Institute of Experimental Morphology and Anthropology

Acta morphologica et anthropologica, 10
Sofia • 2005

Vertebral Artery Arising from Aortic Arch. Embryological Basis and Clinical Implication

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Anatomic variation and routine clinical job are closely related. The detailed knowledge of vascular variations is quite important for the physician. Our study reveals frequently met variation of left vertebral artery found during regular student dissection on an embalmed cadaver. The artery arises directly from the aortic arch and enters the transverse foramen at the level of fifth cervical vertebra. It has a longer course compared with standard one. The authors suggest embryologic basis of its frequency and emphasize the clinical importance. In conclusion we consider that the described variation is an important fact for the physician and should be included in students' anatomy textbooks.

Key words: vertebral artery, variations, aortic arch, embryology.

Introduction

Human anatomy variations are not so rarely found and therefore their clinical significance is reported by many authors [7, 8]. The detailed knowledge of vascular variation is quite important for a physician during his routine work. The vertebral artery unusual beginning is not so often discovered: for the right one the beginning from aortic arch is in 3% [3], while for the left is 4.1% [4]. This study reveals a case of left vertebral artery arising from the aortic arch.

Description

During routine student dissection of a 72 years old male cadaver no vertebral artery was found arising from subclavian artery. The next stage of our work revealed the aortic arch with four branches including the left vertebral artery. The right vertebral artery had normal beginning and course.

The vertebral artery arises from the upper and posterior part of the first part of the subclavian artery. It ascends through the foramina in transverse processes of all the cervical vertebrae save the seventh, winds behind the lateral mass of the atlas, enters the skull through the foramen magnum, and, at the lower border of the pons joins the vessel of the opposite site to form the basilar artery.

The vertebral artery consists of four parts. The first part runs upwards and backwards between the longus colli and the scalenus anterior and behind the common carotid artery. In front, it is related to the common carotid artery and vertebral vein, and is crossed by the inferior thyroid artery. On the left side it is crossed also by the thoracic duct. Behind, it is related to the transverse process of the seventh cervical vertebra, the cervicothoracic ganglion and the ventral rami of the seventh and eighth cervical nerves.

The second part ascends through the transverse foramina of the upper six cervical vertebrae, with a large branch derived from cervicothoracic sympathetic ganglion, and by a plexus of veins, which unite to form the vertebral vein. It lies in front of the ventral rami of the cervical nerves (C2-C6), and pursues an almost vertical course as far as the transverse process of the axis, through which it runs upwards and laterally to the transverse foramen of the atlas.

The third part issues from the foramen on the medial side of the rectus capitis lateralis, and curves backward behind the lateral mass of the atlas, the ventral ramus of the first cervical nerve being on its medial side. It then lies in the groove on the upper surface of the posterior arch of the atlas, and enters the vertebral channel by passing below the lower, arched border of the posterior atlanto-occipital membrane. This part of the artery is covered by the semispinalis capitis and is contained in the suboccipital triangle. The dorsal ramus of the first cervical nerve lies between the artery and the posterior arch of the atlas.

The fourth part pierces the dura and arachnoid mater, ascends in front of the roots of the hypoglossus nerve and inclines medially to the front of medulla oblongata where, at the lower border of the pons, it unites with opposite artery to form the basilar artery.

In our case variation is found of the aortic arch having four branches (Fig. 1). The first branch is the brachiocephalic trunk which appears on 23 mm from the beginning of the aortic arch and its diameter is 13 mm. Upwards it bifurcates into right subclavian (9 mm in diameter) and right common carotid (7.5 mm in diameter) arteries. The second branch is the left common carotid artery (7.5 mm in diameter) lying 14 mm from the previous branch. The third branch is the variable vertebral artery arising 3 mm to the second branch and being 5mm in diameter. The fourth branch is the left subclavian artery 10 mm in diameter. The left vertebral artery arises from the upper part of the aortic arch between the left common carotid and left subclavian arteries. In its prevertebral part climbs upwards between the left brachiocephalic vein in front, and the thoracic duct behind. Craniad medially and behind are the trachea, esophagus and the left laryngeal nerve, while in front is the inferior thyroid artery. Further the artery lies between the scalenus anterior muscle and the longus colli muscle and behind the left common carotid artery. It enters the transverse foramen at the level of fifth cervical vertebra. The entire length of the left vertebral artery in its prevertebral part is 77 mm. The normal right vertebral artery is 44 mm in length.

