Original Article

Comparison of Diagnostic Accuracies of CT Angiography VS Echocardiography in Patients with Aortic Arch Pathologies

Farah Kalsoom, Mustafa Ali Siddiqi, Taha Khalil and Sehrish Khalid

ABSTRACT

Objective: To compare the findings of computed tomographic (CT) angiography with transthoracic echocardiography in patients with aortic arch pathologies.

Study Design: A retrospective, comparative study

Place and Duration of Study: This study was conducted at the Cardiology and Radiology, Ch. Pervaiz Elahi Institute of Cardiology Multan from May, 2020 to May, 2021.

Materials and Methods: The study enrolled patients who were indicated of having congenital heart disease through echocardiogram and clinical evaluation. These patients were then assessed of aortic arch anomalies through computed tomographic (CT) angiography and transthoracic echocardiography and their findings were compared.

Results: A total of 170 patients were included in the study, out of which 112 were male and 58 were female. The most prevalent anomaly among the participants was mirror image branching in the right aortic arch (22% detected by CT angiography vs 4.5% by TEC) followed by coarctation (20% vs 16%). The other aortic arch-associated cardiac anomalies were patent ductus arteriosus, pulmonary atresia, and ventricular septal duct. The two diagnostic techniques (kappa) had an agreement of 0.69 in detecting aortic arch pathologies. However, transthoracic echocardiography had a sensitivity and specificity of 52% and 100%, respectively when compared with computed tomographic angiography.

Conclusion: Transthoracic echocardiography is limited in detecting thoracic vessels and coronary artery abnormalities when compared with computed tomography angiography.

Key Words: Computed tomography angiography, transthoracic echocardiography, aortic arch pathologies, congenital heart defects, comparative study

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INTRODUCTION

Congenital heart diseases (CHDs) significantly contribute to cardiac issues in both children and adults. They affect about 1% of all births, including both cyanotic and acyanotic birth defects [1,2]. Transthoracic echocardiography is used as a primary, non-invasive diagnostic tool for the diagnosis and evaluation, both functional and anatomic, of CHDs[3]. This imaging technique is preferred for its non-invasive and portable nature and its ability to provide high-resolution physiological and anatomic data[4].

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However, it is also limited in terms of defining coronary arteries, pulmonary, and intra-cardiac abnormalities, accurately[5]. Previously, angiography was mainly considered for aortic anomalies and CHD but with time became less preferred due to certain limitations such as invasive nature, higher probability of exposure of radiations and contrast materials to neonates, and compulsion of general anesthesia before the process[6]. Thus, with advancements in the medical field, MRI and computed tomographic (CT) replaced simple angiography. In this regard, CT, particularly its latest generations Multi-detector CT (MDCT) and spiral CT angiography, is widely considered for diagnosing thoracic aortic disorders[7]. Usually, a simple CT is performed but in special cases where detailed information is required, CT with a contrast agent is more helpful. Moreover, dynamic CT is efficient in evaluating blood flow in CVS[8].

MDCT has currently used imaging modality for the detection of various thoracic aorta anomalies, such as atherosclerotic plaques, aortic dissection, aortic aneurysm, congenital deformities [9]. This non-invasive imaging technique is not only capable of detecting

vascular abnormalities but also diagnosing tracheal and esophageal compression[10]. It has been considered highly beneficial due to multiple characteristics such as high speed, excellent spatial resolution, great anatomical coverage, provision of the 3D image which bridges the resolution pitfall of CT [11]. However, it has some unavoidable disadvantages like the inability of providing hemodynamic data, the requirement of contrast material, and extreme exposure to ionizing radiations [10].

When compared with echocardiography, cardiac CT angiography has relatively lesser resolution but is believed to share advantages of multiple imaging techniques such as 3D imaging, high speed, great anatomical coverage, quick acquisition time, the ability of EDG synchronization which all lead to better diagnostic ability and limited risks for the patients [12]. Thus, the present study aims to compare the diagnostic capacity of transthoracic echocardiography and CT angiography in patients with aortic arch anomalies.

