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The Potential Benefit of Multi- Detector Computed Tomography for The Diagnosis of Pediatric Congenital Heart Diseases

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ABSTRACT

Background: For the diagnosis of congenital heart disorders (CHDs), echocardiography and catheter angiography are the two main cardiac imaging techniques. Yet, each modality has its limitations and drawbacks. Modern developments in multidetector computed tomography (MDCT) methods have been made in response to the rising frequency of CHDs. These techniques aid in the confirmation of the diagnosis, offer more specific information about the CHDs, and aid in the preoperative evaluation.

Objective: The aim of the current study is to evaluate the potential benefit of MDCT for the diagnosis of pediatric CHDs.

Patients and methods: A prospective study included 100 patients of pediatric age group presented to Radiology Department at Zagazig and Menoufia Universities by different clinical picture. All patients underwent MDCT and echocardiography (either transthoracic or transesophageal), while only 40 patients underwent invasive catheterization/operation.

Results: MDCT was superior to echo in detecting sinus Venus and unroof coronary atrial septal defect (ASD) while echo was superior in other types, Echo detected ventricular septal defects (VSD) in 43 cases while MDCT in 37cases. MDCT was superior in detection pseudo-coarctation, major aortopulmonary collateral arteries (MAPCAS), peripheral pulmonary stenosis, venous anomalies as well as coronary arteries anomalies. The agreement between MDCT and echo was very good in truncus arteriosus, good in aortic coarctation, moderate in aortic arch abnormalities and left SVC while being fair in persistent left SVC and anomalous pulmonary venous return (APVR).

Conclusion: An important non-invasive diagnostic method for assessing congenital cardiac and extra cardiac great vessels is MDCT. Cardiovascular MDCT is an adjunct to cardiac echocardiography, particularly in complicated heart problems.

Keywords: MDCT, Echo, CHDs, Catheterization, MAPCAs.

INTRODUCTION

Being one of the most prevalent congenital anomalies, congenital heart disease (CHD) affects 4-10/1000 live births. It is a major factor in both morbidity and death [(1)]. It is often characterized as a clinically significant, gross anatomical anomaly of the heart or intrathoracic great vessels that is, or may become, functionally significant [(2)].

The two main heart imaging methods are echocardiography and catheter cardio-angiography; however, both have drawbacks. Echocardiography's primary drawbacks are its restricted field of view, acoustic window, and operator dependence [(3)]. Limitations of catheter cardio-angiography include the overlap of nearby vascular structures, the challenge of simultaneously displaying the systemic and pulmonary vascular systems, catheter-related complications (especially in young children), and relatively high doses of ionizing radiation and iodinated contrast material [(4)].

The cardiac applications of CT have significantly risen as a result of recent breakthroughs in CT methods, which are distinguished by quicker speed, longer anatomic coverage, a more flexible ECG-synchronized scan, and a lower radiation dosage. CT is now being used more and more for congenital heart disease assessment. It's crucial to reduce the radiation exposure caused by CT, especially for youngsters [(5)].

A cardiac CT scan gives hemodynamic information in addition to anatomical information, including information on extracardiac and intracardiac shunts as well as valvular disorders [(1)]. It also makes it possible to thoroughly examine other thoracic structures such the heart, lungs, and airways. The vascular and airway structures are distinguished utilizing highest and lowest intensity projections, respectively, to achieve this. The utilization of cardiac CT scans in children with CHDs can be improved by examining extra-cardiac big arteries throughout their length [(6)].

This study aimed to evaluate the potential benefit of multidetector computed tomography (MDCT) for the diagnosis of pediatric congenital heart diseases.

PATIENTS AND METHODS

A prospective study included 100 patients of pediatric age group presented to Radiology Department at Zagazig and Menoufia Universities by different clinical picture, from February 2021 to August 2022. Patients were referred from Pediatric Departments and outpatient clinics for suspecting CHDs.

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Inclusion Criteria: The study included pediatric patients (up to 18 years old) and patients with suspicious or clinically/echocardiographically known to have CHD.

Exclusion Criteria: Patient unwilling, allergy to contrast media and renal insufficiency (creatinine level ≥1.6 mg/dL).

The patients presented with one or more of the following signs and symptoms, chest symptoms, cyanosis, and delayed milestones.

