An Atypical Branch from the Right Pulmonary Artery During Heart Dissection: A Case Report

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ABSTRACT

Anatomical variations in the pulmonary vasculature are rare but clinically significant, particularly in surgical and interventional cardiology. During a routine heart dissection of a 75-year-old female donor at the Medical University of the Americas, an atypical branch originating from the right pulmonary artery was observed. This branch, measuring approximately 5 mm in diameter, coexisted with an otherwise normal right pulmonary artery. Pulmonary artery anomalies stem from complex embryological processes and have been linked to conditions such as pulmonary artery slings and Kabuki syndrome. Recognizing these variations is crucial for accurate diagnostic imaging, surgical planning, and interventional procedures to prevent complications. This case contributes to the growing body of literature on pulmonary vascular anomalies and highlights the importance of meticulous anatomical evaluation in clinical practice.

Keywords: Right pulmonary artery; Anatomical variation; Pulmonary artery anomaly; Cardiovascular anatomy; Heart dissection; Atypical vascular branch

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INTRODUCTION

Anatomical variations in the pulmonary vasculature are rare but have significant clinical implications, particularly in surgical and interventional cardiology. One such uncommon variation is an atypical branch arising from the right pulmonary artery. These variations can affect diagnostic accuracy and surgical planning, making their identification crucial during both imaging and dissection [1]. This case report details a rare atypical branch observed during a routine heart dissection, contributing to the growing body of literature on vascular variations in the pulmonary circulation.

CASE PRESENTATION

During a routine anatomical dissection of the heart in a 75-year-old female donor, an atypical branch was observed arising from the right pulmonary

artery. The dissection was part of Medical University of the Americas educational program, and the donor had been preserved using standard embalming techniques. Upon dissection, an extra branch was identified originating from the right pulmonary artery. This branch measured approximately 5 mm in diameter. The main right pulmonary artery appeared otherwise normal, without any signs of pathological changes or abnormalities [Figures 1 and 2].

DISCUSSION

The pulmonary circulation is crucial for transporting deoxygenated blood from the right side of the heart to the lungs for oxygenation. The pulmonary trunk arises from the right ventricle and bifurcates into the right and left pulmonary arteries, which supply blood to the respective lungs. These vessels divide into smaller branches-lobar, segmental, and sub-segmental arteries-eventually forming capillaries that surround the alveoli for gas exchange. This high-capacitance, low-pressure system is optimized for efficient gas exchange. The pulmonary trunk, approximately 5 cm in length and 2-3 cm in diameter, exits the right ventricle, running alongside the ascending aorta. It bifurcates at the T4 vertebral level into the right and left pulmonary arteries. The right pulmonary artery runs posterior to the ascending aorta and anterior to the right mainstem bronchus, supplying the right lung, while the left pulmonary artery passes anterior to the descending aorta and lies above the left mainstem bronchus to supply the left lung.

A thorough understanding of the embryology of the pulmonary arteries is essential for comprehending their anatomical variations. The pulmonary arteries are primarily derived from the sixth aortic arch, along with contributions from the truncus arteriosus, conus cordis, and neural crest cells.

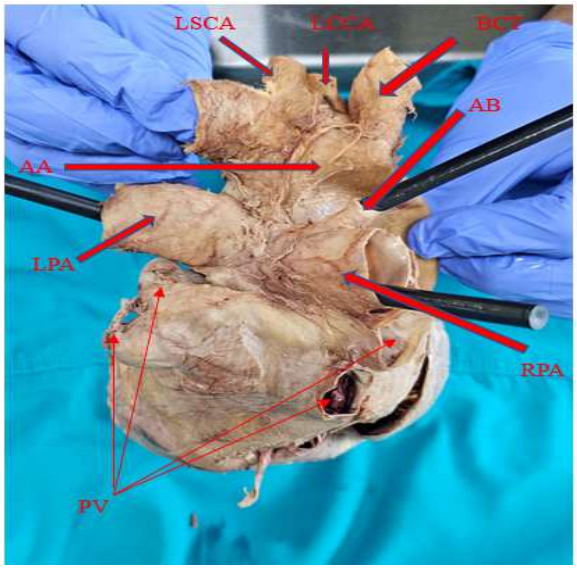

Figure 1: (Posterior surface or base of heart) AA (arch of aorta), BCT (brachiocephalic trunk), LCCA (left common carotid artery), LSCA (left subclavian artery), AB (atypical branch), RPA (right pulmonary artery), LPA (left pulmonary artery), PV (pulmonary veins).

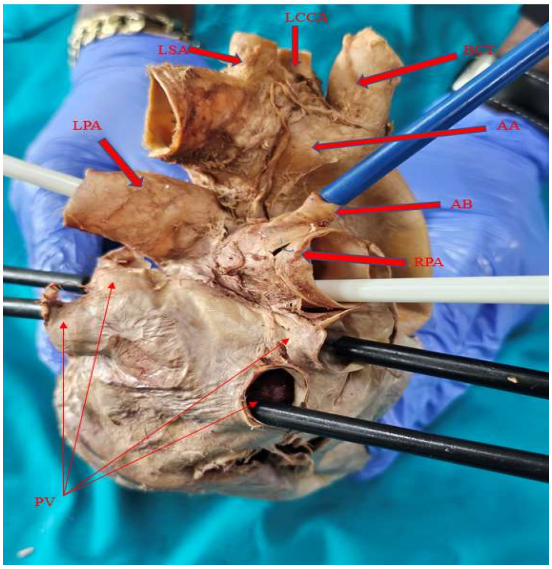

Figure 2: (Posterior surface or base of heart) AA (arch of aorta), BCT (brachiocephalic trunk), LCCA (left common carotid artery), LSCA (left subclavian artery), AB (atypical branch), RPA (right pulmonary artery), LPA (left pulmonary artery), PV (pulmonary veins).

