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Two Cases of Left Vertebral Artery Emerging from a Trunk in Common with the Left Subclavian Artery from the Aortic Arch

Dos Casos de Arteria Vertebral Izquierda Naciendo de un Tronco Común con la Arteria Subclavia Izquierda del Cayado Aórtico

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SUMMARY: Anomalies arising in the embryological development of the aortic arch and its branches are essencial in the emergence of variations in the origin and course of supra aortic vessels. Classically, 95% of cases, the aortic arch gives rise to the brachiocephalic artery, left common carotid artery and left subclavian artery. While the left vertebral artery arises normally from the left subclavian artery. In this presentation we describe two cases of the left vertebral artery being born of the aortic arch. The importance of anatomical knowledge of this arterial variety is fundamental for base neck and aortic arch surgery, in cervicothoracic trauma that compromises the vascular elements and in endovascular procedures in the region.

KEY WORDS: Left vertebral artery; Aortic arch; Thorax.

INTRODUCTION

Anatomical variations present in the aortic arch, and particularly those referring to supra aortic vessels respond to anomalies arising in the embryological evolution of the arch and its branches. Concerning the classical description, the aortic arch provides, from anterior to posterior, the brachiocephalic artery, the left common carotidal artery, and the left subclavian artery. In turn, the left vertebral artery emerges from the left subclavian artery, at the level of its prescalenic portion, medial to the anterior scalene muscle, with a vertical path, then going into the transversal hole of the 6th cervical vertebra and continuing until its final formation, by anastomosis with its counter-lateral homologue from the basilar artery at the encephalic trunk. The frequency of appearance of this classical arrangement is of about 95% (Adachi, 1928; Daseler & Anson, 1959). Several authors describe variations in the branches of the aortic arch, such as Birmingham (1893), Adachi, Barry (1951), Daseler & Anson, Yamaki *et al*. (2006), Jayanthi (2010), among others.

This paper describes two cases of left vertebral artery emerging from the aortic arch, responding to the need to know it in an angiographic diagnosis (Matula *et al*., 1997), surgery of the base of the neck, and other clinical and surgical procedures.

MATERIAL AND METHOD

During usual dissection of adult corpses with a Caucasian origin, 10% formol-fixed after access to the mediastinal region, two cases of left vertebral artery emerging from the aortic arch are found and described. Once the anterior wall of the thorax was resected, the adipose tissue was removed from the area, and this was followed by incision and removal of the pericardium over the heart, the aorta, and the supra-aortic vessels. At this point, the left vertebral artery is found to be emerging from the aortic arch. As a result, opening of the thorax was extended, exposing the deep planes of the neck on the left side for a full display of this variant. While, when the mediastinal region was dissected the thorax was opened with a half-section of the sternal body, but with an unharmed pin, in this case the sternal pin was also sectioned for a wider visual field of the full path of the left vertebral artery: this, instead of entering the transversal hole of the 6th cervical vertebra, does it through the transversal hole of the 4th cervical vertebra, with an extended vertical path. Once the dissection was over, arterial vessels were measured, both concerning their length and the distance of occurrence relative to the origin of the aortic arch, by using a gauge with a 0.05 mm chance of error.

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RESULTS

In both cases, the left vertebral artery emerges from a trunk in common with the subclavian artery on the same side, corresponding to a 3-branch aortic arch: brachiocephalic artery, left common carotid artery, and common trunk between the left vertebral and subclavian arteries. In the former, the common trunk is 43 mm long, while in the latter, the trunk is 74 mm long. Once the arteries corresponding to this common trunk were provided, the arrangement of the supra-aortic vessels, from anterior to posterior, is the following: brachiocephalic artery, left common carotid artery, left vertebral artery, and finally, left subclavian artery. In our statistics, the chances of finding a left vertebral artery emerging from a trunk in common with the left subclavian artery is 3.92% (two cases over 51 corpse dissections).