All patients were subjected to demographic data recording, thorough clinical history taking, full data from Echocardiographic findings, and weighing the patient to determine the appropriate amount of contrast media and sedative substance.

Before the examination:

Instructions were given to fast 4-6 hours before the test, thereafter placement of a peripheral venous line in the great saphenous vein or the antecubital vein of the right upper leg. Children under the age of five who were recalcitrant received intravenous Midazolam diluted at a dose of 0.1 mg/kg before the scan or 10% chloral hydrate, at a dose of 50 mg/kg, 30 min before MDCT scanning. Older youngsters merely need to hold their breath throughout the acquisition to increase the quality of the image.

A programmable power injector pump was used to provide non-ionic contrast medium (Omnipaque 350) at a flow rate of 2-3 ml/s into the right antecubital vein in 90 patients and the great saphenous vein in 10 patients with unsuccessful antecubital vein cannulation. At the same pace, a (20–30 ml) saline chaser bolus was administered.

Image acquisition:

All CT examinations were performed using two 128 multi-detector CT scanners (Philips health care& GE health care, Revolution Evo). The following parameters were used during cardiac CT scanning: Tube current 50–100 mA (depends on body weight: 10 mA/kg BW), Tube voltage: 80–100 kV, thin detector collimation >1 mm, Pitch value of less than 1, slice thickness 0.5mm, slice interval 0.25 with rotation time 0.35sec (gantry speed) and wide field of view.

Technique:

The patients were positioned headfirst in the center of the CT gantry while lying flat. The patient had ECG leads positioned on his or her chest. Where it was possible, patients older than 6 months of age were positioned with their arms over their heads while infants less than 6 months of age were laying with their arms at their sides or above their heads for picture capture.

The center of the AP scout is 2 cm to the left of the dorsal spine, with the field of vision extending from the thoracic inlet to 1 cm below the diaphragm. We adopt a manual real-time bolus tracking approach; the capture begins when contrast opacification of the aorta and pulmonary arteries is accomplished since the ideal timing of image collection is challenging due to the aberrant hemodynamic condition in CHD. Throughout the scanning, an ECG was captured concurrently. The calcium score is incomplete.

Image reconstruction:

The axial source pictures were examined first in the CT scans. A comprehensive reconstruction was performed to get the data using cutting-edge off-line Philips and GE workstations, using the obtained axial pictures at various times of the cardiac cycles. These images were rebuilt with 0.6 mm slice thickness. To assess the intra-cardiac structures, vessels (veins and arteries), and other thoracic or upper abdominal structures, axial pictures were thoroughly reviewed.

Other reconstruction techniques included the following:

- 3D volume rendering (3D-VR) offers a vascular image made up of the amount of contrast that fills the vessel's lumen, making it easier to identify the source, course, and typical variations of the vessels.
- Multiplanar reconstruction (MPR): This technique provides sections of the vessels in a variety of orientations by identifying the vessel's center through a series of axial pictures. This method allows for a clear view of the vessel's lumen and wall, permitting a thorough investigation of the vessels.
- Maximum intensity projection (MIP): Used to draw attention to the vascular system.

Strategies for reduction of radiation exposure:

Using Tube currents of 50–100 mA (depending on body weight: 10 mA/kg BW), 80–100 kV, fast table speeds of more than one second, thin detector collimations of more than one mm, and pitch values of less than one, CT scan dose parameters were individually adjusted to body habitus and dose-saving techniques for reducing radiation exposure (0.6).

Echocardiographic examination: by using Vivid 9, GE Vingmed, Norway equipped with a (1.7 – 4 MHz and 2.7 – 8 MHz) phased-array transducers.

Transthoracic Echocardiographic Examination: Routine M-mode, two dimensional and doppler echocardiography were recorded for all subjects. Standard parasternal, apical, suprasternal, and Subcostal views were used.

Transesophageal Echocardiographic Examination: Standard upper esophageal, mid esophageal and trans gastric views were used.

