

Case report and literature review

Fetal bovine aortic arch – review



Shehla Guliyeva¹ , Maria Respondek-Liberska² 

¹Department of Radiology, Ganja International Hospital, Ganja, Azerbaijan

²Department of Prenatal Cardiology, Polish Mother's Memorial Hospital, Research Institute, Lodz, Poland

Abstract

Prenatal evaluation of fetal aortic arch is not an easy task, especially during obstetrical screening; however, in tertiary centres, both high-quality ultrasound machines and experience of physicians/echocardiographers have achieved great progress in recent years in the evaluation of this particular part of the fetal heart. It is possible to distinguish between left and right fetal aortic arch, to describe fetal double arch, fetal interrupted aortic arch, coarctation of the aorta, and it is even possible to detect major aorto-pulmonary collateral arteries coming from the descending artery. In a referral centres for fetal cardiology, from time to time we also detect bovine aortic arch, but fetal literature on this topic is rare.

Key words: heart, aortic arch, fetal, bovine aortic arch.

Corresponding author:

Dr. Shehla Guliyeva
Department of Radiology
Ganja International Hospital
Ganja, Azerbaijan
e-mail: drshehla1992@yahoo.com

Introduction

Prenatal evaluation of fetal aortic arch is not an easy task, especially during obstetrical screening; however, in tertiary centres, both high-quality ultrasound machines and the experience of physicians/echocardiographers had led to great progress in recent years in the evaluation of this particular part of the fetal heart. It is possible to distinguish between left and right fetal aortic arch [1-3], to describe fetal double arch [4], fetal interrupted aortic arch [5], coarctation of the aorta [6], and it is even possible to detect major aorto-pulmonary collateral arteries coming from the descending artery [7]. In a referral centres for fetal cardiology, from time to time we also detect bovine aortic arch, but fetal literature on this topic is rare.

Ultrasound/echo technique

Visualisation of the aortic arch is usually possible in fetal mediastinum in a 3-vessel view; however, its longitudinal scan should also be recorded but is not always easy to notice and prove, especially in the 3rd trimester of pregnancy. Therefore,

fetal aortic arch in the 1st or 2nd trimester in a more flexible fetal position, in the case of good quality for recording, also deserves our attention. Our main goal is to confirm its continuity, to exclude hypoplasia, right aortic arch, double aortic arch, coarctation of the aorta, and interruption aortic arch; however, with the current technology, aortic arch branches are also ready for our evaluation.

Ultrasound technique

Branching of the aortic arch can be detected in the sagittal plane, when both ascending and descending aorta are visible. Branching is first demonstrated with B-mode greyscale imaging and then confirmed with colour or power Doppler imaging (Figure 1). Images are acquired during conventional scanning in the sagittal plane, at the level of the aortic arch, avoiding acoustic shadows from the spine and ribs. The preferable sagittal planes are obtained while the fetus is in a dorsoposterior or dorsoanterior position. The images acquired should be performed during fetal rest in the absence of fetal movements.

