CASE REPORT

Presence of the Bovine Aortic Arch in Patients Undergoing Computed Tomography

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Abstract

A retrospective case series was conducted using contrast-enhanced computed tomography scans of the chest performed at National Hospital Sri Lanka. A total of 50 CT studies were reviewed. Bovine aortic arch was identified based on established imaging criteria. Demographic characteristics and associated vascular variations were recorded. Descriptive statistics were used to calculate prevalence and percentages. Comparison between male and female patients was performed using Fisher's exact test, and statistical significance was set at $p < 0.05$. Bovine aortic arch was identified in 14 of 50 patients, yielding a prevalence of 28%. The median age of the individuals was 64 years (range 0.44–81 years). Nine cases occurred in males and 5 in females, with no statistically significant difference between genders ($p = 0.77$). One patient demonstrated an associated left vertebral artery arising directly from the aortic arch. No additional major arch anomalies were included in this focused series. The presence of a Bovine aortic arch is a common aortic arch variant in this Sri Lankan cohort, with a prevalence comparable to previous local data and at the higher end of global estimates. Recognition of this variant on CT imaging is important due to its potential implications for vascular and endovascular procedures.

Key words: Bovine aortic arch; Aortic arch variation; Computed tomography; Vascular anatomy

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Introduction

The aortic arch normally gives rise to three major branches: the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery. Consistent with prior publications, we used the definition of the Bovine aortic arch (BAA) as the innominate artery and the left common carotid artery sharing a common origin, or the left common carotid artery arising from the innominate artery (1).

The definition of BAA used in humans displays little resemblance to the aortic arch of cattle, in which a single large brachiocephalic trunk branches off the aortic arch, and both subclavian arteries and a BI carotid trunk arise from this brachiocephalic trunk (1). However, this term represents an anatomical misnomer. Layton et al. demonstrated that true bovine anatomy differs from the human configuration, in which BAA refers to either a common origin of the brachiocephalic trunk and left common carotid artery or the left common carotid artery arising from the brachiocephalic trunk (2). Contemporary imaging-based classifications continue to use this terminology for consistency in clinical practice (3, 4). In this study, bovine arch refers to a two-vessel aortic arch.

The prevalence of BAA varies across populations, with imaging studies reporting rates between 10% and 25%, making it the most common aortic arch variant worldwide (5, 6). Increasing evidence suggests that BAA is not merely an anatomical curiosity but may be associated with thoracic aortic pathology, cerebrovascular events, and technical challenges during surgical and endovascular interventions (6, 7). Computed tomography allows accurate identification of this variant and associated vascular anatomy, which is essential for procedural planning (8). This case series aims to describe the incidence and imaging characteristics of BAA in a Sri Lankan cohort and to emphasize its clinical relevance.

Methods

This retrospective case series was conducted over a three-month period spanning from June to August 2023 at the Radiology Department of the National Hospital of Sri Lanka. All patients who underwent contrast-enhanced computed tomography (CECT) of the chest during the study period were reviewed to identify cases demonstrating BAA anatomy. Studies were included if a BAA variant was clearly visualized on CT imaging. Patients with prior thoracic vascular surgery, congenital cardiac surgery, or inadequate image quality were excluded from the analysis. Computed tomography imaging was performed using a multi-detector 16-slice CT scanner (Toshiba Aquilian) with three-dimensional reconstruction capabilities. Intravenous iodinated contrast medium (Omnipaque 300, iohexol) was administered using a weight-based protocol at approximately 1 mL/kg, with a mean volume of 80 ml. Automated bolus tracking was performed by placing the region of interest at the level of the aortic arch, with arterial-phase image acquisition initiated approximately 20 seconds after contrast administration.

All images were analyzed in the arterial phase using axial, coronal, sagittal, and three-dimensional reconstructed views. Image interpretation was performed at the workstation by a radiologist and a vascular surgeon using dedicated post-processing software (Vitrea). Data collected included patient demographics and the specific anatomical subtype of bovine aortic arch identified on CT imaging. Studies with suboptimal contrast timing, insufficient exposure, or significant artefacts related to central venous catheters, previous surgical

procedures, or mediastinal pathology were excluded.