Interpretation of the study: Two distinct radiologists each provided their interpretation of the CT scan. About the results of the echocardiogram, they were blind. Three letters "S, D, S" (three stages) were employed to characterize the viscero-atrial situs (1st letter: S), ventricular looping (2nd letter: D), and location and relation of the major vessels (3rd letter: S) in Van Praagh's systematic approach to congenital heart disease [(7)]. The third radiologist compared the results of the CT and Echo scans.

Ethical Approval:

This study was ethically approved by the Ethics Committees of the Zagazig and Menoufia universities. Informed consent was obtained from all patients' parents after full explanation of the benefits and risks of the procedure. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

The collected data were introduced and statistically analyzed by utilizing the Statistical Package for Social Sciences (SPSS) version 20 for windows. Qualitative factors like gender and the direction of the heart apex were characterized in terms of frequencies. The correlation or link between two or more dichotomous categorical variables was examined using Chi square Test (X^2). When more than 25% of the cells had an anticipated count of less than five, the Fisher exact test was used to 2x2 qualitative variables.

When there are two raters, Cohen's kappa (K) was used as a gauge of inter-rater agreement for categorical variables (Echo and MDCT) Area under the curve (AUC) was used to determine how well the MDCT can discriminate between juvenile congenital cardiac disorders that are positive and those that are not.

The AUC might be between 0 and 1. MDCT performed better at accurately diagnosing the illnesses the higher the AUC. Calculations were made to determine the sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy. P value ≤0.05 was considered to be statistically significant.

RESULTS

Our study involved 100 patients (68 males and 32 females). Their ages ranged from 1day to 18 years old with 76.0% of the studied children were under one year old. The sedation was used in most of patients representing 86% as most of patients were less than 5 years old.

Echo had the upper hand in detecting ostium secundum and ostium primum atrial septal defect types while MDCT was superior in detection of other types of ASDs (sinus venosus and unroofed coronary sinus), There was very good agreement between MDCT and Echo for ASD detection with AUC was 0.898 **(Table 1)**.

Table (1): ASD types among the studied children.

Parameter	Multi-detector CT	Echo	Test of significance	***P*-Value**	k(p)	AUC
	No.	No.				
Ostium secundum ASD	13	15	$\chi2$= 176.975	MC *p* <0.001	0.908* (<0.001*) very good	0.898
Ostium primum ASD	10	12				
Sinus venosus ASD	8	3				
Coronary sinus ASD	3	0				

χ^2: **Chi square test**. MC: **Monte Carlo**. *: Statistically significant at p ≤ 0.05. K: **Kappa.** AUC: Area under Curve.

There were significant differences between MDCT and Echo in detection of different types of ventricular septal defect in the studied children (P <0.001) as MDCT was able to detect 17 patients with Type II (subaortic) in comparison to Echo that detected 20 patients for the same type (Type II subaortic). **Table 2** summarizes MDCT sensitivity, specificity, positive predictive value, negative predictive value, and accuracy. The agreement between MDCT and echo for VSD detection was very good (Kappa = 0.898, P <0.001) with AUC was 0.968.
In the current study, there were not significant differences between MDCT and Echo in detection of other intra-cardiac abnormalities including Patent foramen ovale, AVSD, single atrium, cortriatrium, single ventricle and RVOTO in the studied children (P >0.05). The agreement between MDCT and Echo for PFO detection was good (Kappa = 0.737, P <0.001) with AUC was 0.813.

Table (2): The agreement between Echocardiography and Multi-detector CT in detection of VSD types among the studied children.

Variable	**VSD Echo and catheterization**				**Sensitivity**	**Specificity**	**PPV**	**NPV**	**Accuracy**	**AUC**
	Negative		**Positive**							
	No.	**%**	**No.**	**%**						
VSD MDCT	**(n = 57)**		**(n = 43)**							
Negative	57	100	6	14	86.05	100	100	90.48	94	0.968
Positive	0	0.0	37	86						
k(p)	0.898* (<0.001*) Very good				-----					

