VIA MEDICA

CASE REPORT

Folia Morphol.
Vol. 65, No. 2, pp. 167–170

ISSN 0015–5659
www.fm.viamedica.pl

A rare variation of the vertebral artery

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[Received 29 September 2005; Revised 31 March 2006; Accepted 31 March 2006]

Variations of the vertebrobasilar arterial complex are important with regard to their potential clinical impact. We present an unusual case of the vertebral artery, in which the left vertebral artery in its ascent in the neck through the transverse foramina passed posteriorly between the transverse processes of C3 and C4 and supplied the posterior muscles of the neck without continuing intracranially. Albeit speculatively, we hypothesise that the variation of the vertebral artery reported here was caused by degeneration of the proximal portion of the left postcostal longitudinal anastomosis (i.e. C1 and C2 intersegmental arteries) in the context of a persistent third cervical intersegmental artery. Our case is unique in that the left vertebral artery terminated extracranially. Knowledge of the variations of the vertebrobasilar arterial complex is important for surgeons operating at the skull base, craniocervical junction, and cervical region, and for clinicians interpreting the imaging of this region.

Key words: vertebral, artery, variation, vertebrobasilar, anatomy

INTRODUCTION

Anatomical variation is defined as the normal flexibility in the topography and morphology of body structures. Advances in imaging techniques and surgery, especially reconstructive and minimally invasive procedures, have necessitated a more accurate knowledge of the variability of the human body [11, 13]. Interestingly, it has been estimated that up to 10% of malpractice involving physicians may be due to a lack of knowledge of anatomical variations [11].

Arteriosclerosis, aneurysms, and infarction often involve the vertebrobasilar arterial system [6]. Although maldevelopment anomalies of the vertebral arteries are generally considered very rare and, to date, have been described only in single case reports and in small series of patients with a single type of pathology, in approximately 60% of cases the vertebral arteries are of unequal size [5]. The left vertebral artery is often larger than the right vertebral artery [5]. The vertebral arteries usually originate as the first branches of the subclavian arteries; however, in approximately 6% of the population the left vertebral artery arises directly from the aortic arch, usually between the left common carotid and subclavian arteries [8, 9]. The posterior inferior cerebellar arteries may arise extracranially from the vertebral artery [4]. The vertebral artery may also be fenestrated [10].

We present a case of a left vertebral artery with a unique extracranial course in which this vessel terminated in the posterior muscles of the neck and did not join the contralateral vertebral artery to form the basilar artery. The possible embryological origin of this variation is discussed as well as its potential clinical importance.

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CASE REPORT

Following the removal the calvaria and brain of a 56-year-old formalin-fixed male cadaver, the basilar artery was noted in the midline of the clivus and when examined was found to be formed solely by the right vertebral artery 3.5 cm superior to the foramen magnum (Fig. 1A). The left vertebral artery originated normally from the left subclavian artery. Once the anterior portion of the transverse processes of the right cervical vertebrae was removed from C6 to C3, the left vertebral artery was noted to ascend posteriorly between the transverse processes of vertebrae C3 and C4 and ended by supplying the deep muscles of the neck. (Fig. 1B). No primitive hypoglossal or proatlantal arteries were identified. The anterior spinal artery originated from the normally positioned right vertebral artery.

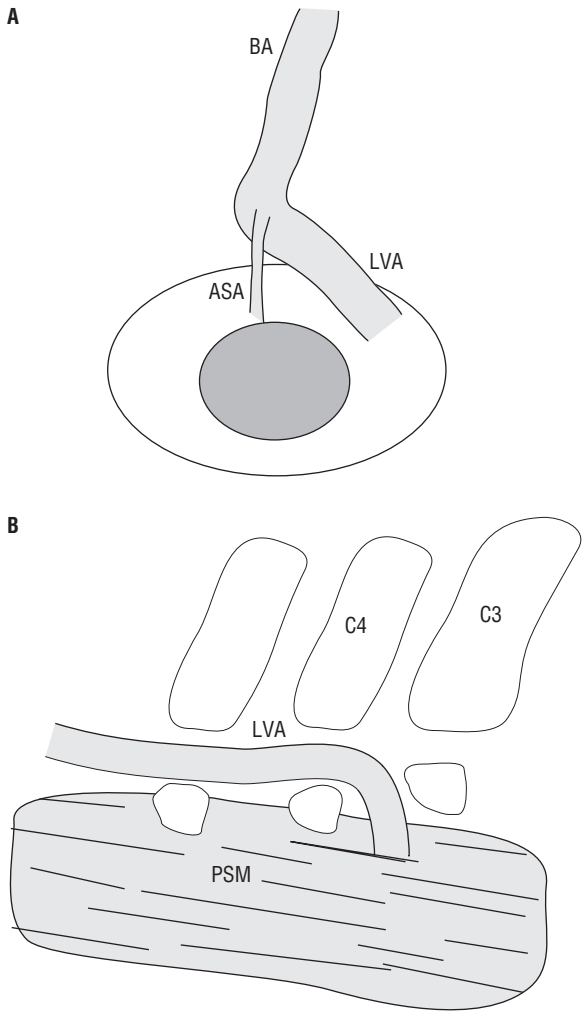

Figure 1. Schematic depiction of the variation of the vertebral artery as described in our report. **A.** An intracranial drawing with the outer circle representing the foramen magnum and the darker inner circle representing the transected junction between the brainstem and spinal cord. **B.** An extracranial longitudinal drawing noting the vertebral artery terminating in paraspinal musculature. LVA — left vertebral artery; BA — basilar artery; ASA — anterior spinal artery; PSM — paraspinal muscles; C3 and C4 — third and fourth cervical vertebrae.