Results

A total of 50 contrast-enhanced computed tomography scans of the chest were included in the analysis, comprising 30 males (60%) and 20 females (40%). BAA anatomy was identified in 14 individuals, yielding a prevalence of 28%. Among patients with bovine aortic arch, nine were male (9/14, 64.3%) and five were female (35.7%) This difference was not statistically significant (p = 0.77). One patient (7.1% of bovine arch cases; 2% of the total cohort) demonstrated an associated left vertebral artery originating directly from the aortic arch. Other aortic arch variants identified in the overall cohort included isolated right-sided aortic arch, and aberrant right subclavian artery (2%) and left vertebral artery arising directly from the aortic arch (8%) of whom one also had a bovine arch configuration.

Discussion

Nomenclature and the "bovine" misnomer

The term *bovine aortic arch* is commonly used to describe a shared origin of the brachiocephalic trunk and the left common carotid artery, or the left common carotid artery arising from the brachiocephalic trunk. However, this terminology represents a well-recognized anatomical misnomer. Layton *et al,*. demonstrated that the true bovine aortic arch in cattle consists of a single arterial trunk giving rise to both subclavian arteries and a BI carotid trunk, a configuration fundamentally different from the human variant described as "bovine" (2). Despite this inaccuracy, the term remains widely used in clinical and radiological practice due to its familiarity and descriptive convenience.

Embryological basis

The aortic arch branching pattern results from complex embryological development involving the pharyngeal arch arteries, dorsal aortae, and the aortic sac. The aortic arch develops from paired embryonic pharyngeal (aortic) arch arteries that connect the truncus arteriosus to the dorsal aortae (Figure 1).

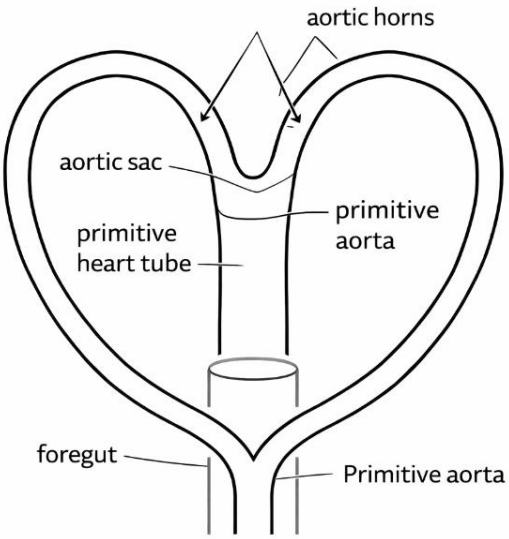

Figure 1: Primordial aortic arch

The third arches form the common carotid arteries, the left fourth arch contributes to the definitive aortic arch, and the right fourth arch forms part of the right subclavian artery, while the sixth arches give rise to the pulmonary arteries and ductus arteriosus (Figure 2).

Normal adult branching results from selective regression and remodeling of these arches and the aortic sac. A BAA variant is thought to arise from altered absorption or asymmetric remodeling of the aortic sac, leading to a common origin of the brachiocephalic trunk and left common carotid artery or the left common carotid artery arising from the brachiocephalic trunk (Figure 3) (9).