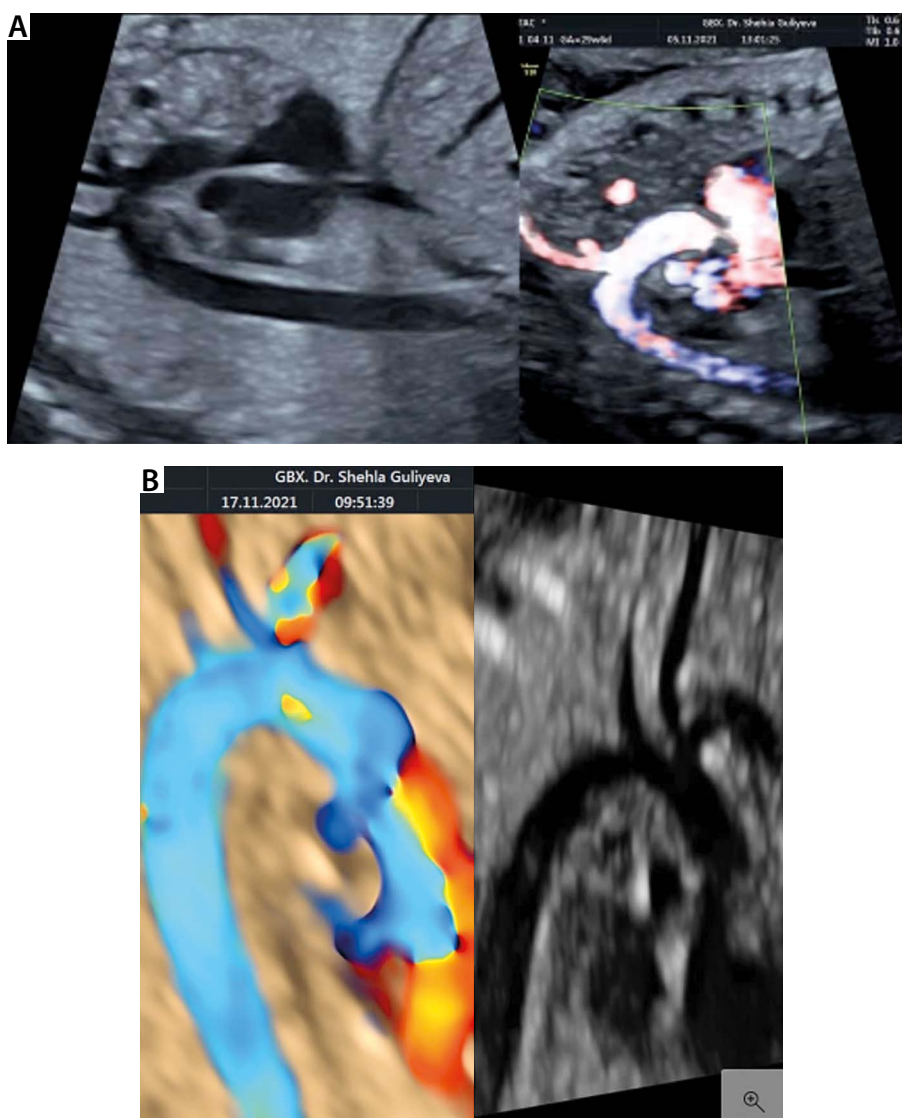


Figure 1. Branching of the aortic arch detected in the sagittal plane, when both ascending and descending aorta were visible. Branching demonstrated with B-mode greyscale imaging and confirmed with power Doppler imaging (A) or colour Doppler imaging (B). Images acquired during fetal rest in the absence of fetal movement

It is worth adding that often the aortic arch and its branches are easier to evaluate during fetal life, compared to early postnatal neonatal echocardiography, due to physiologically short neonatal neck. It usually takes 3-4 years until good suprasternal aortic arch visualization is possible again without causing discomfort for infants and toddlers.

Types of aortic arch branches

From an anatomical point of view there are several types of aortic arch branches.

The most common aortic arch branching pattern found in humans has separate origins for the innominate, left common carotid, and left subclavian arteries (Figures 1A, 1B, 2).

The second most common pattern of human aortic arch branching has a common origin for the innominate and left common carotid arteries. This pattern has been referred to as a “bovine arch” (Figure 3); however, it is not “pure” bovine aortic arch.

Another variant of aortic arch branching, the left common carotid artery, originates separately from the innominate artery. This pattern has also been erroneously referred to as a “bovine arch” (Figure 4).

So-called “true bovine aortic arch” – the aortic arch branching pattern found in cattle – has a single brachiocephalic trunk originating from the aortic arch and eventually splits into the bilateral subclavian arteries and a bicarotid trunk.

Bovine aortic arch

Bovine aortic arch in the majority of ultrasound prenatal studies is defined as the second most common variant of aortic arch branching, in which only 2 branches originate directly from the aorta (Figure 5). The prevalence of this condition has been reported in different studies to be around 4.8% in human fetuses and 11-27% in the adult population [8] or the common origin of the brachiocephalic trunk and left common carotid