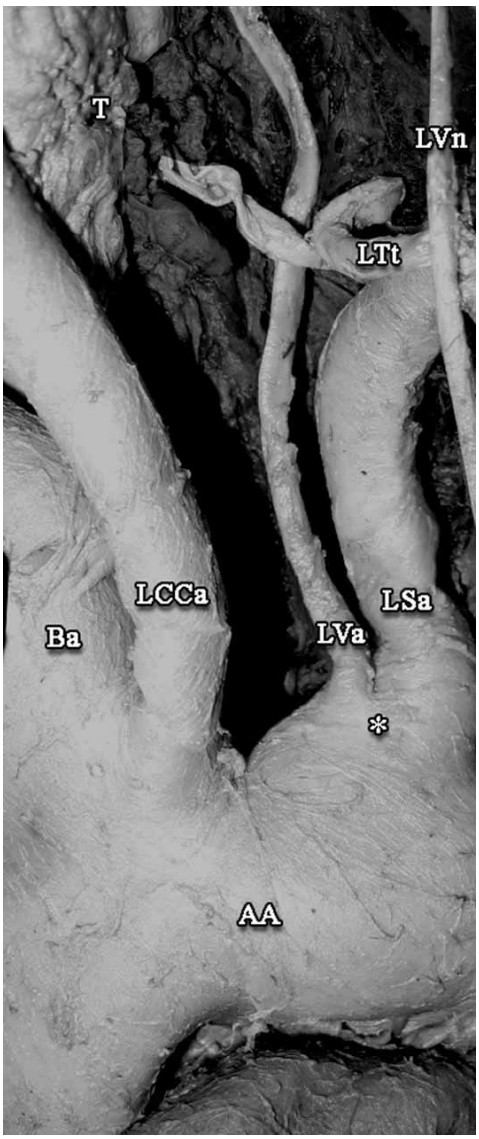

Fig. 2. Case 2: left vertebral artery emerging from a trunk in common with the left subclavian artery from the aortic arch. AA, Arch of Aorta; Ba, Brachiocephalic artery; LCCa, Left common carotid artery; LVa, Left vertebral artery; LSa, Left subclavian artery; LTt, Left thyrocervical trunk; LVn, Left vagus nerve; T, Thyroid gland; * Left vertebral and subclavian arteries common trunk.

