CASE REPORT

MULTIPLE ANATOMICAL VARIATIONS IN THE BRANCHES OF THE AORTIC ARCH AND MIDDLE CEREBRAL ARTERY: AN ANGIOGRAPHIC STUDY

MÚLTIPLAS VARIAÇÕES ANATÔMICAS NOS RAMOS DO ARCO AÓRTICO E ARTÉRIA CEREBRAL MÉDIA: UM ESTUDO ANGIOGRÁFICO

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ABSTRACT

The understanding of anatomical variations of blood vessels requires prior knowledge of embryonic vasculogenesis and angiogenesis. This study reports the case of a 32-year-old female with a 24-hour history of holocranial headache and nausea, unresponsive to analgesics. Imaging revealed occlusion of the right vertebral artery and dissection of the left vertebral artery. The aortic arch presented non-pathological anatomical variations, including an anomalous origin of the right subclavian artery and a common carotid trunk. Additionally, a trifurcation of the middle cerebral artery, not considered a non-pathological variant, was also observed. In this way, anatomical variations are clinically essential for safe and effective decision-making.

Keywords: Aorta; Subclavian Artery; Brachiocephalic Trunk; Middle Cerebral Artery; Anatomic Variation

RESUMO

A compreensão das variações anatômicas de vasos sanguíneos requer o conhecimento prévio da vasculogênese e angiogênese do embrião. Esse estudo reportou um caso de um paciente do gênero feminino, 32 anos, com historia de cefaleia holocraniana e náusea por 24 h, e não foi responsiva a analgésicos. Foi submetida a exames de imagem que evidenciaram oclusão da artéria vertebral direita e dissecção da artéria vertebral esquerda, arco aórtico apresentando variações anatômicas não patológicas com a origem anômala da artéria subclávia direita e um tronco comum das artérias carótidas, além de variação anatômica não patológica da trifurcação de artéria cerebral média. As repercussões clínicas das variações anatômicas são clinicamente importantes para uma análise individual mais adequada e segura na tomada de decisão.

Palavras-chave: Aorta, Artéria Subclávia; Artéria Cerebral Média; Tronco Braquiocefálico; Variação Anatômica.

INTRODUCTION

The left common carotid artery (LCCA), left subclavian artery (LSA), and brachiocephalic trunk (BT) originate from the convexity of the aortic arch, which is formed from the fourth left primitive arch.[1]

The arteries of the internal carotid and vertebrobasilar systems provide cerebral perfusion and arise directly or indirectly from the aortic arch. Together, these arteries form the circle of Willis at the base of the skull, from which the major cerebral arteries emerge.[2]

Although less frequent than in other major cerebral arteries, the middle cerebral artery (MCA) may present several anomalies. The MCA typically arises as a single trunk from the internal carotid artery. However, in some cases, two MCAs may originate from the internal carotid artery, presenting as either an accessory MCA or a duplicated MCA.[3–5] In other instances, the MCA may arise as a single trunk but shows fenestration.[6] A duplicated MCA may also occur when two separate MCA arise from the terminal internal carotid artery and merge to form an arterial ring [7]. In a branch-like MCA anomaly, the MCA forms an arterial network resembling tree branch.[8–12]

Understanding the anatomical variations of blood vessels directly or indirectly related to cerebral perfusion is essential for surgeons, as it allows accurate and safe preoperative planning while reducing the risk of intraoperative complications. There-

fore, the present study reported a rare case of multiple anatomical variations involving branches of the aortic arch and the MCA.

CASE REPORT

A 32-year-old female patient with no history of diabetes mellitus, systemic arterial hypertension, or family history of stroke presented to the emergency department with a 24-hour holo-cranial headache and nausea, unresponsive to analgesics. Brain magnetic resonance imaging and cervical arterial angiography revealed occlusion of the right vertebral artery and dissection of the left vertebral artery. To clarify the diagnosis and guide treatment, angiographic studies of the aortic arch, carotid arteries, and vertebral arteries were performed.