MATERIALS AND METHODS

A retrospective study was conducted at the cardiology and radiology department of Ch. Pervaiz Elahi Institute of Cardiology Multan for 1 year from 11th May 2020 to 11th May 2021. The study included patients whose clinical signs and transthoracic echocardiography confirmed the presence of CHD. Whereas patients who were sensitive to contrast agents or had inefficient renal systems were excluded from the study. All patients were informed of the study objective and written consent was sought. Similarly, ethical permission was taken from the ethical review committee of the hospital. All patients were investigated for demographics and baseline characteristics through a self-investigated questionnaire. It was then followed by the conduction of CT angiography by an experienced radiologist. The patients in our study ranged from 1 month to 10 years old children. Following the protocol, children less than 7 years of age were given anesthesia whereas in older subjects CT scan was carried out without anesthesia. Visipaque was used as a contrast agent in a dose of 2-2.5 cc/kg. The speed of injecting contrast was kept proportional to the length of the scan. Body sections in between the mid-neck line and iliac crest were scanned.

Statistical Analysis: SPSS (version 20) was used for statistical analysis. The data were presented as relative frequency and percentage.

RESULTS

The study included a total of 170 patients with CHD. Out of which, 112 (65.8%) were male and 58 (34.1%) were female. The median age of the patients was 2 years. Table I represents the congenital aortic arch anomalies detected by transthoracic echocardiography (TEC) and CT angiography. The most prevalent anomaly among the participants was mirror image branching in the right aortic arch (22% detected by CT angiography vs 4.5% by TEC) followed by coarctation (20% vs 16%). In some cases, two or more simultaneous anomalies were simultaneously diagnosed: ventricular arrhythmias (VA) with coarctation (9 patients, 5.2%), tubular hypoplasia with coarctation (6 patients, 3.5%), right subclavian artery anomaly with coarctation (5 patients, 2.9%), cervical arch with coarctation (3 patients, 3.5%), VA with cervical arch (2 patients, 1.17%), VA with right subclavian artery anomaly (3 patients, 3.5%), tubular hypoplasia with subclavian artery anomaly (2 patients, 1.1%), cervical arch with tubular hypoplasia (1 patient, 0.5%) interruption with hypoplastic arch (2 patients, 1.1%). Ventricular arrhythmia was not detected in any patient through TEC against 6 patients found by CT. Among those 6 patients, 2 (33.3%) demonstrated left VA left-sided arch while 4 (66.6%) showed right VA. Based on CT findings, 2 cases (3.2%) had an interruption of Type A and B, each while the single diagnosed case of interruption TEC was of Type B.

Table No.1: Aortic arch anomalies diagnosed by CT angiography and Transthoracic echocardiography (n=70)

Aortic arch anomaly	CT angiography (n=70)		Transthoracic echocardiography (n=70)	
	Yes (n, %)	No (n, %)	Yes (n, %)	No (n, %)
Coarctation	14 (20%)	56 (80%)	11 (16%)	61 (89%)
Ventricular arrhythmia	6 (8.6%)	64 (91.4%)	0 (0%)	70 (100%)
Tubular hypoplasia	4 (5.2%)	66 (94.8%)	0 (0%)	70 (100%)
Mirror imaging branching in right-sided arch	15 (22%)	55 (78%)	5 (4.5%)	65 (95.5%)
Interruption	2 (3.2%)	68 (96.8%)	1 (1.4%)	69 (98.3%)
Cervical arch	2 (3%)	68 (97%)	1 (1.4%)	69 (98.3%)
Bovine arch	1 (2%)	69 (98%)	0 (0%)	70 (100%)
Double aortic arch	1 (2%)	69 (98%)	0 (0%)	70 (100%)

Table 2 presents the cardiac-related anomalies in patients with aortic arch anomalies. Among the detected anomalies, patent ductus arteriosus (46, 65.4%), pulmonary atresia (43, 62.1%), and ventricular septal defect (26, 38.3%) were the most prevalent among the enrolled patients. The two diagnostic techniques (kappa) had an agreement of 0.69 in detecting aortic arch pathologies. However, transthoracic echocardio-

graphy had a sensitivity and specificity of 52% and 100%, respectively when compared with computed tomographic angiography.