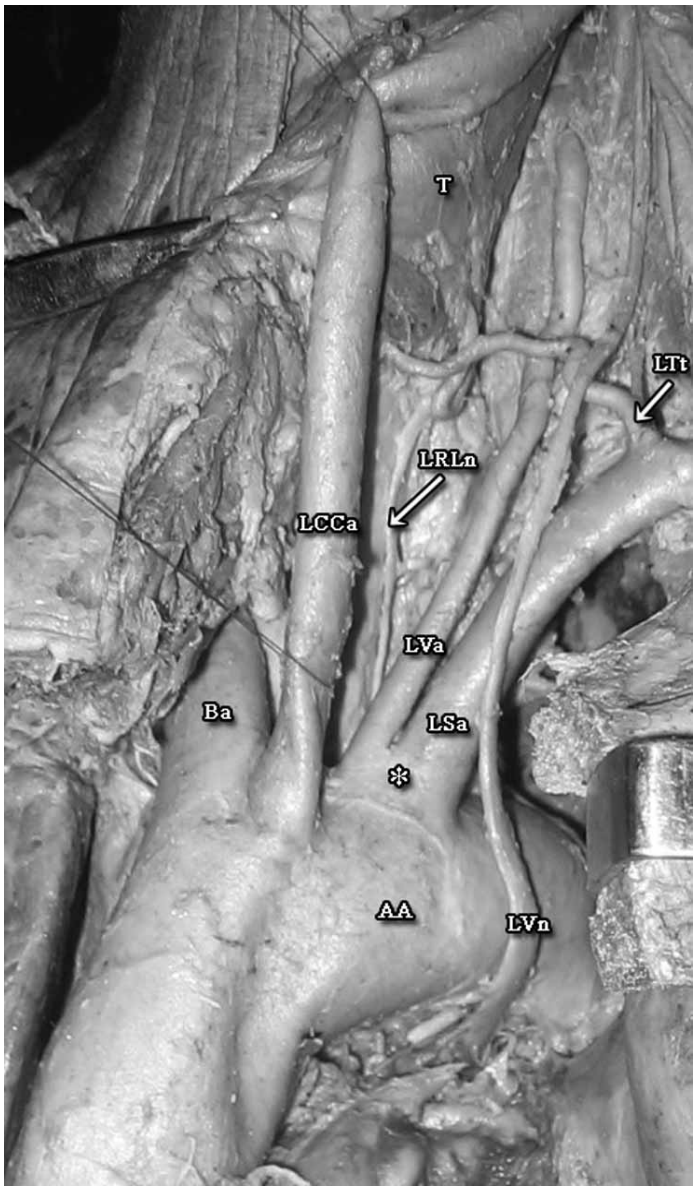

Fig. 1. Case 1: left vertebral artery emerging from a trunk in common with the left subclavian artery from the aortic arch. AA, Arch of Aorta; Ba, Brachiocephalic artery; LCCa, Left common carotid artery; LVa, Left vertebral artery; LSa, Left subclavian artery; LTt, Left thyrocervical trunk; LVn, Left vagus nerve; LRLn, Left recurrent laryngeal nerve; T, Thyroid gland; * Left vertebral and subclavian arteries common trunk.

DISCUSSION

Among the various origins of vertebral arteries (Gluncic *et al.*, 1999) those corresponding to the left vertebral artery the most common, as opposed to the right vertebral artery (5.8% and less than 1%, respectively, according to Yamaki *et al*.). This increases the importance of the possible presence of abnormal origins for the left vertebral artery, upon determination in angiographic head and neck procedures, among other clinical and surgical actions.

The left vertebral artery usually emerges from the corresponding subclavian artery before this goes behind the anterior scalene muscle. Then, after a short path, it enters through C6 transversal hole. A left vertebral artery originating in the aortic arch happens in about 6% of cases (Adachi, 5.4%; Daseler & Anson, 4.25%; Yamaki *et al*., 5.8%; Jayanthi *et al*., 5%).

Our research deals with two cases with the rarest arrangements concerning the origin of the left vertebral artery from the aortic arch. The most common origin for the left vertebral artery is directly from the aortic arch, between the common carotid artery and the left subclavian artery. For Adachi the most common arrangement is the one at 36 to 40 mm from the origin of the left subclavian artery, in 31.9% of left vertebral arteries emerging from the arch. On the other, Yamaki *et al.*, describes a 31-35 mm distance as the most common origin for the left subclavian artery. In our case, the distance would correspond to 0 mm regarding the origin of the left subclavian artery, as they are emerging from a common trunk in the aortic arch. Adachi has not described any cases of this kind; Yamaki *et al.*, reports four findings, corresponding to 1.2% of cases of left vertebral arteries emerging from the aortic arch.

In order to understand the origin of this variation, it is important to know the normal embryological development of the aortic system (Mori, 1941). Dorsal (right and left) aortas, and the two ventral ones (forming the aortic sac), originate in the embryonic mesenchyme angioblasts. The ventral aorta is the continuation of the arterial trunk. Dorsal and ventral aortas are connected through 6 pairs of arterial vessels called aortic arches. These are vascular formations included in the mesenchyme of brachial arches, which are not simultaneously present in mammals, as some of them undergo involution. The first aortic arch forms the mandibular arterial arch. The second one forms the hyoideal and stapes muscle arteries. The third aortic arch forms the common carotid artery and the first part of the internal carotid artery. The rest of the internal carotid is formed by the cephalic portion of the dorsal aorta. External carotids on each side originate as an evagination of the third aortic arch binding to the remaining parts of the first and second arches. The fourth aortic arch persists on both sides, but its final portion differs on the right and left sides. It persists on the left to form the aortic arch, between the common carotid artery and the seventh left intersegment artery; the latter is going to become the left subclavian artery. On the right side it constitutes the brachiocephalic artery and the most proximal segment of the right subclavian artery, whose distal part is formed by a part of the right dorsal aorta and the seventh right intersegment artery. The two dorsal aortas join and form a main posterior trunk, the descending aorta. Its ventral branches form the intercostal arteries and the dorsal branches are relative to the neural tube and form the vertebral arteries. The fifth aortic arch undergoes complete or partial involution and then regression. The proximal portion of the sixth aortic arch, on the right side, forms the proximal portion of the right pulmonary artery, the distal portion becomes disconnected with the dorsal aorta and disappears. The sixth left aortic arch forms the proximal segment of the left pulmonary artery, does not lose its distal portion, and maintains its relation with the dorsal aorta throughout life in the uterus. In this way, it is bound to the ventral aorta or aortic sac and to the posterior or dorsal aorta, thus forming Botal's arterial duct.

