asymmetry of the right and hypoplastic left vertebral arteries.*

stroke-like episodes may follow cervical manipulation [2-5]. Although the precise incidence of this complication is unknown, a conservative estimate based on the approximately 33 million cervical manipulations reported to be performed in this country each year would place the incidence of lethal stroke syndrome following cervical manipulation at about one in one million manipulations [1,6]. In addition, transitory deficits may be more common and may frequently go unreported [7].

The vertebral arteries are uniquely susceptible to mechanical injury because of their unique relationship to the surrounding bony structures in the cervical region (Fig. 4). After arising from the subclavian arteries, the vertebral arteries traverse the structures of the neck through the transverse foramina of the cervical vertebrae. After emerging from the atlas, the vertebral artery runs posteriorly and medially through the lateral articular process of the atlas. The artery then penetrates the oblique ligament of the atlas, pierces the spinal dura, and passes superiorly through the foramen magnum where it unites with the opposite vertebral artery to form the basilar artery [7,8]. The vertebral arteries then are most susceptible to external forces at three sites: during their ascent in the foramina of the first six cervical vertebrae, at the C1-C2 junction, and at the craniocervical junction [3,7,8].

The mechanism of injury usually involves either cervical hyperextension or hyperextension with contralateral rotation. In 1927, DeKleyn, and later Tatlow, demonstrated that upon overextension and rotation of the head, the circulation to the contralateral vertebral artery is transiently obstructed [8,9]. In the normal person, temporary occlusion of a vertebral artery does not significantly reduce blood flow to the posterior cerebral circulation [10].

Brainstem infarction has been documented from occlusion of the vertebral artery circulation following rapid turning of the head with associated hyperextension in a variety of circumstances which include: chiropractic manipulation, spontaneous head turning in an automobile, minor falls, and blunt force trauma to the side of the neck [11].

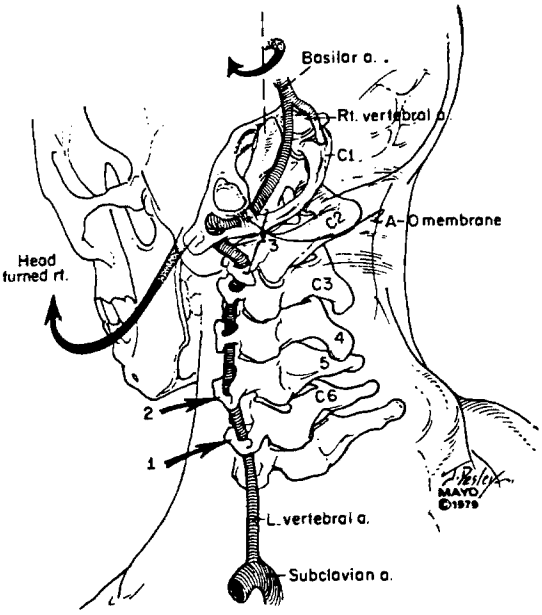

FIG. 4—*This drawing depicts the anatomic relationship of the vertebral artery to the surrounding osseoligamentous structures. The artery is prone to injury during its ascent through the vertebral foramina, at the C1-C2 junction, and at the craniocervical junction. (Figure courtesy of* The Mayo Clinic Proceedings.*)*

The risk of vertebral artery injury increases with the presence of vascular abnormalies which include preexisting atherosclerosis, congenital asymmetry of the vertebral arteries, aneurysm formation, cervical spondylosis, or congenital deformities of the cervical spine [*10–12*]. Studies have shown that the vertebral arteries have considerable size variation, as in the present case, with equal sized arteries present in only 8% of the population [*2*].

Clinically, patients with vertebral artery related ischemia may exhibit a wide spectrum of signs and symptoms. These may include bilateral medullary infarction syndrome or Wallenberg's syndrome, which is the most common syndrome associate with chiropractic manipulation [*7*]. Major components of this syndrome include ipsilateral loss of cranial nerves, V, IX, X, and XI associated with cerebellar ataxia, Horner's syndrome, and contralateral loss of pain and temperature sensation. Additionally, patients may demonstrate the locked-in syndrome which consists of quadraplegia with loss of all lower cranial nerves. Numerous transient neurological deficits including nausea, tinnitus, vertigo, ataxia, and visual disturbances may occur and frequently go unreported [*7*]. Quadraplegia and sudden death have also been described.