There were no significant differences between MDCT and Echo in detection of coarctation of aorta, Patent ductus arteriosus and over-riding aorta in the studied children while there were significant differences between MDCT and Echo in detection of pseudo-coarctation of aorta and aortic arch abnormities. Echocardiography was unable to identify any patients with pseudo-coarctation of the aorta, whereas MDCT was able to identify six patients with the condition. There was moderate agreement between MDCT and Echo for aortic arch abnormalities detection was moderate**.** In the present study, there were significant differences between MDCT and echo in detection of Peripheral Pulmonary stenosis and MAPCA. There was moderate agreement between MDCT and Echo in diagnosis of peripheral pulmonary stenosis. Echo was able to identify 5 cases with Peripheral Pulmonary stenosis while MDCT was able to diagnose 11 cases there was very good agreement between MDCT and Echocardiography in diagnosis of truncus arteriosus (Kappa = 0.947, P <0.001, with AUC of 0.994) **(Table 3).**

Table (3): Arterial vascular abnormalities among the studied children

Parameter	**Multi-detector CT**	**Echo**	**Chi square**	***^{FE}P* value**
	No 100 100%	No 100 100%		
Coarctation of aorta	12 (12)	11(4)	0.0491	0.824 K(*P*) = 0.754* (<0.001*) good
Pseudo-coarctation of aorta	6 (6)	0 (0.0)	6.186	0.029
PDA	18 (18)	18 (18)	0.000	1.000
Overriding aorta	22 (22)	22 (22)	0.000	1.000
Aortic arch abnormities' No Bovine arch Double aortic arch Gothic arch Interrupted arch Right sided arch	 72 (72) 12 (12) 2 (2) 4 (4) 8 (8) 2 (2)	 88 (88) 4 (4) 1 (1) 1 (1) 4 (4) 2 (2)	31.06	MC *p* <0.001 K(*P*) = 0.51(0.001) Moderate agreement
Peripheral Pulmonary stenosis	11 (11)	5 (2)	6.663	0.009* K(p) = 0.594* (<0.001*) moderate
Transposition of great vessels D-TGA L TGA	 13 (13) 7 (7)	 13 (13) 7 (7)	0.000	1.000
Truncus arteriosus	11 (11)	10 (10)	0.0532	0.817 K(p)=0.947* (<0.001*) very good

χ^2: **Chi square test.** MC: **Monte Carlo.** *: Statistically significant at p ≤ 0.05. K: Kappa.

Table 4 summarizes MDCT and Echo sensitivities, specificities, PPVs, and NPVs. In this study MDCT was able to detect anomalous pulmonary venous return with sensitivity (100%), specificity (100%), PPV (100%), and NPV (100%) while echo in comparison with invasive techniques showed sensitivity (20%), specificity (100%), PPV (100.0), and NPV (91.84). There was fair agreement between MDCT and Echocardiography (Kappa = 0.310, P 0.004, with AUC of 0.959). There was fair agreement between MDCT and Echocardiography in detecting (persistent left superior vena cava) (Kappa = 0.342, P 0.001, with AUC of 0.964). Echo was able to detect 2 patients with sensitivity (22.22%), specificity (100%), PPV (100%), and NPV (92.86%) (**Table 4**).

Table (4): The Sensitivity, specificity, positive and negative predictive values, and accuracy of MDCT and Echo in assessment various vascular anomalies.

Anomalies	Sensitivity	Specificity	PPV	NPV	Accuracy	KP (between echo and MDCT)
MAPCAS						
MDCT	100	100	100	100	100	0.516* (0.004*)
Echo	40	100	100	86.96	88	moderate
APVR						
MDCT	100	100	100	100	100	0.310* (<0.001*)
Echo	20	100	100	91.84	92	fair
PLSVC						0.342* (<0.001*)
MDCT	100	100	100	100	100	fair
Echo	22.22	100	100	92.86	93	
Left sided SVC.						
MDCT	100	100	100	100	100	0.435* (<0.001*)
Echo	30	100	100	2.78	93	moderate

In this study, there was moderate agreement between MDCT and Echocardiography in diagnosis of left sided SVC (Kappa = 0.435, P 0.004, with AUC of 0.976). Our study showed that Echo was able to identify origin anomalies of coronary artery in 7 cases while MDCT was able to identify the origin anomalies in 12 cases. Transthoracic echo was unable to identify proximal course abnormalities, while MDCT was able to identify three patients with prepulmonic course and 5 patients with retroaortic course (**Table 5**).

Table (5): Coronary artery abnormalities among the studied children.