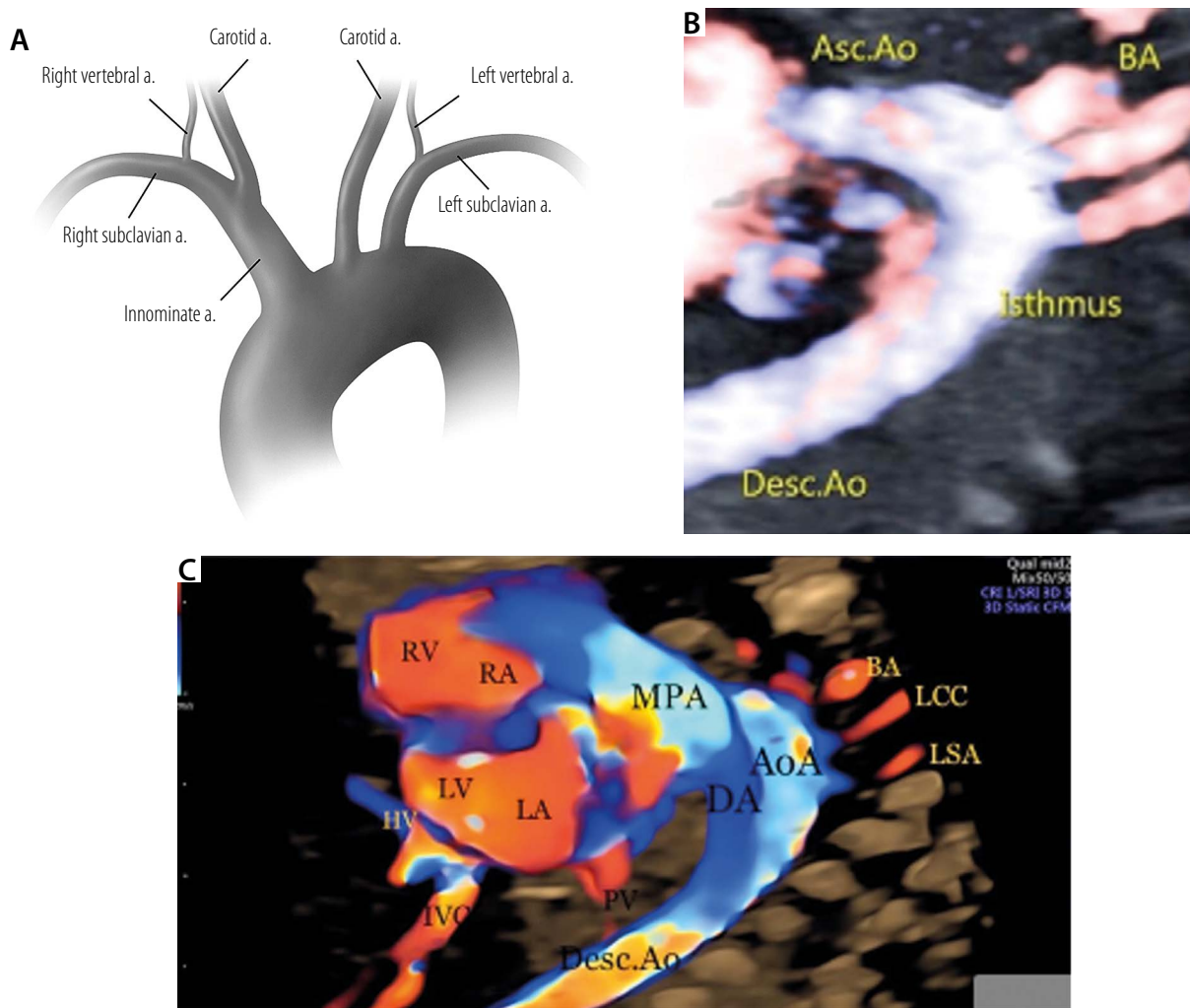


Figure 2. The most common aortic arch branching pattern: separate origins for the innominate, left common carotid, and left subclavian arteries

artery (“bovine arch”/type II aortic arch), with an incidence of 7.2–21.1% [9].

In study research from Israel a bovine aortic arch was found in 20/413 fetuses between 15 and 40 weeks of gestation (4.8%, 95 CI: 3.1–7.3%), of whom 14/310 (4.5%) had no fetal anomalies and 6/77 (7.8%) exhibited minor changes ($p = 0.241$).

