

An Anatomical Case Report of the Misnomer 'Bovine Aortic Arch'

Bukkambudhi V. Murlimanju,¹ Mangala M. Pai,¹ Latha V. Prabhu,¹ Vandana Blossom¹

¹Department of Anatomy, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India-575001

Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: The usual branches of the aortic arch include three large sized arteries brachiocephalic trunk (BCT), left common carotid artery (LCCA) and left subclavian artery.

Case report: during the routine dissection procedure performed for the medical students, it was noticed that the left common carotid artery was branching from the brachiocephalic trunk.

Conclusion: It is important to identify this type of arterial anomaly during the surgery to prevent iatrogenic injury to the artery and subsequent bleeding. This morphological variant is commonly known as 'bovine aortic arch' in the radiological and surgical literature. But this was later considered as a misnomer in the scientific literature as there was no similarity between this branching pattern in humans and the bovine aortic arch.

Keywords: Anatomic Variation; Aortic Arch; Endovascular Procedures.

Introduction

The variant branching of aortic arch is usually due to embryological reasons. This happens due to the persistence of arteries, which should disappear during the course of the fetal life. The aorta mainly develops from the fourth arch, variation of the fate of fourth arch leads to the congenital variant branching. The pulmonary trunk and aorta are developed from the common chamber, truncus arteriosus. The change in the formation of spiral septum may also lead to several variations.^{1,2} The usual branches of the aortic arch include three large sized arteries brachiocephalic trunk (BCT), left common carotid artery (LCCA) and left subclavian artery.³ In the present case, we report a variant origin of LCCA from the BCT. This anatomical variation of the artery is known as 'bovine aortic arch'⁴ in the radiological and surgical literature. But this was later considered as a misnomer in the scientific literature as there was no similarity between this and the bovine aortic arch.

Case Report

During the teaching of first year medical students, a formalin fixed male cadaver of approximately 70 years was dissected. This embalmed cadaver was an Indian by the ethnicity. Initially, the thoracic cage was opened by cutting the ribs at the midclavicular plane and the manubriosternal joint with the bone cutter. This exposed the thoracic cavity and the superior mediastinum was further dissected. While cleaning the arch of aorta, it was observed that there was variation of the branching of arch of aorta. The LCCA was arising from the BCT (Fig. 1) at a distance of 3 millimetres from the arch of aorta level. BCT later bifurcated into right common carotid artery and subclavian artery (Fig. 1).

The left subclavian artery was branching from the arch of aorta as usual. There was no other arterial variation and congenital anomaly observed in the heart.

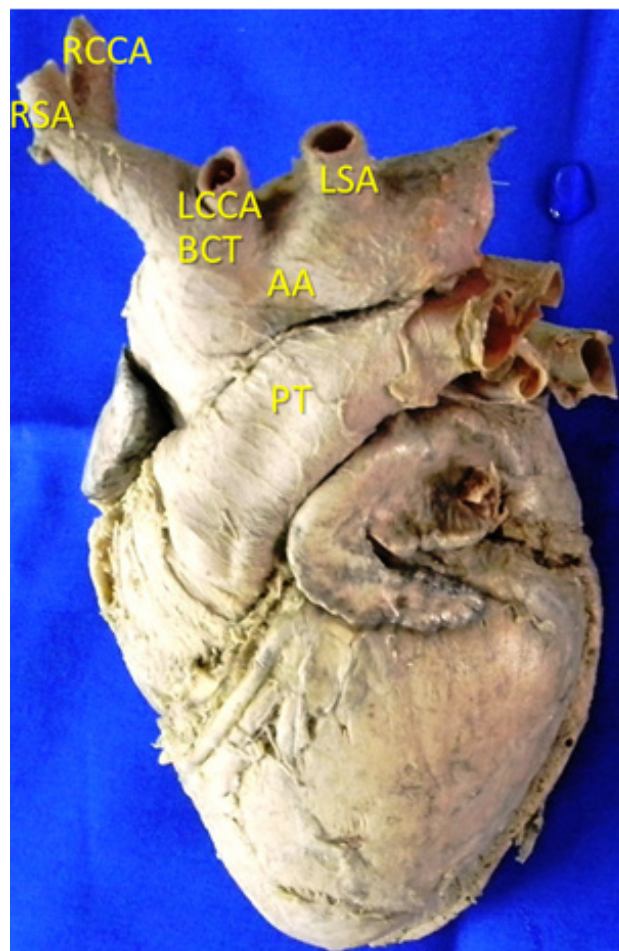


Figure 1. The cadaveric heart specimen showing the arterial variation, the LCCA was arising from the BCT. (Right common carotid artery-RCCA; Right subclavian artery-RSA; Left Subclavian Artery-LSA; Arch of Aorta-AA; Pulmonary trunk-PT).