The pathological alteration of the vertebral arteries following cervical manipulation have been demonstrated in some cases. These include complete thrombotic occlusions and aneurysm formation with dissection. Subintimal hematomas may result when the small vasa vasorum arteries are disrupted within the arterial adventitial tissue, as in this case. Distal branch occlusions may develop from propagation of thrombi or thromboembolism. Occasionally, no pathological findings are present suggesting that arterial spasm may play a role in vertebral artery infarction syndromes [*7*].

The use of postmortem arteriography greatly assists in the localization of possible occlusions, thereby expediting the actual postmortem examination. We find that the posterior cervical approach permits maximal exposure of the craniocervical region when the superior margin is extended laterally. Additionally, in situ amputation of the brainstem at the pontine-midbrain level assists in exposing this area intracranially.

Conclusion

In summary, we present a middle aged male who died from vertebral-basilar ischemic infarction immediately following chiropractic manipulation. He was predisposed to infarction, despite numerous previous uneventful manipulations, by a congenital asymmetry of the vertebral arteries. The complications of chiropractic manipulation, although rare, are devastating and potentially lethal. Cerebral arteriography and careful postmortem dissection are crucial in the documentation and evaluation of these injuries in cases of suspected injury following chiropractic manipulation.

Acknowledgment

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References

[*1*] Crawford, J. P. and Sherman, D. G., "Vascular Ischemia of the Cervical Spine: A Review of the Relationship to Therapeutic Manipulation," *Journal of Manipulative and Physiological Therapeutics*, Vol. 7, No. 3, Sept. 1984, pp. 149-155.

[*2*] Smith, R. A. and Estridge, M. N. "Neurologic Complications of Head and Neck Manipulations, Report of Two Cases," *Journal of the American Medical Association*, Vol. 182, No. 5, Nov. 1962, pp. 528-531.

[*3*] Mechalic, T. and Farhat, S. M., "Vertebral Artery Injury from Chiropractic Manipulation of the Neck," *Surgical Neurology*, Vol. 2, March 1974, pp. 125-129.

[4] Fritz, V. V., Maloon, A., and Tuch, P., "Neck Manipulation Causing a Stroke, Case Reports," *The South African Medical Journal,* Vol. 145, March 1985, pp. 844-846.
[5] Braun, I. F., et al., "Brain Stem Infarction Due to Chiropractic Manipulation of the Cervical Spine," *Southern Medical Journal,* Vol. 76, No. 12, Dec. 1983, pp. 1507-1510.
[6] Hosek, R. S., et al., "Cervical Manipulation," *Journal of the American Medical Association,* Vol. 245, No. 9, March 1981, pp. 922.
[7] Schellhas, K. P., et al., "Vertebrobasilar Injuries Following Cervical Manipulation," *Journal of the American Medical Association,* Vol. 244, No. 13, Sept. 1980, pp. 1450-1453.
[8] Tatlow, W. F. and Bammer, H. G., "Syndrome of Vertebral Artery Compression," *Neurology,* Vol. 7, 1957, pp. 331-340.
[9] Barton, J. W. and Margolis, M. T., "Rotational Obstruction of the Vertebral Artery at the Atlantoaxial Joint," *Neuroradiology,* Vol. 9, Nov. 1974, pp. 117-120.
[10] Easton, J. D. and Sherman, D. G., "Cervical Manipulation and Stroke," *Stroke,* Vol. 8, No. 5, Sept.-Oct. 1977, pp. 594-597.
[11] Krueger, B. R. and Okazaki, H., "Vertebral-Basilar Distribution Infarction Following Chiropractic Cervical Manipulation," *Mayo Clinic Proceedings,* Vol. 55, May 1980, pp. 322-332.
[12] Vakili, S. T., Aquillar, J. C., and Muller, J., "Sudden Unexpected Death Associated with Atlanto-Occpital Fusion," *The American Journal of Forensic Medicine and Pathology,* Vol. 6, No. 1, March 1985, pp. 39-43.

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