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 essential 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 carotid 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).
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 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 dor-sal intersegment arteries 1<sup>st</sup> to 6<sup>th</sup>. 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).

**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 de un tronco común con la arteria subclavia izquierda del cayado aórtico. Inter. J. Morphol., 31(2):646-649, 2013.

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