Discussion

During those years, when angiography was the initial method of examining the arteries of the brain, there used to be overlapping of the anatomical structures. This limited the clear visualisation and demarcation of the anatomy. If the LCCA was arising from the BCT, this had a more horizontal course than its origin from the aortic arch. This resembled the horns of a bovine, which are typically horizontal at the top of the head of animal and then curved superiorly⁵. This registered the first occurrence of the term "bovine arch" in humans. According to a study by Budhiraja *et al.*,⁶ the aortic arch gave three branches in 63.5% cases and 36.5% of their cases showed branching variations. It was reported that, more than 20 various types of morphological variants of branching of arch of aorta exist.^{7,8}

Natsis *et al.*⁹ described 8 varieties of branching pattern of aortic arch based on their incidences observed. The type 1 was the most common variety and type 8 was the least commonly observed in their study. The type 1 was described as the normal aortic arch giving 3 branches, BCT, LCCA and left subclavian artery respectively. Type 2 branching pattern had two branches of the aortic arch, a first common stem which is divided into the right subclavian artery, right common carotid artery and LCCA. The type 3 pattern had left vertebral artery arising directly from the arch and not from the left subclavian artery. The type 4 pattern had common trunk giving the right and left common carotid arteries.⁹ In this variety, aortic arch had 3 branches, the first one was the right subclavian artery, second one was the common stem providing right and left common carotid arteries (bicarotid trunk) and the third branch was left subclavian artery.⁹ The type 5 pattern was single trunk for the common carotids and aberrant right subclavian artery. This pattern had 3 branches, common stem for the right and left common carotid arteries, left subclavian artery and the right subclavian artery as the final branch. The type 6 variety had solitary origin of the carotids and solitary origin of the subclavians. This type had aortic arch with only two branches and this is the avian variety. The absence of BCT and aortic arch providing 4 branches is considered as type 7. The type 8 had an additional branch, the thyroidea ima artery which supplies the thyroid gland and here the arch had 4 branches.⁹

In the present observation, the LCCA instead of branching directly from the aorta, was branching from the BCT. This falls under the type 2 variety as per classification by Natsis *et al.*⁹ The bovine aortic arch is more prevalent in people of African descent. This variation has incidence of 10% in blacks and 5% in whites, however the overall incidence was 9%.¹⁰ Angouras *et al.*¹¹ reported slightly higher frequency of 35-45% in African Americans and 13-25% in Caucasians. Cadaveric studies reported the occurrences of bovine aortic arch in 25% of black population and in only

8% of white population.¹² According to Lippert and Pabst⁷, bovine aortic arch has an overall prevalence of 13%. It was realized that, arch of aorta of bovine has no similarity with the aortic arch in humans. In a cattle animal, there will be solitary great vessel which branches from the arch of aorta.¹³ This solitary branch, the BCT trifurcates into a bicarotid trunk and subclavian arteries for the each side. The left and right common carotid arteries were later originating from the bicarotid trunk. These common carotid arteries entered into the neck.³ The presence of solitary large vessel which branches out from the arch of aorta is quiet common in animals which have deeper chests. Veterinary anatomists opine that due to the longer distance of thoracic inlet from the aortic arch leads to the single vessel, which is given the name, BCT in animals.³ In this context, being anatomists we agree with the opinion of Layton *et al.*³ that the nomenclature 'bovine type of arch of aorta' should be considered as a misnomer. We suggest that the variation observed in the present case can be just named as 'variant origin of LCCA'. This variant LCCA was branching from the BCT.

It was reported that the people having the bovine aortic arch are prone to develop aneurysm in the ascending aorta.¹⁴ The etiopathology between bovine aortic arch and the aneurysm was studied by Malone *et al.*¹⁵ It was reported that the bovine aortic arch should be deliberated as a risk factor for developing the aneurysm of aorta. The mechanism of ascending aortic dilation in bovine arch remains unidentified. However the histological study revealed that the bovine aortic arch samples had highest elastin and collagen contents in the tunica media. It was also observed that the tunica media was smallest in the thickness of bovine arch. However there was highest thickness in the tunica intima and tunica adventitia.¹⁵ Hornick *et al.*¹⁶ observed that the bovine arch is more prevalent in patients with thoracic aortic disease than in the general population. From the radiological study of 612 patients, they could make out that the aorta expanded more rapidly in the setting of this morphology. The aortic expansion rate was 0.29 cm per year in the bovine arch group and 0.09 cm per year in the non-bovine arch group. About 26.3% of their patients with bovine morphology had thoracic aortic disease. According to Hornick *et al.*¹⁶, bovine variety should not be considered as a normal anatomic variant and ignored.