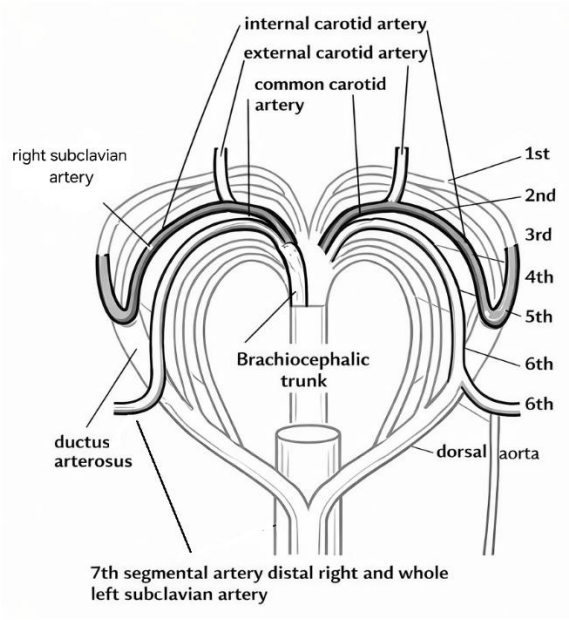

Figure 2: Development of vessels from the aortic arch

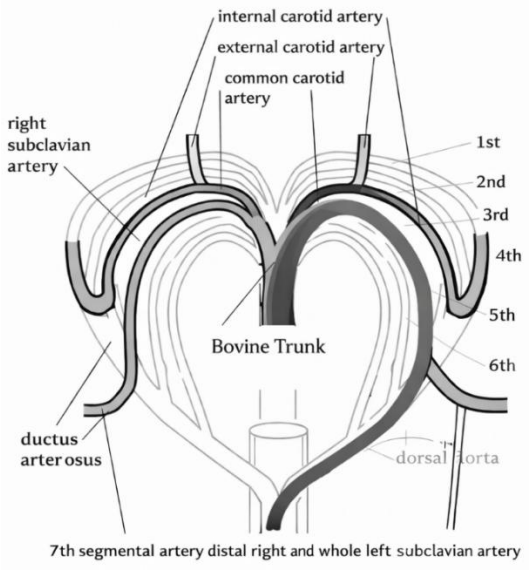

Figure 3: Formation of the Bovine aortic arch

Minor deviations in these developmental processes can lead to a common origin of the supra-aortic vessels, explaining the anatomical patterns observed in adults.

Global incidence of BAA

The prevalence of BAA varies across populations and imaging studies, largely due to differences in definitions and methodologies. Large CT-based series have reported prevalence rates ranging from approximately 10% to 25% in adult population (5). Moorehead et al. demonstrated that bovine aortic arch configuration occurs frequently in adults regardless of the presence of thoracic aortic pathology, confirming it as the most common aortic arch variant worldwide (5). The prevalence of 28% observed in the present study lies at the higher end of the reported global range.

Associated clinical and surgical conditions

Although often regarded as a benign anatomical variant, bovine aortic arch has been associated with several clinically significant conditions. Hornick et al. proposed BAA as a marker for thoracic aortic disease, demonstrating an association with aneurysmal pathology (10). Malone et al, reported an association between bovine aortic arch and thoracic aortic dilatation (6). In acute aortic syndromes, Dumfarth et al. showed that BAA was associated with a higher incidence of arch dissection and stroke in patients with DeBakey type I aortic dissection (11). More recently, Lo Russo et al. demonstrated an increased risk of stroke following transcatheter aortic valve replacement in patients with bovine arch anatomy, further highlighting its clinical relevance (7).

Implications for vascular access and endovascular interventions

BAA anatomy has important implications for vascular and endovascular procedures. The altered angulation and shared origins of the supra-aortic vessels may increase technical difficulty during carotid artery stenting, neuro-interventional procedures, and thoracic endovascular aortic repair (11, 10). Recognition of this anatomy on pre-procedural imaging allows appropriate planning of access routes and device selection, potentially

reducing procedural complications (Figure 4 and 5).