In another study by Chaoui et al. in addition to observing anatomic structures in 6 fetuses with bovine aortic arch (among 39 fetuses) they studied haemodynamic evaluation and found statistically significant differences between the bovine arch and normal aortic arch. They concluded that there is a possible relationship with the incidence of some pathologies in adult life, and prenatal knowledge of anatomic variants of the aortic arch can bring benefits to the individual’s health for future possible cardiovascular investigations [9].

Although few publications deal with fetal bovine aortic arch, it is well known in radiology. There is also lots of scientific discussion about the term per se. The human “bovine” variant may be present in dogs, cats, and most rabbit species (2 major branches from the aortic arch, the first being an innominate or brachiocephalic artery giving origin sequentially to the left common carotid and right common carotid arteries,

and the second being a left subclavian artery). But it is not seen in cattle. So, according to the human arch variant described above, using a term like “canine”, “feline”, or “lapine” aortic arch would be more appropriate [10–13].

Clinical presentation

Bovine arch in the fetus is not typical and may cause parental anxiety, and in current perinatal medicine there might be a question from the primary care obstetrician: does it need genetic work-up? This common variant is asymptomatic most of the time. In rare cases of head and neck surgery during postnatal life, e.g. tracheostomy, it can be a risk factor for injury and cause complications. In combination with an aberrant right subclavian artery (ARSA) it can cause a dysphagia lusoria. The bovine arch pattern has been described in the paediatric literature as associated with coarctation of the aorta, and higher rates of prevalence have been reported in paediatric populations with congenital disease (17.6% among patients with aortic coarctation compared to 15.2% in the entire population studied).

In adults the prevalence of a bovine aortic arch configuration is higher in patients treated for thoracic aortic aneurysms and type B dissection, and in a group with aortic isthmus trauma [14]. The bovine aortic arch was significantly more com-

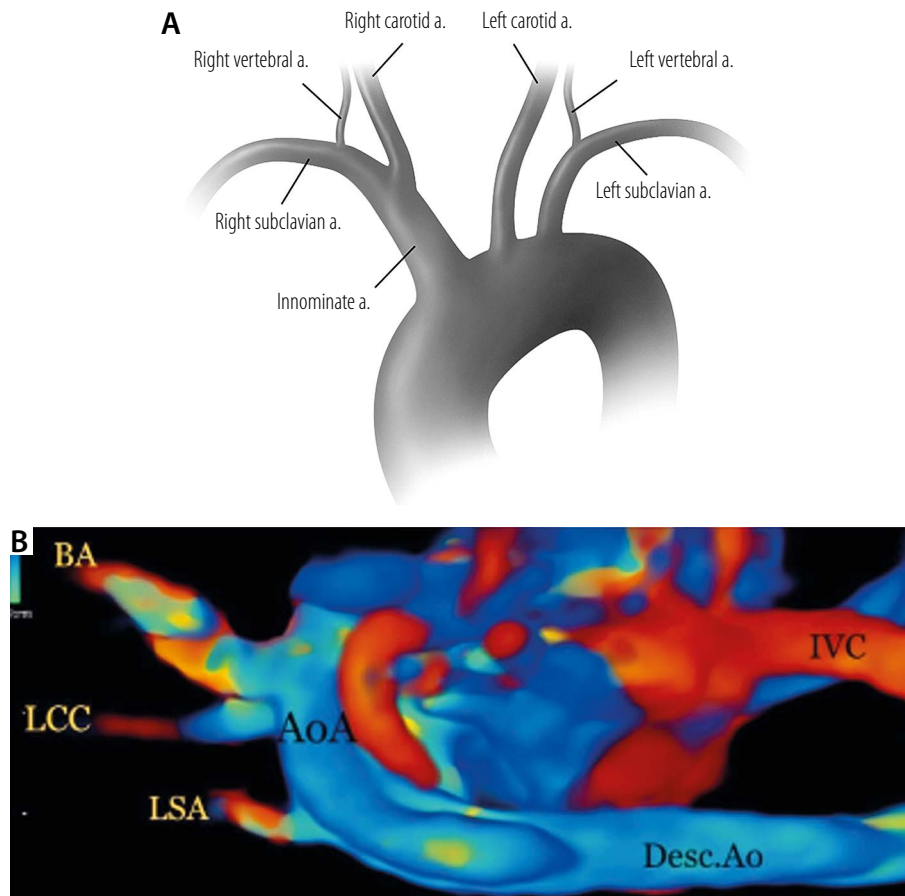


Figure 3. The second most common pattern of human aortic arch branching: a common origin for the innominate and left common carotid arteries. This pattern has erroneously been referred to as a “bovine arch”