The morphological knowledge of variation in the branching pattern of arch of aorta is important radiologically and surgically. This helps in the diagnosis and management of head neck and thoracic illness. The variant anatomy of the branching pattern is enlightening to the interventionists and endovascular surgeons.⁴ It has been reported that, variations in the branching pattern of arch of aorta and site of origin of LCCA need to be studied prior to the catheterization of the femoral artery during the procedures like

angiography and angioplasty. This helps in the faster procedure, prevents complications and no failure of the procedure.¹⁷

Conclusion

The nomenclature of the morphological variant observed in the present case is the 'bovine aortic arch' as per the radiological and surgical literature. But we opine that this is a misnomer as there is no similarity

between this branching pattern in humans and the aortic arch in bovine animals. Hence this variant should not be considered as a normal anatomical variant, as this is often associated with thoracic aortic diseases. We believe that reporting the present case is enlightening to the operating surgeon and radiologist. Identification of this type of anatomical variation will prevent the misinterpretations and subsequent complications.

References

- Bergman RA, Thompson SA, Afifi AK, Saadeh F. *Compendium of Human Anatomic Variation: Text, Atlas, and World Literature*, Urban & Schwarzenberg, Munich, 1988
- Sadler TW. *Cardiovascular System*. In: Sadler TW. (ed.) *Langman's medical embryology*. 10th Ed. Lippincott Williams Wilkins, Philadelphia, 2006:159-194
- Layton KF, Kallmes DF, Cloft HJ, Lindell EP, Cox VS. Bovine aortic arch variant in humans: clarification of a common misnomer. *AJNR Am J Neuroradiol* 2006;27(7):1541-1542
- O'Malley AM, El Kininy WH, Debebe H, Burukan AB, Davy SW. A cadaveric study of aortic arch variation in an Irish population. *Ir J Med Sci* 2018;187(3):853-858
- Ridley LJ, Han J, Xiang H. The "bovine aortic arch": time to rethink the true origin of the term? *Am J Neuroradiol* 2019;40(2):E7-E8
- Budhiraja V, Rastogi R, Jain V, Bankwar V, Raghuvanshi S. Anatomical variations in the branching pattern of human aortic arch: a cadaveric study from central India. *ISRN Anatomy*, 2013; Article ID 828969, 5 pages
- Lippert H, Pabst R. *Aortic arch*. In: *Arterial Variations in Man: Classification and Frequency*. JF Bergmann-Verlag, Munich, Germany, 1985:3-10
- McDonald JJ, Anson BJ. Variations in the origin of arteries derived from the aortic arch, in American whites and Negroes. *Am J Phys Anthropol* 1940;27(1):91-107
- Natsis KI, Tsitouridis IA, Didagelos MV, Fillipidis AA, Vlasis KG, Tsikaras PD. Anatomical variations in the branches of the human aortic arch in 633 angiographies: clinical significance and literature review. *Surg Radiol Anat* 2009;31(5):319-323
- Deutsch L. Anatomy and angiographic diagnosis of extracranial and intracranial vascular disease. In: Rutherford RB (ed) *Vascular Surgery*. Elsevier Saunders, Philadelphia, 2005:1916-1957
- Angouras DC, Boudoulas KD, Boudoulas H. Bovine aortic arch: normal variant or a marker of aortopathy?. *Cardiology* 2012;123(2):113-115
- De Garis CF, Black IB, Riemenschneider EA. Patterns of the aortic arch in American white and Negro stocks, with comparative notes on certain other mammals. *J Anat* 1933;67:599-618.
- Habel RE, Budras KD. *Thoracic cavity*. In: *Bovine Anatomy: An Illustrated Text*. Schlütersche GmbH & Co, Hanover, Germany, 2003:62-65
- Pham T, Martin C, Elefteriades J, Sun W. Biomechanical characterization of ascending aortic aneurysm with concomitant bicuspid aortic valve and bovine aortic arch. *Acta Biomater* 2013;9(8):7927-7936
- Malone CD, Urbania TH, Crook SES, Hope MD. Bovine aortic arch: A novel association with thoracic aortic dilation. *Clin Radiol* 2012;67(1):28-31
- Hornick M, Moomiaie R, Mojibian H, *et al.* 'Bovine' aortic arch - a marker for thoracic aortic disease. *Cardiology* 2012;123(2):116-124
- Uchino A, Saito N, Okada Y, *et al.* Variation of the origin of the left common carotid artery diagnosed by CT angiography. *Surg Radiol Anat* 2013;35(4):339-342

Received: March 5, 2021
Accepted: August 25, 2021

Corresponding author
B.V. Murlimanju
E-mail: flutemist@gmail.com