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Anatomy

A Rare Branching Pattern of Arch of Aorta

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Case Report

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Abstract: A 'bovine aortic arch' in human is the commonest branching anomaly of Aortic Arch which is described as a common origin of Brachiocephalic Trunk and Left Common Carotid Artery. The term is considered as misnomer by some authors as it does not exactly match with the typical single branched aortic arch found in cattle. More than 20 different types of aortic arch branching anomalies have been reported. Each researcher has described the pattern of branching different ways. We report a rare anomalous branching of the aortic arch in an adult male cadaver. In the present case, Left Common Carotid Artery is originating from brachiocephalic trunk. Variations in the branching pattern of the arch of aorta can alter the cerebral haemodynamic that leads to cerebral abnormalities. Aberrant anatomy of aortic arch becomes relevant to interventional radiologists and CVTS surgeons in endovascular interventions in the head and neck and intracranial territories, thoracic endovascular aneurysm repair and diagnosis of an intracranial aneurysm after subarachnoid haemorrhage.
Keywords: Arch of Aorta, Bovine Arch, Brachiocephalic Trunk.

INTRODUCTION

The brachiocephalic trunk (BT), left common carotid artery (LCCA) and left subclavian artery (LSA) are the normal branches of arch of aorta originating from the beginning of the arch or the superior part of the ascending aorta with varying distances between their origins. Other branches may arise from the aortic arch, including the inferior thyroid, thyroidea ima, thymic, left coronary and bronchial arteries [1].

More than 20 different aortic arch configurations have been described, but the commonest variation is a proximal shifting of LCCA origin either overlapping the origin of BT or from the BT itself, latter being less common. Both common variations are referred as 'Bovine Arch'. True Bovine aortic arch bears no resemblance to any of the common human aortic arch variations. In cattle, a single great vessel originates from the aortic arch. This large brachiocephalic trunk gives rise to both subclavian arteries and a bicarotid trunk. The bicarotid trunk then bifurcates into the LCCA and right common carotid (RCCA) artery [2].

Aberrant anatomy of aortic arch becomes relevant to interventional radiologists and CVTS surgeons in endovascular interventions in the head and neck and intracranial territories, thoracic endovascular aneurysm repair and diagnosis of an intracranial aneurysm after subarachnoid haemorrhage.

CASE REPORT

During routine dissection for undergraduate medical students, a variant branching pattern of the arch of aorta was observed in an adult male cadaver. In the present case, only two branches of Arch of Aorta were observed in the form of a BT and LSA. The LCCA was originating from BT (Fig. 1 and 2).

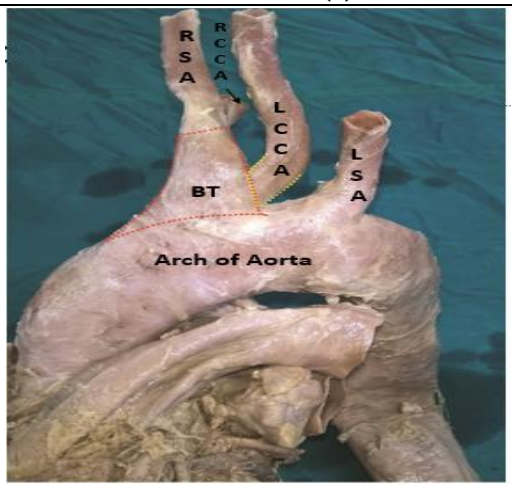

Fig-1: Specimen of heart showing anomalous branching pattern

BT– Brachiocephalic Trunk, RSA – Right Subclavian Artery, RCCA – Right Common Carotid Artery, LCCA – Left Common Carotid Artery, LSA – Left Subclavian Artery.