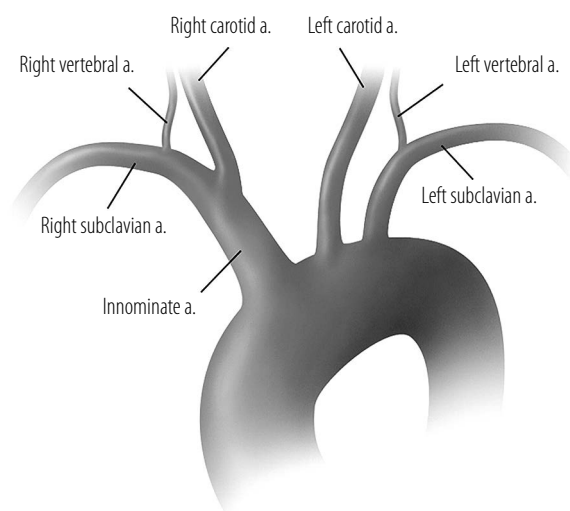


Figure 4. Variant of aortic arch branching: the left common carotid artery originates separately from the innominate artery. This pattern has also been erroneously referred to as a “bovine arch”

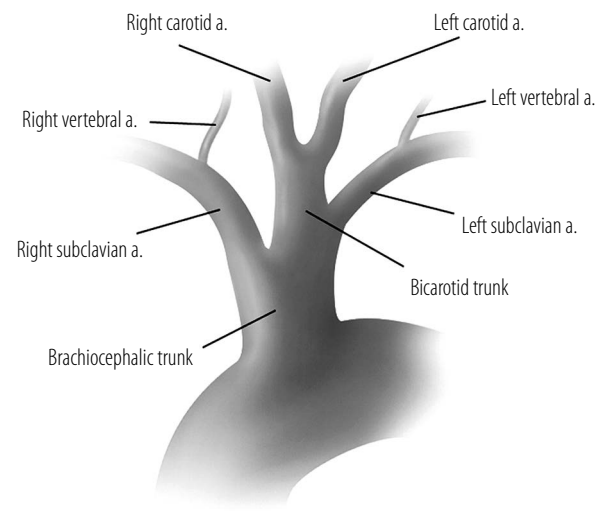


Figure 5. True bovine aortic arch. The aortic arch branching pattern in cattle: a single brachiocephalic trunk originating from the aortic arch and eventually splitting into the bilateral subclavian arteries and a bicarotid trunk

mon among embolic stroke patients, probably due to altered haemodynamic properties within the bovine arch [15].

Coming back to prenatal life, based on literature search and our own experience, in the case of the good quality visualisation of the aortic arch in longitudinal scan and an attempt to evaluate its branches, we propose a special step-

by-step diagnostic process as part of the echocardiographic report (Figure 6).

Conclusions

The presence of “bovine aortic arch” in the fetus may have some haemodynamic differences. And maybe there is a possi-