Initially, both the right and left sixth aortic arches contribute to pulmonary arterial flow, but as the right arch regresses, the left sixth arch becomes the

main source of blood supply for both pulmonary arteries. During fetal development, the ductus arteriosus allows oxygenated blood to bypass the lungs and flow directly into the aorta. In the fifth week of gestation, the truncus arteriosus, conus cordis, and neural crest cells work together to form the pulmonary trunk and ascending aorta, along with the right and left ventricular outflow tracts. Opposing ridges within the truncus arteriosus twist and merge to divide it into the pulmonary trunk and ascending aorta. The conal ridges fuse to form the outflow tracts for the right and left ventricles, positioning the right ventricular outflow anterolaterally and the left posteromedially [2]. Several rare variations in the anatomy of the pulmonary arteries have been reported.

Khawaja et al. [3] described a case involving an 82-year-old female patient with poly-metastatic breast cancer, where CT images revealed an incidental finding of a small accessory left pulmonary artery. This vessel originated from the inferior aspect of the right pulmonary artery and coursed anteriorly to the airways, ultimately supplying the lingula of the left lung. In another case, Maldjian et al. [4] reported a rare instance of a partial anomalous left pulmonary artery sling, identified incidentally in an adult patient via CT. In this variation, the pulmonary trunk bifurcates normally into the right and left pulmonary arteries, but the left upper lobe pulmonary artery originates anomalously from the right pulmonary artery, traversing between the trachea and esophagus, forming a partial left pulmonary artery sling. A pulmonary artery sling is a rare congenital anomaly where the left pulmonary artery originates from the right pulmonary artery, encircling the trachea and right mainstem bronchus. This condition often leads to airway compression and respiratory distress in infants, with early diagnosis and surgical intervention being critical, as most affected infants experience severe symptoms within their first year [5]. Giudici et al. [6] presented three cases of duplicated left pulmonary arteries. Two of these cases involved children with Kabuki syndrome, where the duplicated left pulmonary artery created a pseudo-pulmonary sling without causing tracheal compression. These anomalies were discovered during routine heart examinations, and neither child required surgery. These were the third and fourth reported cases of this kind in children with Kabuki syndrome, where the artery branches do not form a typical sling. The third case differed, as it involved a duplicated left pulmonary artery that formed a true pulmonary sling. Loomba et al. [7] reported a complex congenital anomaly in the anatomical arrangement of the great vessels. In this case, the aorta was positioned posterior and to the right of the pulmonary trunk, deviating from the typical arrangement. While the right pulmonary artery arose normally from the pulmonary trunk, the left pulmonary artery had an anomalous origin from the anterior aspect of the ascending aorta. This left pulmonary artery then traveled leftward, crossing over the origin of the right pulmonary artery. The branching patterns of the right pulmonary artery (RPA) discussed in Kandathil and Chamarthy [1] highlight the variability in its division into segmental arteries. Normally, the RPA gives off branches to the upper, middle, and lower lobes of the right lung. However, variations may occur, such as accessory branches or atypical segmental distributions.

The case report we provided; the anomalous branch observed from the right pulmonary artery could potentially represent a variation in the typical branching pattern of the pulmonary arteries. Pulmonary arteries normally bifurcate into lobar, segmental, and sub-segmental branches, which supply the respective parts of the lung. In this particular case, since an extra branch was observed

arising from the right pulmonary artery, it might be one of the following:

Accessory Pulmonary Artery: This is a possible accessory vessel that supplies a part of the lung that typically receives blood from another main branch of the pulmonary artery. It may represent an additional or duplicated branch that supplies the lung parenchyma.

Anomalous Pulmonary Arterial Branch: This could be a rare anatomical variation where an extra branch arises from the right pulmonary artery, which might supply an atypical region of the lung, such as a segment not commonly supplied by the right pulmonary artery.

Aberrant Vascular Supply: The atypical branch could represent a previously undocumented or unusual vascular supply, possibly serving an abnormal or ectopic lung segment.

An Early lobar branch- It can be an early lobar branch originating before the pulmonary artery enter at the hilum of lung.

CLINICAL IMPLICATIONS

Surgical Considerations: An atypical branch from the right pulmonary artery can complicate surgical procedures such as lung resections, pulmonary artery catheterization, or heart transplantation.

Diagnostic Imaging: Awareness of such variations is essential for accurate radiological interpretation to avoid misdiagnoses or procedural errors.

Interventional Procedures: Interventions like pulmonary artery stenting or balloon angioplasty require precise anatomical knowledge to avoid injury to anomalous branches.

CONCLUSION

Understanding the anatomy of the pulmonary artery is crucial in cardiothoracic surgery, especially when dealing with congenital conditions or complex cases. Variations such as the one presented in this case report can complicate procedures and necessitate specialized surgical planning. Early recognition of these anomalies through imaging or dissection can aid in preventing complications during surgical and interventional procedures.

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