

## COMPARATIVE ANALYSIS OF THE FINDINGS OF CT ANGIOGRAPHY AND ECHOCARDIOGRAPHY IN AORTIC ARCH ANOMALIES

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**Abstract:** *The retrospective study was conducted in the Department of Cardiology Nishtar Medical Hospital Multan from January 2021 to January 2022 to compare CT angiography and echocardiography findings in patients with aortic arch abnormalities. The study was conducted on a total of 200 patients. Patient data was recorded, including demographic details and CT angiographic and echocardiographic findings. Results showed that Anomalies of coarctation of the aorta (COA) were most commonly reported. The most common anomalies associated with aortic arch anomaly included patent ductus arteriosus (PDA), patent ductus arteriosus (PDA), and ventricular septal defect (VSD). Of 200 patients, 66 (33%) had normal CT results, while 64 (32%) had normal transthoracic ECG results. For aortic arch anomalies, the specificity and sensitivity of TEC were 100% and 58%, and the agreement between CT angiography and TEC was .72 (Kappa coefficient). For COA, the specificity and sensitivity of TEC were 100% and 90%, and agreement in both modalities was 0.93. Transthoracic echocardiography was unable to detect congenital anomalies in a few cases. CT angiography provides better imaging quality and anatomical coverage and can be used to improve diagnostic accuracy.*

**Keywords:** CT Angiography, Echocardiography, Congenital Heart Disease

### Introduction

Congenital heart disease (CHD) form a significant portion of cardiac disorders. Transthoracic echocardiography is the most commonly used non-invasive imaging technique (Öztürk et al., 2021). CHD includes cyanotic and a cyanotic heart defects and has an incidence of 1% (Enaba et al., 2017; Madsen et al., 2016). Transthoracic echocardiography allows high resolution functional and anatomic evaluation and is a portable and non-invasive technique (Semalti et al., 2022). However, it has limitations such as less accurate coronary and pulmonary artery definition, intra-cardiac anomalies, and great arteries (Dodge-Khatami and Adebo, 2021). In the past, CHD was diagnosed mainly through angiography. Now its application is limited due to invasive techniques, the need for general anesthesia, iodinated contrast material, and high radiation exposure (Krishna and Kumar, 2020). Advancements in technology have led to increased use of magnetic resonance imaging (MRI) and computed tomography (CT). CT, particularly multi-detector computed tomography (MDCT) and spiral CT angiography is used to diagnose thoracic

aortic diseases (Dong et al., 2020). A contrast, CT provides more valuable information compared to simple CT.

Moreover, dynamic CT is helpful in the assessment of cardiovascular blood flow. MDCT is a widely used imaging modality for detecting congenital malformations, traumatic aortic injury (TAI), atherosclerotic plaques, aortic intramural hematoma, aortic dissection, and aortic aneurysm (Wu et al., 2022). MDCT angiography is used for the evaluation of thoracic aortic anomalies. It is a non-invasive technique to assess esophageal or tracheal compression and vascular anomalies. It offers advantages like good temporal and spatial resolution, anatomical coverage, and multi-planar reformatting (Hart and Lee, 2020). However, it also has disadvantages like exposure to ionizing radiation, lack of hemodynamic information, and requirement of contrast material. Different studies have been conducted to analyze the pros and cons of angiography and echocardiography to assess aortic arch abnormalities (ELATAFY et al., 2019; Öztürk et al.,

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2021). However, there is scarcity of local data in this regard. Thus, the aim of this study is to do comparative evaluation of the findings of CT angiography and echocardiography in patients with aortic arch abnormalities.

**Methodology**

The retrospective study was conducted in the Department of Cardiology, Nishtar Medical Hospital Multan, from January 2021 to January 2022. Patients aged 1 week to 10 years with clinical or echocardiographic evidence of CHD were included in the study. Patients with renal disorder and sensitivity to contrast media were excluded. The study was conducted on a total of 200 patients. Informed consent of the participants was taken. The ethical board of the hospital approved the study.

Patient data was recorded, including demographic details and CT angiographic and echocardiographic findings. For CT imaging in patients < 7 years, anesthesia was performed; in those > 7 years, a CT scan was done without anesthesia. A contrast agent (visipaque) was injected at a speed proportional to the length of the CT scan (1-3 cc/s). CT image included the region from the mid of the neck to the iliac crest. Volume rendering (VR), maximum intensity projection (MIP), and multi-planar reconstruction (MPR) images were obtained from raw sections. Expert radiologists analyzed images.

SPSS version 23.0 was used for data analysis. Qualitative variables were presented as frequency and percentages.

**Results**

Of 200 participants, 96 (48%) were female, and 104 (52%) were male. Findings of transthoracic echocardiography (TEC) and CT angiography in patients with aortic arch anomalies are shown in Table I. Anomalies of coarctation of the aorta (COA) were

most commonly reported. Some patients had more than one anomaly. Three patients had anomalies of COA with ventricular arrhythmia (VA), 8 had coarctation along with tubular hypoplasia, 3 had COA along with aberrant right subclavian artery (ARSA), 1 had ARSA with VA anomaly, 1 had a hypoplastic arch and VA anomaly, 3 had a right-sided aortic arch with mirror image branching with VA anomaly, 2 had a cervical arch with tubular hypoplasia, 1 had a cervical arch with ARSA, 1 had right SCA with ARSA, 1 had right SCA with truncus arteriosus, and 2 had cervical arch with ARSA.