DISCUSSION

Embryologically, the development of the vertebral artery is preceded by the formation of postcostal longitudinal anastomoses, which link the cervical intersegmental arteries [1]. Fusion of the embryonic longitudinal arteries forms the basilar artery in a craniocaudal direction by approximately the fifth week of foetal development [7]. Each individual somite receives its blood supply from a single branch of the dorsally paired aorta, namely its intersegmental arteries (Fig. 2A). The proatlantal intersegmental artery between the occipital and cervical somites accompanies the first cervical nerve and provides communication between the developing carotid and vertebral artery circulations [12] (Fig. 2A). The second pair of segmental arteries, the so-called hypoglossal arteries, accompanies the hypoglossal nerves. The hypoglossal arteries provide branches that aid in the formation of the cerebral part of the vertebral artery and anastomose with the posterior branches of the internal carotid artery. Later the hypoglossal artery atrophies and its anastomotic branch to the posterior communicating artery remains connected to the ipsilateral proatlantal and longitudinal neural axis [12]. This connection corresponds to the distal portion of the vertebral and basilar arteries (Fig. 2A, B).

We hypothesise that the absence or degeneration of the proximal portion of the left postcostal longitudinal anastomoses and proximal intersegmental arteries in association with a persisting third cervical intersegmental artery resulted in the formation of the variation of the vertebral artery seen in our specimen (Fig. 2C, 2D). The only similar reports of non-union of the left and right vertebral arteries found in our review were by Berry [3] and Batujeff [2]. Berry [3] reported a right vertebral artery that did not join the left vertebral artery but rather ended in the cerebellum. This author also stated that very rarely the two vertebral arteries may fail to unite to form a single median basilar artery and that this artery is thus formed by two longitudinal trunks united by transverse anastomoses. Batujeff [2] described an unusual right vertebral artery that terminated as the posterior inferior cerebellar artery.

Although the notion is controversial, some authorities believe that vertebrobasilar arterial variations

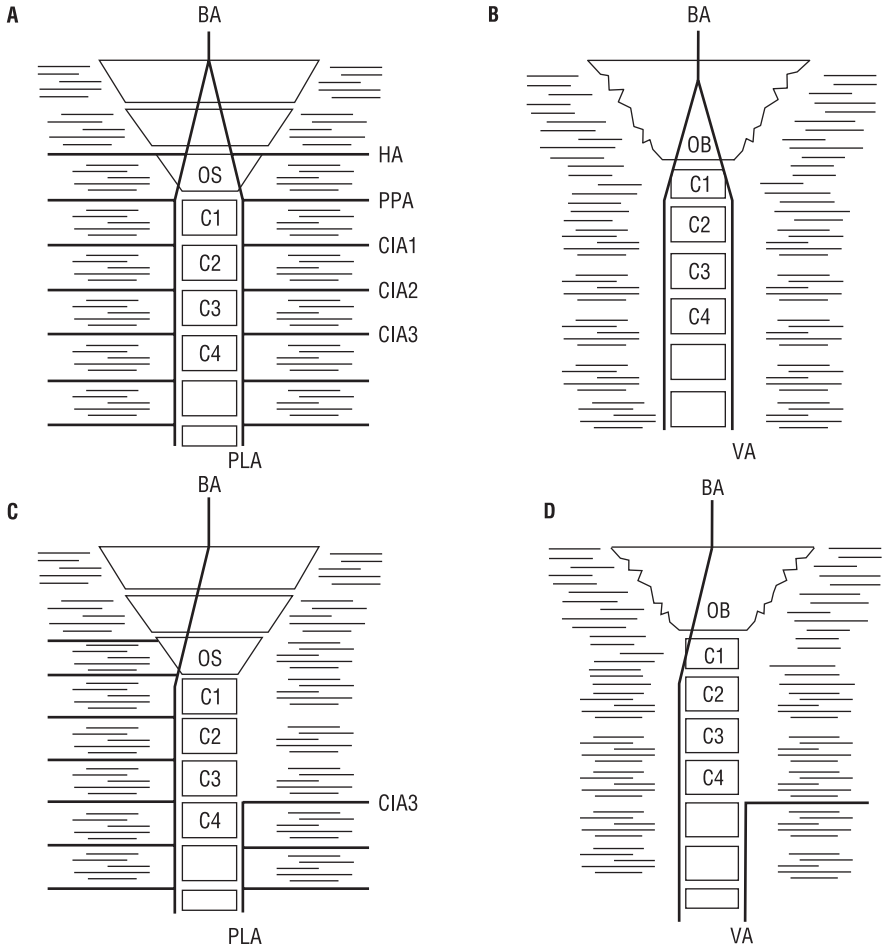

Figure 2. Schematic representation of the vertebrobasilar arterial complex with both normal embryological formation and a potential mechanism of variation as de[icted in our report (see Discussion). VA — vertebral artery; BA — basilar artery; PLA — postcostal longitudinal anastomoses; OS — occipital somite; OB — occipital bone; C1–C4 — cervical vertebrae; HA — hypoglossal artery; PAA — proatlantal artery; CIA13 — cervical intersegmental arteries 1–3.

may lead to cerebral disorders by altering the vascular haemodynamics, thereby placing patients at greater risk of thrombosis, aneurysms, occlusion, arterial dissection, and, potentially, atherosclerosis [14]. Surgical procedures that would necessitate exposure of the vertebral artery include repair of aneurysms, excision of craniocervical junction masses, vertebral endarterectomy, vertebral artery bypass, and bony decompression of the vertebral artery. Ultimately, with respect to individual variations of the vertebral artery, a thorough knowledge of vertebrobasilar variations may improve the outcome of skull base and other head and neck operations and aid in the interpretation of imaging.

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