The abnormal origin of the left vertebral artery from the aortic arch could be explained by the chance of this becoming formed through the connection of the 4th aortic arch to the upper wall of the aortic arch, with a failure in the normal embryological process (Albayram *et al*., 2002; Bhatia *et al.*, 2005; Paniker *et al.*, 2002). During the embryonic period, 1st to 6th intersegment arteries are longitudinally anastomosed, with their caudal end connecting to the 7th dorsal intersegment artery (Yamaki *et al*.). Robinson (Iyer, 1927) explains this anomaly by suggesting that the proximal portion if the subclavian artery disappears, and as a result, the vertebral and subclavian arteries are originated separately from the aorta. Cairney (Iyer) suggests that the left vertebral artery emerging from the beginning of the aortic arch could correspond to the embryological persistence of the sixth dorsal intersegment artery, which normally disappears. Daseler & Anson suggest this too, and explain that vertebral arteries are formed from a number of longitudinal anastomoses among the seven upper dorsal segment arteries. The proximal portion of the first six upper dorsal segment arteries involved in such anastomosis usually disappears; therefore, the vertebral artery originates as a branch of the subclavian artery. However, if the proximal portion of the sixth dorsal segment artery persists, the left vertebral artery will originate as a branch of the aortic arch close to the left subclavian artery.

In addition, in our two cases, the left vertebral artery enters at the level of C4 transversal hole. The frequency at which the left vertebral artery, emerging from the subclavian artery, enters at the level of C6 transversal hole is 80.2%, according to Yamaki *et al*. In turn, a left vertebral artery originating in the arch aortic and entering at the level of C6 transversal hole occurs only in 33.3%. Consequently, this variation has a higher frequency of entrance into the left vertebral artery at the C3, C4, or C5 level. In our case, and based on the statistics by Yamaki *et al*., the percentage of finding a left vertebral artery entering at the C4 level would be 16.7% (C3: 6.7% and C5: 43.3%).

From an embryological standpoint, an abnormal connection of the 4th aortic arch could occur simultaneously with certain longitudinal anastomosis anomalies among dorsal intersegment arteries 1st to 6th. Thus, a vertebral artery might enter a transversal hole at a cephalic level above C6 (Yamaki *et al.*).

The importance of anatomical knowledge on this arterial variety is crucial for surgery of the base of the neck or cervical-thoracic traumatisms involving cervical vascular elements, with their eventual encephalic impact (Bernardi & Dettori, 1975; Komiyama *et al*., 2001).

OTTONE, N. E.; CASOLA, L.; CIRIGLIANO, V.; OLORIZ, L.; BLASI, E. B.; MEDAN, C. D. & ALGIERI, R. D. Dos casos de arteria vertebral izquierda naciendo de un tronco común con la arteria subclavia izquierda del cayado aórtico. ***Int. J. Morphol., 31(2)***:646-649, 2013.

RESUMEN: Anomalías desarrolladas en la evolución embriológica del arco aórtico y sus ramos son fundamentales en la aparición de variaciones en el origen y trayecto de los vasos supra aórticos. Clásicamente, en el 95% de los casos, el arco aórtico da nacimiento a las arterias braquiocefálica, carótida común izquierda y subclavia izquierda. Mientras que la arteria vertebral izquierda nace normalmente de la arteria subclavia izquierda. En este trabajo se exponen dos casos de la arteria vertebral izquierda naciendo del arco aórtico. La importancia del conocimiento anatómico de esta variedad arterial es trascendente para la cirugía de la base del cuello, cayado aórtico, en los traumatismos cervicotorácicos que comprometen los elementos vasculares y en procedimientos endovasculares de la región.

PALABRAS CLAVE: Arteria vertebral izquierda; Arco de la aorta; Tórax.

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