Intracranial nuclear magnetic resonance imaging and cerebral magnetic resonance angiography (arterial and venous phases) showed no evidence of intracranial expansive process, extra-axial fluid collections, intraparenchymal hemorrhage, or midline shift. The ventricular system presented normal topography, morphology, and dimensions. The brain parenchyma, brainstem, and cerebellum presented usual signal intensity and preserved morphology. The cerebellar tonsils were located above the foramen magnum. A common origin of the right and left common carotid arteries from the aortic arch was observed. Post-gadolinium imaging revealed signal defects in segments V2 and V3 of the right vertebral artery, with reduced caliber in segment V4 compared with the contralateral side. Additional angiographic investigation evaluation was recommended. No arteriovenous malformations, aneurysms, or dural sinus thrombosis were identified.

Arteriography was performed via percutaneous puncture of the right common femoral artery, with selective catheterization of the aortic arch, common carotid arteries, and vertebral arteries. Images were acquired using digital radiography. Anatomical variations included an aberrant right subclavian artery and a common trunk of the carotid arteries (bovine trunk) arising from the aortic arch (Figure 1). The right common carotid artery presented normal bifurcation, and the internal carotid artery showed smooth, regular walls without evidence of dissection or arteritis; intracranial segments demonstrated normal venous drainage and patent dural sinuses. The left common carotid artery also demonstrated bifurcation, and the internal carotid artery had smooth, regular walls with no evidence of dissection or arteritis. Additionally, a trifurcation of the MCA was identified (Figure 2), with preserved venous drainage and patent dural sinuses. Within the vertebrobasilar system, the left vertebral artery was patent with normal caliber, whereas the right vertebral artery was patent but narrowed. The basilar artery and its branches were occluded, though their calibers and contours were otherwise normal. Either supra- and infratentorial venous drainage were preserved and visualized in real time.

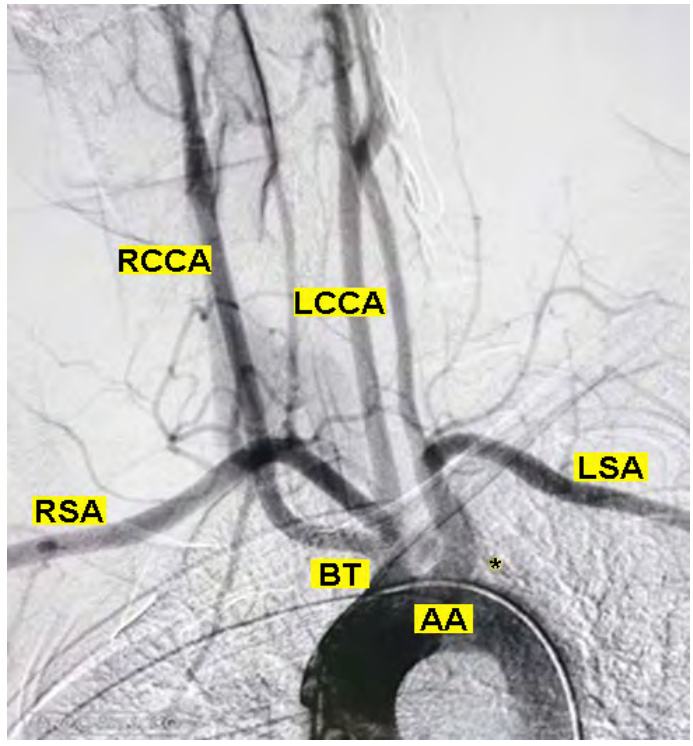

Figure 1. Arteriography of the aortic arch showing a common origin of the common carotid arteries (bovine trunk) and anomalous origin of the right subclavian artery (aberrant). Aortic arch (AA), brachiocephalic trunk (BT), right common carotid artery (RCCA), left common carotid artery (LCCA), left subclavian artery (LSA), right subclavian artery (RSA), *Origin of the right subclavian artery in the aortic arch.