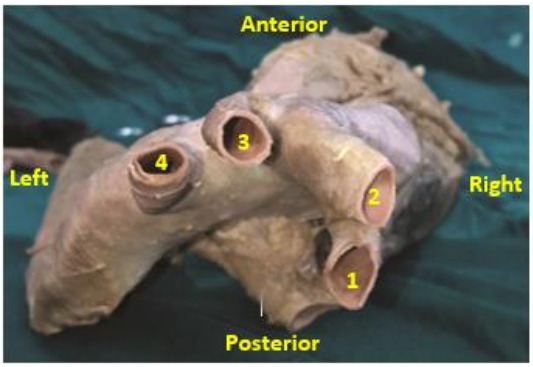

Fig-2: Superior View

1 – RCCA- Right Common Carotid Artery, 2 – Right Subclavian Artery, 3 – LCCA- Left Common Carotid Artery, 4 – LSA- Left Subclavian Artery.

The BT was originating about 73.42 mm distal to the origin of Right Coronary Artery and LSA was seen originating about 12.32 mm distal to BT. The LCCA was originating from BT about 2.59 mm from the convex border of Aortic arch from its left side. At 21.56 mm distal to the origin of LCCA, the BT was dividing into a right subclavian artery (RSA) and RCCA. Interior of aortic arch showed only two openings, proximal being the BT and distal being LSA (Fig.3). The morphometric analysis of each artery was recorded as shown in the Table 1. Internal diameters of common trunk and left subclavian at their origin were also recorded as shown in the Table 2.

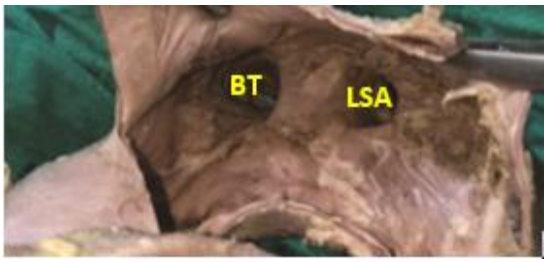

Fig-3: Interior of Arch of Aorta

BT- Brachiocephalic Trunk, LSA- Left Subclavian Artery

Table-1: Morphometric analysis

Artery	Transverse Diameter (mm)	Anteroposterior diameter (mm)
Ascending Aorta	34.53	24.18
Brachiocephalic Trunk (before origin of LCCA)	22.94	17.80
Brachiocephalic Trunk (after origin of LCCA)	14.32	9.43
Right Subclavian	6.09	7.93
Right Common Carotid	8.15	10.69
Left Common Carotid	7.02	6.67
Left Subclavian	12.11	10.85

Table-2: Internal diameters of common trunk and left subclavian artery

Artery	Transverse Diameter (mm)	Anteroposterior diameter (mm)
Brachiocephalic Trunk	17.05	11.84
Left Subclavian artery	11.13	12.09

DISCUSSION

Isolated variant anatomy of aortic arch is mostly asymptomatic. Significant clinical symptoms may arise owing to compression of neighbouring structures such as trachea and oesophagus by abnormal branches. The accurate recognition and appreciation of branching pattern of aortic arch is an essential prerequisite for surgical planning to avoid surgical complications. Unidentified variations in the branches of aortic arch during the thoracic endovascular aneurysm repair, may lead to iatrogenic injury resulting in endoleak or ischaemic complications in the brain or upper limbs an appreciation of variant anatomy is also important in undertaking procedures such as needle biopsy or injections around this territory [3]. A recent study by Turek *et al*. shows that children undergoing extended end-to-end repair with bovine arch anatomy are at a significantly increased risk of recoarctation [4].

A multidetector computed tomographic study by Jakani *et al*. in 945 cases revealed conventional configuration in 74%. Second most frequent pattern was a common origin to the BT and LCCA origin (bovine arch), which occurred in 20% patients. In 53 patients (6%), the left vertebral artery arose directly from the aortic arch. [5] Karacan *et al*. studied aortic arch branching pattern by multi detector computed tomography in 1000 cases and variations thus observed were classified into 7 types. Type 1, the normal or commonest pattern was observed in 79.2%. The commonest variation was BT and LCCA arising from the aortic arch in a common trunk, termed as bovine arch was seen in 14.1 %. Rest different types occupying the remaining cases [6]. In both the studies mentioned above there is no mention about LCCA originating from BT.