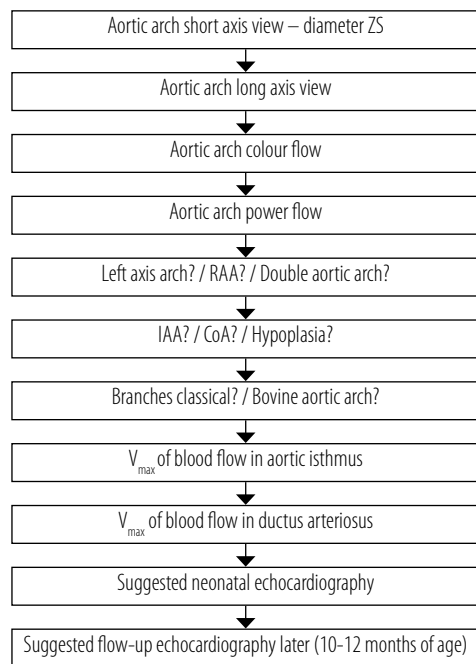


Figure 6. Steps in the diagnostic process

ble relationship with the incidence of some pathologies in adult life. Therefore, prenatal knowledge of anatomic variants of the aortic arch can bring benefits to the individual's prophylactic health for future possible cardiovascular investigations.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. Bravo C, Gámez F, Pérez R, Álvarez T, De León-Luis J. Fetal aortic arch anomalies: key sonographic views for their differential diagnosis and clinical implications using the cardiovascular system sonographic evaluation protocol. *J Ultrasound Med* 2016; 35: 237-251.
2. Wójtowicz A, Respondek-Liberska M, Słodki M, Kordjalik P, Płuzańska J, Knafel A, et al. The significance of a prenatal diagnosis of right aortic arch. *Prenat Diagn* 2017; 37: 365-374.
3. Campanale CM, Pasquini L, Santangelo TP, Iorio FS, Bagolan P, Sanders SP, et al. Prenatal echocardiographic assessment of right aortic arch. *Ultrasound Obstet Gynecol* 2019; 54: 96-102.
4. Trobo D, Bravo C, Alvarez T, Pérez R, Gámez F, De León-Luis J. Prenatal sonographic features of a double aortic arch: literature review and perinatal management. *J Ultrasound Med* 2015; 34: 1921-1927.
5. Słodki M, Moszura T, Janiak K, Sysa A, Seligman NS, Weiner S, et al. The three-vessel view in the fetal mediastinum in the diagnosis of interrupted aortic arch. *Ultrasound Med Biol* 2011; 37: 1808-1813.
6. Słodki M, Rychik J, Moszura T, Janiak K, Respondek-Liberska M. Measurement of the great vessels in the mediastinum could help distinguish true from false-positive coarctation of the aorta in the third trimester. *J Ultrasound Med* 2009; 28: 1313-1317.
7. Moszura T, Janiak K, Respondek-Liberska M, Mazurek-Kula A, Dryżek P, Moll J, et al. Prenatal diagnosis of major aortopulmonary collateral arteries. *Kardiologia Pol* 2011; 69: 146-151.
8. Goldsher YW, Salem Y, Weisz B, Achiron R, Jacobson JM, Gindes L. Bovine aortic arch: Prevalence in human fetuses. *J Clin Ultrasound* 2020; 48: 198-203.
9. Clerici G, Giulietti E, Babucci G, Chaoui R. Bovine aortic arch: clinical significance and hemodynamic evaluation. *J Matern Fetal Neonatal Med* 2018; 31: 2381-2387.
10. Elster AD. "Bovine" aortic arch. *AJNR Am J Neuroradiol* 2008; 29: e2.
11. Layton KF, Kallmes DF, Cloft HJ, Lindell EP, Cox VS. Bovine aortic arch araiant in humans: clarification of a common misnomer. *AJNR Am J Neuroradiol* 2006; 27: 1541-1542.
12. Vitek JJ. Bovine aortic arch. *AJNR Am J Neuroradiol* 2007; 2487: 1205.
13. Dome SH, Goody PC, Evans SA, Strickland NC, et al. *Color Atlas of Veterinary Anatomy. Volume 3. The Dog and Cat.* Mosby-Yearbook, St Louis 1996.
14. Mertens R, Velásquez F, Mertens N, Vargas F, Torrealba I, Mariné L, et al. Higher prevalence of bovine aortic arch configuration in patients undergoing blunt isthmic aortic trauma repair. *Ann Vasc Surg* 2020; 67: 67-70.
15. Syperek A, Angermaier A, Kromrey ML, Hosten N, Kirsch M. The so-called "bovine aortic arch": a possible biomarker for embolic strokes? *Neuroradiology* 2019; 61: 1165-1172.

Division of work:

Shehla Guliyeva (ORCID: 0000-0002-6142-6553): collection and/or assembly of data, data analysis and interpretation, critical revision of the article, final approval of the article
 Maria Respondek-Liberska (ORCID: 0000-0003-0238-2172): equal contribution of all authors, research concept and design, collection and/or assembly of data, writing the article, critical revision of the article, final approval of the article