



Review

Anatomical characterization of the vertebral artery from a local study population using angiography by computed tomography



Gloria Patricia Baena-Caldas ^a, Juan Felipe Orejuela Zapata ^{b,*}, Ana María Granados Sánchez ^c

^a Morphology Department, Universidad del Valle, Colombia

^b Biomedical Engineer, Radiology Department, Fundación Valle del Lili, Colombia

^c Radiologist, Radiology Department, Fundación Valle del Lili, Colombia

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KEYWORDS

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Abstract *Purpose:* Despite most anatomical variations of the vertebral artery (VA) related to the origin and intraforaminal entrance remain asymptomatic because of the collateral irrigation system, it is important to know their anatomical presentation in order to prevent complications that could be neurologically devastating for patients. The aim of this study was to characterize the VA anatomy using computed tomography angiography (CTA) in the Colombian population.

Methods: Study was descriptive, observational and cross-sectional. Neck and thorax CTA studies performed between 2010 and 2017 in adult population were reviewed. Studies with low image-quality or artifacts, or patients with vascular malformations or injuries history, as well as non-Colombian patients were excluded. Frequencies and percentages were calculated.

Results: 500 CTA were studied, 362 (72.4%) from male patients, 138 (27.6%) from female patients. In the 18% (n = 90) of the study population, there was at least one VA variation; 73.33% (n = 66) of these cases were male patients and 26.67% (n = 24) were female patients, however, the percentage of VA variations was similar in both genders (18.23% men, 17.39% women).

Conclusion: Our findings suggest that the VA anatomy should be assessed prior to any surgical procedure in thoracic or neck region that involves the VA as any complication may be deleterious for the patient. Patients with neurological symptoms and VA variations should be evaluated for arterial dissection. VA variants should be included in the radiology report as they may be useful for clinicians not only for diagnostic but also for preventive purposes.

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* Corresponding author. Radiology Department, Fundación Valle del Lili, Avenida Simón Bolívar Cra 98 # 18-49, Cali, Colombia.

E-mail addresses: gloria.baena@correounivalle.edu.co, gpaena@hotmail.com (G.P. Baena-Caldas), jorejuela@fctl.org (J.F. Orejuela Zapata), anamaria.granados@gmail.com (A.M. Granados Sánchez).

Introduction

For the study of the vertebral artery (VA), the classical anatomy has divided it from caudal to cephalic in 4 segments. The prevertebral part, from VA origin in the subclavian artery (SA) to the transverse process of C7, where the VA ascends posterior to the common carotid artery and vertebral vein, and anterior to the prevertebral muscles and the cervicothoracic ganglion; the transverse or cervical segment, where the VA enters commonly through the transverse foramen of C6 to ascend through the transverse foramina of the first six cervical vertebrae, until reaching the transverse process of the Atlas (C1), usually accompanied by the vertebral nerve and the vertebral venous plexus in front of the ventral branches of the corresponding spinal nerves; the atlantic or suboccipital portion, where the VA pass through the suboccipital trigone to the foramen magnum; and the intracranial segment, when the VA enters to the skull going through the dura mater and the arachnoid, ascending anterior to the roots of the hypoglossal nerve and going medially and anterior to the medulla oblongata to anastomose with the contralateral VA giving origin to the basilar artery.^{1–5}

The main variations of the VA are related to the origin, course, and intraforaminal entrance, and may be unilateral or bilateral in both male and female patients.⁶ Although most variations of the VA remain asymptomatic because of the collateral irrigation system, in some cases it is important to know its course and anatomy, such as management of thoracic and neck trauma or surgical procedures with an anterior approach to the cervical spine where complications may involve the cerebellum, brainstem, and spinal cord, being potentially devastating for patient.^{7–9} Moreover, despite most common etiology of the VA dissection is blunt trauma, spontaneous dissection, and antecedent of neck manipulation or other sudden movements, VA dissection may also result from uncommon intraforaminal entrance induced by normal physiologic motion.¹⁰ VA dissection has been associated with thrombosis, occlusion, dissection-induced stenosis, and pseudoaneurysm formation; and it represents, with the carotid dissections, around the 2% of all ischemic strokes, and up to 25% of the cases in young and middle-age patients.^{11–14} Knowledge of the VA anatomy may be useful in cases when patients have neurologic symptoms with physiologic cervical movements without trauma history, as it may correspond to a VA dissection.¹⁰

Anatomy of the VA has been described extensively in both in-vivo and postmortem studies, mainly in high-income countries. However, to our knowledge, this is the first study of VA anatomy concerning the origin and intraforaminal entrance from the Colombian population with the largest sample in the studies reported from the low- and middle-income countries. Hence, the aim of this study was to characterize the VA anatomy using computed tomography angiography in the Colombian population.

Methods

Subjects

All neck and thorax computed tomography angiographies performed in adult population (older than 18 years)

between 2010 and 2017 were reviewed. Studies with low image-quality, or with artifacts related to beam hardening or patient movement that could affect the assessment of the vascular structures of interest were excluded. Patients with history of vascular malformations or injuries, as well as non colombian patients were also excluded. The Institutional Ethics Committee approved this study.

Acquisition protocol

All studies were performed in a multidetector computed tomography equipment (LightSpeed, VCT, General Electric Medical Systems, USA), obtaining axial acquisitions from the thoracic operculum to the base of the skull in three phases: a single phase, an arterial phase after injection of the contrast medium, and a venous phase after the arterial phase. A 75 mL of water-soluble contrast medium was used at an injection rate of 5.0 mL/s with subsequent injection of 40 mL of saline at the same rate. The images were obtained from the Picture Archiving and Communication System (PACS) from the institution, and they were analyzed with the Vascular CT workflow of Syngo. Via VA30A_HF06 (SIEMENS, Germany) using multiplanar, maximum intensity projections and volume rendering techniques.

Image interpretation

All images were reviewed and analyzed by a radiologist with 16 years of experience in neck and thorax studies, and a professional in morphology specialist in anatomy with more than 10 years of experience in both in-vivo and post-mortem morphological studies. As variables were considered sex, laterality of the variation, the origin of the VA and first foramen of penetration of the artery.

Statistical analysis

Frequencies and percentages were calculated using Excel[®] for the prevalence of VA regarding the sex, location, the origin of the vessel and the first foramen of penetration of the artery.

Results

From 705 studies initially reviewed, 500 CTA studies were included after exclusion criteria, 362 (72.4%) from male patients, and 138 (27.6%) from female patients. The mean age was 41.94 years-old, and the standard deviation was 18.79 years-old. In the 18% (n = 90) of the study population, there was at least one variant of the vertebral arteries; 73.33% (n = 66) of these cases were male patients and 26.67% (n = 24) were female patients, however, the percentage of the presence of some variation was similar in both genders (18.23% in men, 17.39% in women).

The right vertebral artery was originated from the right subclavian artery in all male patients, while in female patients, it was originated from the right subclavian artery in 137 (99.3%) patients and from the common carotid artery in 1 (0.7%) patient. In male patients, the left vertebral artery was originated from the left subclavian artery in 332

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