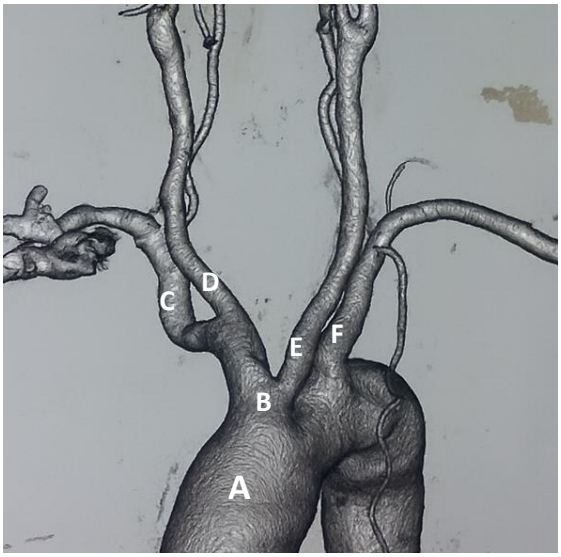

Figure 4: CT showing the BAA: A-aortic arch, B – Brachiocephalic trunk giving rise to E – Left common carotid artery, C – Right subclavian artery, D – Right common carotid artery, F – Left subclavian artery

Sri Lankan data and comparison with previous studies

Data on aortic arch variations in the Sri Lankan population are limited. Arudchelvam et al. reported that variations in aortic arch branching patterns were present in 40. 0% of individuals, with the bovine aortic arch being the most common variant, accounting for 28.0% of cases (12).

The prevalence of bovine aortic arch observed in the present study mirrors these findings, suggesting consistency within the local population. Unlike previous studies that broadly assessed multiple arch variants, the present case series focuses specifically on bovine aortic arch anatomy, allowing more detailed characterization of this common variant.

Importance of CT-based identification

Multidetector computed tomography with three-dimensional reconstruction provides an optimal modality for accurate delineation of aortic arch anatomy and associated vascular variants (3, 8). Routine identification of BAA on CT imaging is essential for risk stratification and procedural planning, particularly in populations with a relatively high prevalence of this anatomical variant.

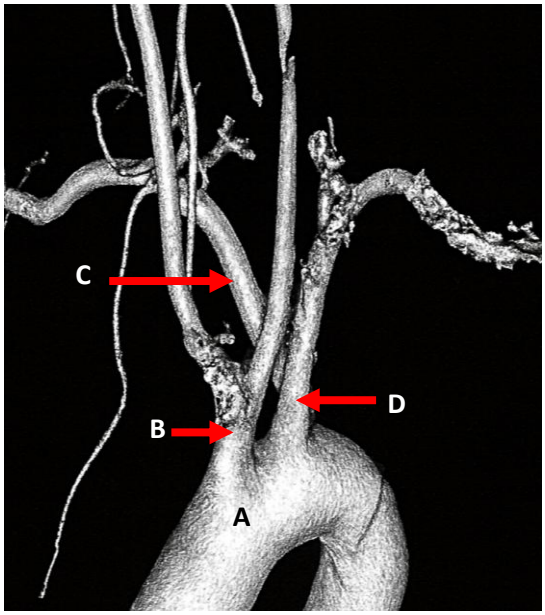

Figure 5: Bovine Aortic Arch: A – Aortic arch, B – Brachiocephalic trunk giving rise to both Right and Left Common Carotid Arteries, C – Right Subclavian artery arising from the aortic arch, D-Left Subclavian Artery

Conclusion

This case series demonstrates that bovine aortic arch is a common aortic arch variant in the Sri Lankan population, with a prevalence of 28%, comparable to previously reported local data and at the higher end of global estimates. Although often regarded as a benign anatomical variation, BAA has important clinical and procedural implications, particularly in patients undergoing vascular, cardiothoracic, and neurointerventional procedures. Accurate identification of this variant on contrast-enhanced computed tomography is essential for appropriate pre-procedural planning and risk stratification.

The findings of this study should be interpreted in light of certain limitations. The sample size was relatively small and derived from the National Hospital of Sri Lanka, which cannot be generalized to the broader Sri Lankan population. The retrospective design and imaging-based assessment precluded correlation with long-term clinical outcomes. Larger multicenter studies with outcome-based analysis would further clarify the clinical significance of BAA in this population.

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Disclaimer

This study represents a focused secondary analysis of imaging data derived from a previously published study by Arudchelvam *et al.,* (12) which examined overall variations in aortic arch branching patterns within the same cohort. This manuscript specifically evaluates the prevalence and imaging characteristics of the BAA. Selected imaging and figures have been reproduced with appropriate permission and acknowledgment of the original publication.

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