Of 200 patients, 66 (33%) had normal CT results, while 64 (32%) had normal transthoracic ECG results. In patients with ventricular anomaly originating from the arch, CT angiography showed that 12 had left VA and 2 had right VA, while transthoracic echocardiography did not detect this anomaly. In cases with interruption, CT detected 2 (1%) as type A, 1 (0.5%) as type B, and 2 (1%) as type C, while ECG showed 1 patient had type B and 1 had type C. The most common anomalies associated with aortic arch anomaly included patent ductus arteriosus (PDA), patent ductus arteriosus (PDA), and ventricular septal defect (VSD). For aortic arch anomalies, the specificity and sensitivity of TEC were 100% and 58%, and the agreement between CT angiography and TEC was .72 (Kappa coefficient). For COA, the specificity and sensitivity of TEC were 100% and 90%, and agreement in both modalities was 0.93. In patients with hypoplastic arch, the specificity and sensitivity of TEC were 100% and 55%, and agreement between both methods was 0.68. The right-sided aortic arch with mirror image branching specificity and sensitivity of TEC were 100% and 28.1%, and the agreement between both methods was 0.38. For interruption, the specificity and sensitivity of TEC were 100% and 75%, and agreement between both methods was 0.32. For truncus arteriosus, the specificity and sensitivity of TEC were 100% both, and the agreement between both methods was 1.

**Table I Comparison of CT Angiographic and Echocardiographic Findings in Patients with Aortic Arch Anomalies**

Type of Anomaly	CT angiography		Transthoracic echocardiography	
	Yes	No	Yes	No
Coarctation	38 (19%)	162 (81%)	34 (34%)	166 (83%)
VA originating from arch	14 (7%)	186 (93%)	0	200 (100%)
Tubular hypoplasia	9 (4.5%)	191 (95.5%)	0	200 (100%)
Aberrant right SCA	25 (12.5%)	175 (87.5%)	4 (2%)	196 (98%)
Hypoplastic arch	21 (10.5%)	179 (89.5%)	10 (5%)	190 (95%)
Right-sided arch with mirror image branching	36 (18%)	164 (82%)	10 (5%)	190 (95%)
Interruption	5 (2.5%)	195 (97.5%)	2 (1%)	198 (99%)
Cervical arch	4 (2%)	196 (98%)	1 (0.5%)	199 (99.5%)
Right-sided arch with aberrant left SCA	9 (4.5%)	191 (95.5%)	5 (2.5%)	195 (97.5%)
Bovine arch	1 (.5%)	199 (99.5%)	0	200 (100%)
Double aortic arch	1 (.5%)	199 (99.5%)	0	200 (100%)

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## Discussion

The current study evaluated the diagnostic role of transthoracic echocardiography and CT angiography for aortic arch anomalies. Coarctation and right-sided arch with mirror image branching were the most commonly reported anomalies. Moreover, common anomalies associated with aortic arch anomaly included patent ductus arteriosus (PDA), patent ductus arteriosus (PDA), and ventricular septal defect (VSD). Based on the data, the sensitivity and specificity of TEC were calculated. COA occurs due to the narrowing of the aorta, and its early diagnosis is significant for successful therapy. In this study, 19% of patients had COA. A previous study reported its incidence to be 6.5% (Verheijen et al., 2022). COA is the most frequent CHD, accounting for 7% of congenital abnormalities. It consists of focal stenosis that originates mostly from the aortic isthmus but can also be tubular. The second most common anomaly reported in our study was mirror image branching of the arch vessels (18%). Most patients had the right aortic arch pattern. A previous study reported that about 50% of patients with TA and 25% with tetralogy of Fallot had mirror images branching the right aortic arch (Tapia-Nañez et al., 2021). In the current study, 3 had COA along with ARSA. Aortic coarctation is usually associated with the aberrant subclavian artery. A previous study evaluated aberrant subclavian arteries using MDCT angiography. It reported that of 17 patients, 11 had aberrant right subclavian arteries originating from the left aortic arch, while 6 had aberrant right subclavian arteries originating from the left aortic arch (Schorn et al., 2021). An aberrant subclavian artery is usually associated with COA, patent ductus arteriosus, and intracardiac abnormality. In the current study, 54% of patients had PA, 42% had PDA, and 62% had VSD. A previous study reported that PA was the most commonly associated anomaly, with an incidence of 56% (Ahmed et al., 2021).

In the current study, CT angiography was more accurate than echocardiography for diagnosing VA and interruption. A previous study reported that MDCT angiography provides more accurate information regarding thoracic and vascular anomalies than other imaging modalities. It exhibits anatomical details and the relationship of vascular structures with adjacent organs (Recht et al., 2023). For aortic arch anomalies, the specificity and sensitivity of TEC were 100% and 58%, and the agreement between CT angiography and TEC was .72 (Kappa coefficient). A previous reported sensitivity, specificity, and accuracy of Doppler echocardiography to 28%, 97%, and 76.3%, respectively (Soleimantabar et al., 2019). For COA, the specificity and sensitivity of TEC were 100% and 90%, and agreement in both modalities was 0.93. It

suggests that both methods are equally good for the diagnosis of COA. However, a previous study suggested that CT angiography is the most accurate for assessing CHD, including COA (Shaaban et al., 2020). The limitation of this study is that it is a single-centered study; thus, results cannot be generalized.

## Conclusion

Transthoracic echocardiography was unable to detect congenital anomalies in a few cases. CT angiography provides better imaging quality and anatomical coverage and can be used to improve diagnostic accuracy.

## Conflict of interest

The authors declared absence of conflict of interest.

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