Table No.2: Cardiac associated anomalies in patients with aortic arch pathologies (n=70)

Related cardiac anomaly	Yes (n, %)	No (n, %)
Pulmonary atresia	43 (62.1%)	27 (37.9%)
Ventricular septal defect	26 (38.3%)	44 (61.7%)
Patent ductus arteriosus	46 (65.4%)	24 (34.6%)
Atrial septal defect	10 (14.3%)	60 (85.7%)
Transposition of the great arteries	9 (13.2%)	61 (86.8%)
Double inlet left ventricle	1(1.4%)	69 (99%)
Double outlet right ventricle	3 (4.7%)	67 (95.3)
Dextrocardia	2 (3.3%)	68 (96.7%)

DISCUSSION

The present study evaluated the comparative roles of CT angiography and transthoracic echocardiography in detecting aortic arch anomalies. The most prevalent anomaly among the participants was mirror image branching in the right aortic arch followed by coarctation. Moreover, the most common associated cardiac anomalies were patent ductus arteriosus, pulmonary atresia, and ventricular septal defect. The collected data were used to calculate the sensitivity and specificity of TEC. Coarctation is a congenital heart defect that results from narrowing of the aorta which can resent as an isolated abnormality or in association with multiple other lesions. Thus, the early accurate detection of the anomalies is very important to opt for an accurate therapeutic strategy.

In this regard, multiple non-invasive methods, including MRI, CT, and transthoracic echocardiography are used. TEC is a safe and accessible method that is mainly used as a screening technique. It can also be used for intraoperative assessments or in hemodynamic studies, but CT is mostly preferred before finalizing any therapeutic approach or any surgical method. Darabian et al. reported excellent diagnostic capacity of cardiac CT in their study revealing its high spatial resolution and great power to detect associated anomalies [13].

Our study has found mirror-image branching of the right aortic arch as was the most common anomaly found among the patients. Literature also supports and found mirror-image branching of the right aortic arch in 95% of cases. In previous studies, 25%-50% of patients with truncus arteriosus and 25% of patients with truncus arteriosus presented with mirror-image branching of the right aortic arch [14]. The second most prevalent anomaly is coarctation, affecting 20% of patients. Abbruzzese and Aidala, however, reported 6.5% of patients affected by aortic coarctation among participants of CHD [15]. It is the most frequently noted CHD, accounting for about 7% of all inherited cardiac lesions. This anomaly is characterized by focal stenosis found at the aortic isthmus; however, it can also present in tubular fashion [15].

In the above-mentioned study, patent ductus arteriosus (46, 65.4%), pulmonary atresia (43, 62.1%), and ventricular septal defect (26, 38.3%) were the most prevalent among the enrolled patients. A study evaluated the role of 16-slice CT angiography in characterizing the anatomic features of pathological subclavian arteries [10]. The study reported that 11 patients presented with atypical right subclavian artery generating from the left aortic arch, 6 had atypical left subclavian artery generating from the right aortic arch, 3 had kommerell's diverticulum, and 2 patients had an aneurysm [10].

In our study, 5 patients had atypical right subclavian artery with coarctation. The pathological state in the left subclavian artery arises from interruption between the left subclavian artery and left carotid artery in forming a double aortic arch. Generally, left-sided aortic arch along with the right subclavian artery is the most reported aortic arch pathology, affecting about 0.5-2% of individuals. CT angiography.

CT angiography is appraised as an authentic and non-invasive imaging modality owing to its advantages such as easy availability, quick acquisition time, and excellent spatial resolution. Therefore, it is the preferred imaging technique for the evaluation of thoracic and vascular anomalies. The ability allows the effective evaluation of congenital abnormalities. TEC is the initial screening technique in patients but it is sometimes limited in the detection of pathologies of thoracic vessels and aortic arch. Moreover, despite having great anatomical coverage and its capacity for great functional evaluation, it might have limited applicability in non-responsive patients [16, 17].

The two diagnostic techniques (kappa) had an agreement of 0.69 in detecting aortic arch pathologies. However, transthoracic echocardiography had a sensitivity and specificity of 52% and 100%, respectively when compared with computed tomographic angiography which demonstrates the limited capacity of TEC in comparison to CT.

The study is limited in terms of limited sample size and inability to assess these evaluated techniques monitoring the intraoperative surgical situation in patients with cardiac anomalies. Therefore, it is suggested to conduct further studies to assess not only the diagnostic capacity of imaging techniques but also their role in monitoring the disorders.

CONCLUSION

Transthoracic echocardiography is limited in detecting thoracic vessels and coronary artery abnormalities when compared with computed tomography angiography.

Author's Contribution:

Concept & Design of Study:	Farah Kalsoom
Drafting:	Mustafa Ali Siddiqi, Taha Khalil
Data Analysis:	Taha Khalil, Sehrish Khalid
Revisiting Critically:	Farah Kalsoom, Mustafa Ali Siddiqi
Final Approval of version:	Farah Kalsoom

Conflict of Interest: The study has no conflict of interest to declare by any author.

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