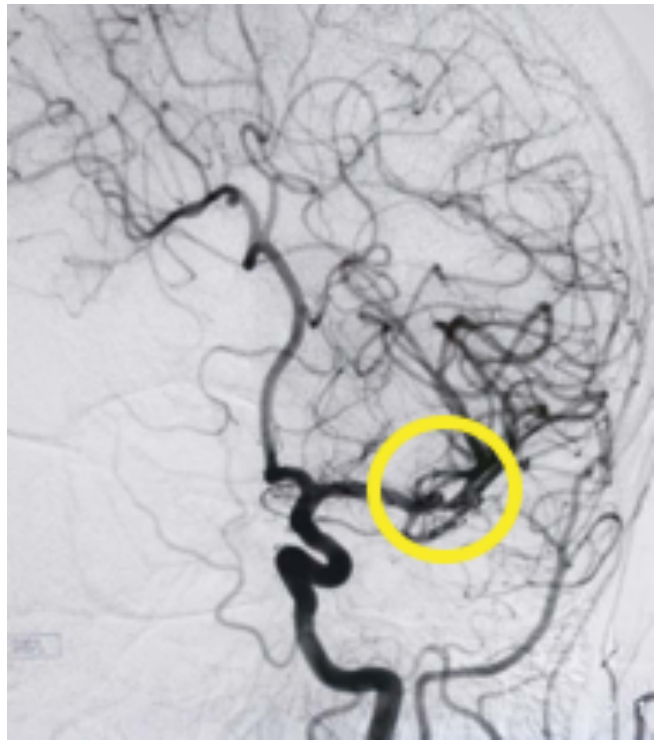

Figure 2. Oblique angiographic image showing trifurcated middle cerebral artery (MCA).

COMMENTS

Numerous anatomical variations may occur in blood vessels originating from the aortic arch. The most common branching pattern consists of three branches: (1) the BT, which divides into the right subclavian artery (RSA) and the right common carotid artery (RCCA), (2) the LCCA, and (3) the LSA.13

The literature describes between 8 and 15 types of aortic arch branching patterns13-14 In the eight-type classification, type I is the most common, whereas type VIII is the rarest. In this system, branches are described from right (first branch) to left (last branch). Type I is the most frequent or "normal" type of aortic arch with three branches: (1) BT (innominate artery), which splits into RSA and RCCA, (2) LCCA, and (3) LSA. Type II is the second most common pattern, with only two branches: (1) a common trunk giving rise to RSA, RCCA, and LCCA and (2) LSA. In type III, the left vertebral (LV) arises directly from the arch and not from the LSA, setting a pattern of four branches in the aortic arch: (1) BT, (2) LCCA, (3) LV, and (4) LSA. The type VI is characterized by common origin of the common carotid arteries and common origin of the subclavian arteries: (1) common trunk for the RCCA and LCCA and (2) common trunk for the RSA and LSA. Type VII is characterized by the absence of BT, with four separate branches: (1) RSA, (2) RCCA, (3) LCCA, and (4) LSA, while type VIII presents an additional branch of the aortic arch, the thyroid ima artery, (arch with four branches): (1) BT, (2) thyroid ima artery, (3) LCCA, and (4) LSA.14

In the 15-type classification, the pattern observed in the present case had a prevalence of 0.7%.13 In this variant, the aortic arch presented three branches (from right to left): (1) a common trunk for the RCCA and LCCA, (2) LSA, and (3) RSA (aberrant).

The MCA is the largest and most complex cerebral artery due to the highly developed cerebral neocortex in humans. It represents a relatively recent phylogenetic development and may be considered as a collateral branch of the anterior cerebral artery. Although MCA anomalies are less frequent than those of other major intracranial arteries, several variants have been reported, including accessory MCA, duplicated MCA, early bifurcation, and fenestration.15

Additional branching patterns of the MCA have also been described, such as lateral bifurcation (48% of cases), trifurcation (25% of cases), lateral pseudo-bifurcation (18.5% of cases), pseudobifurcation in the middle of the sphenoidal segment (origin of the orbitofrontal or temporopolar artery; 6% of cases)1, and medial bifurcation (2.5% of cases). The present study identified a trifurcation of the left MCA associated with the aforementioned aortic arch variations.

Anatomical variations and vascular anomalies may markedly affect cerebral perfusion and are frequently detected incidentally during neurosurgical or endovascular procedures for tumors, aneurysms, or arteriovenous malformations. Their recognition is essential for surgical planning to minimize iatrogenic injury by accounting for vessel origin and course, and to accurately assess the vascular territories at risk during occlusion.

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