Discussion

Many variations occur in number and position of vessels arising from the aortic arch. There may be as few as one or as many as six branches. The usual combination of three branches is reported in 80% of cases, right brachiocephalic, left common carotid and left subclavian [3]. If a vertebral is present, the left more frequently than the right vertebral, then the variation of four vessels has a frequency of about 5% [3].

Fig. 1. Left vertebral artery arising from aortic arch

The frequency of the left vertebral artery arising from the aortic arch is: Pelligrini — Examined 104 specimens and noted the variation 3 times; Bean — Examined 129 specimens and reported the variations 3 times; Canivares — Examined 40 subjects and 80 individual hearts and noted the variation 2 times; Dubreuil-Chambardel — Examined 250 subjects and found the vertebral artery arising 2 times from the aortic arch [3]. In our case the founding belongs to the variation of aortic branches, which is second by frequency. The role of this study is to accentuate the significance of the embryologic basis as an explanation for the high frequency of this variation and its clinical importance for the medical practice.

Embryologic basis

The anomalies and variations of the aortic branches are based on the deviation of the transformation of the aortic arches. The aortic arches of the human embryo have great significance when viewed comparatively. Five or more pairs of arches are

provided in connection with the functional gills of fishes and either three or four pairs serve the same purpose in tailed amphibians. In higher vertebrates there is both a reduction in number and an extensive transformation into vessels more appropriate to air-breathing animals. In the embryos of man and other mammals six pairs of aortic arches developed but all are not present at one time. The primitive internal carotid arteries begin with the third arch and continue by way of the dorsal aorta to the head region. Both fourth arches persist, but their histories differ. On the left side the arch becomes the permanent arch of the aorta. On the right side a right portion of the aortic sac elongates into the brachio-cephalic trunk.

The vertebral arteries are an important pair of vessels, which arise as secondary developments from two series of dorsal rami belonging to the neck (Fig. 2). These rami undergo longitudinal linkage just dorsal to the ribs (postcostal anastomosis). All of their original stalks then atrophy except the most caudal one in the series. The resulting longitudinal vessel is a vertebral artery. The latter together with subclavian artery begins from the six intersegmental artery [2].

We suppose that the rising of the left vertebral artery directly from the aortic arch is due to the higher beginning (fifth or fourth intersegmental artery) of the 'postcostal anastomosis' and persistence of the part of each intersegmental artery which appears to be the origination of the vertebral artery. In connection with the faster growth craniad of the adjacent structures the root of the left subclavian as well as the proximately placed variable left vertebral artery shift considerably higher on the permanent aortic arch.

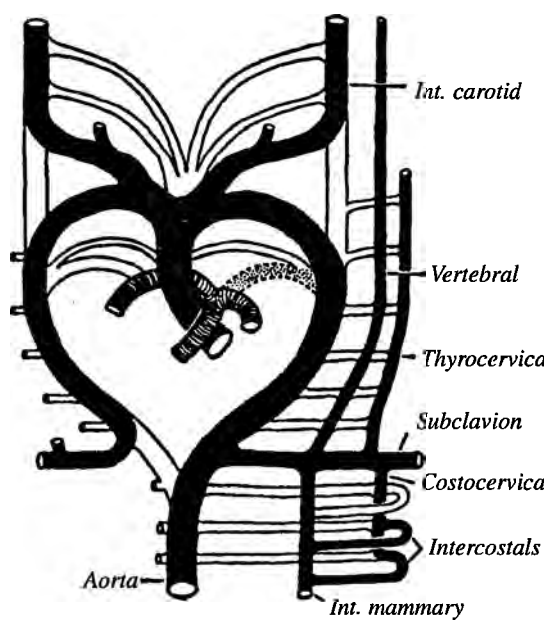

Fig. 2. Derivatives of the dorsal branches of the human aorta in the vicinity of the subclavian artery

Clinical implications

The knowledge of the structures connected with brain blood supply and their relations in the superior mediastinum and the neck is very important with clinical diagnosis and especially with vertebro-basilar syndrome [6]. According to the available data [5] our case is essential for the surgeon during operation for metastases and lymph nodes of esophageal cancer and malignant vertebral tumors. Very significant are the relations of the aorta and its branches during total aortic arch replacement [1]. To know about this finding seems to be very important not only in diagnosis (angiography, color coded Doppler sonography) but also in surgical and endovascular treatment.

Conclusion

The variation described by the authors is not infrequently found which is suggested by our embryologic interpretation. The last conclusion together with the undoubted clinical importance of the variant vertebral artery makes it an important fact for the physician. We consider that the described variation should be included in students' anatomy textbooks.

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