Lei Wang *et al*. [7], who studied morphometric features of the aortic arch and its branches in 2370 Chinese patients have classified it into five types from A to E, where A is the commonest or normal branching arch (83.8%). Type B was the second most common pattern or commonest variation described as a common origin of BT and LCCA with or without another anomaly depending on which it was further divided into B1 to B4. Our case matches with the description of Type B4 classification described by the Lei Wang *et al*.

Layton *et al.* [2] classified commonly observed branching patterns of arch of aorta into three categories in order of frequency of appearance, namely 1. Standard Aortic Arch. 2. Common Origin of the BT and LCCA and 3. Origin of the LCCA from the BT (Fig. 4). Our case is similar to the third category described by the Layton *et al*. These aberrations are commonly referred as ‘Bovine Aortic Arch’ but none of these variations accurately matches with true bovine arch (Fig. 5) seen in cattle as described earlier; hence it is termed as a medical misnomer [3]. A similar type of presentation was reported by Paraskevas *et al*. [8] in a cadaver of an 81-year old Caucasian man; the frequency of this occurrence was reported as 0.2%. The schematic representation of the present case is illustrated in the Figure 6.

Fig-4: Layton *et al*. [2] branching pattern of arch of aorta
1 – Arch of Aorta, 2 – Brachiocephalic Trunk, 3 – Right Subclavian Artery, 4 – Right Common Carotid Artery, 5 – Left Common Carotid Artery, 6 – Left Subclavian Artery

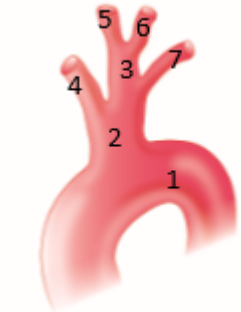

Fig-5: Typical Bovine Arch Found in Cattles
1 – Arch of Aorta, 2 – Brachiocephalic Trunk, 3 – Bicarotid Trunk, 4 – Right Subclavian Artery, 5 – Right Common Carotid Artery, 6 – Left Common Carotid Artery, 7 – Left Subclavian Artery

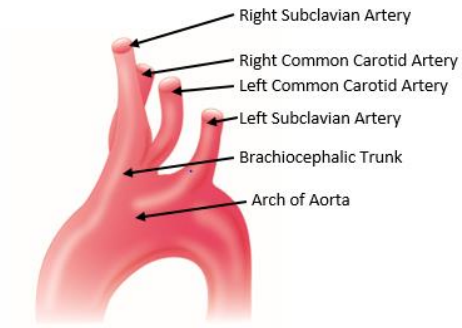

Fig-6: Schematic representation of present case

Internal diameter of BT in present case was more (17.5 mm) than the normal BT (8.3– 14.5 mm) without giving origin to LCCA or any other anomalous artery as recorded by Manole *et al* [9]. Variations in the branching pattern of the arch of aorta can alter the cerebral haemodynamics that leads to cerebral abnormalities [10]. The present scheme of definition and classification of Bovine Aortic Arch seems incomplete and ununiform. The terms Common Origin and Common trunk needs to be defined succinctly. Common origin of BT and LCCA can be different from LCCA originating from BT which will require different presurgical or pre-procedural planning involving Arch of aorta and its branches.

CONCLUSION

With ever expanding field of endovascular surgery and interventional radiology related to aortic arch and its branches knowledge of their variations is critical for the clinicians. The term bovine arch in human is a misnomer and defined individually. Variations in the branches of aorta such as bovine arch should be anticipated before planning for the surgery in the region. The exact origin of LCCA in bovine arch needs clarification for better preoperative planning.

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