Parameter	Multi-detector CT	Trans thoracic Echo
	No 100	No 100
Origin anomalies		
Anomalous origin from opposite or non-coronary sinus	8	6
High take-off	3	1
Single coronary artery	1	0
Proximal course abnormalities		
Prepulmonic course	3	0
Retroaortic course	5	0

CASE 1

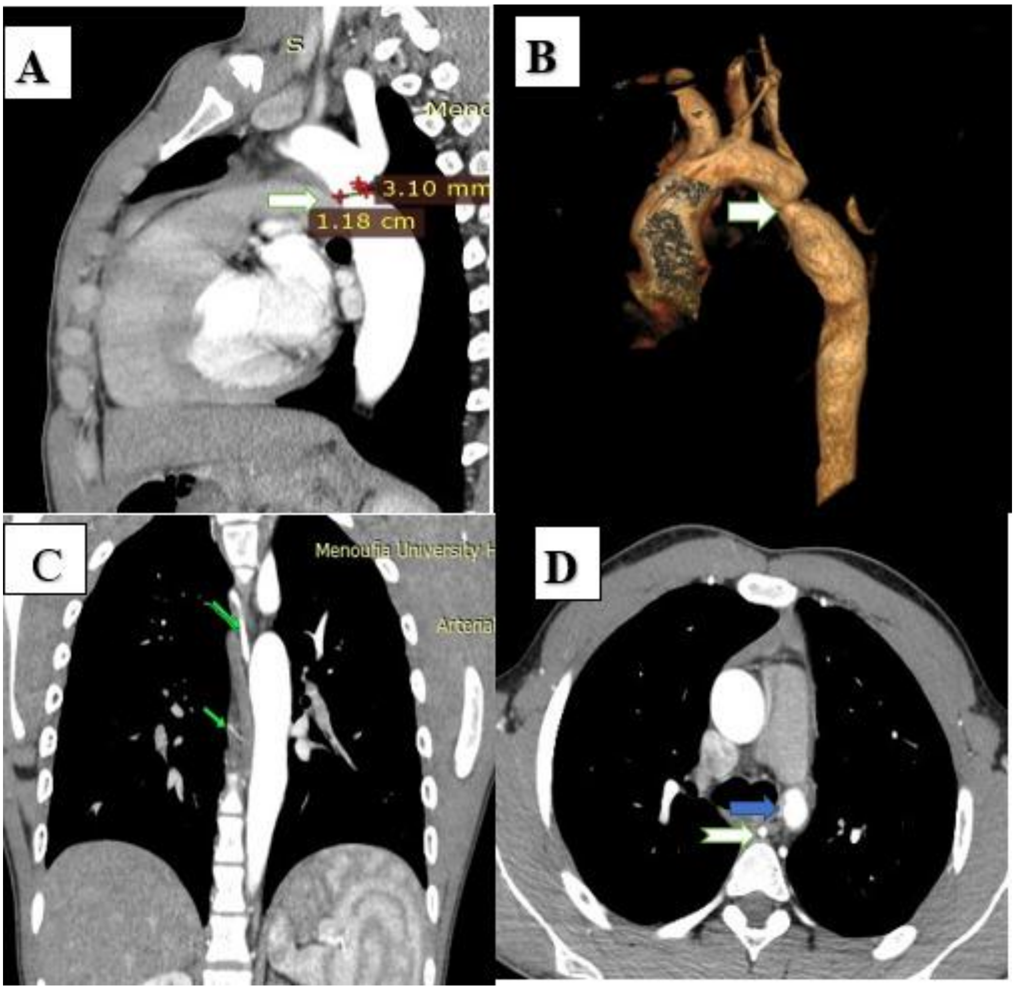

Figure (1): A 15-year-old male presented by shortness of breath, unexplained high blood pressure with chest pain. TTE detected the coarctation with significant pressure gradient across the coarctation.

CT findings: Sagittal image (A) and VR image (B): Aortic coarctation (white arrows) is seen 3.1mm distal to the origin of left subclavian artery, it measures about 12 mm at its width and1.2mm at its length. **Coronal image (C):** Few collaterals from intercostal arteries supplying descending aorta distal to site of coarctations. **Axial image (D):** Aortic narrowing (coarctation) (blue arrow) with collaterals (white arrow).

CASE 2

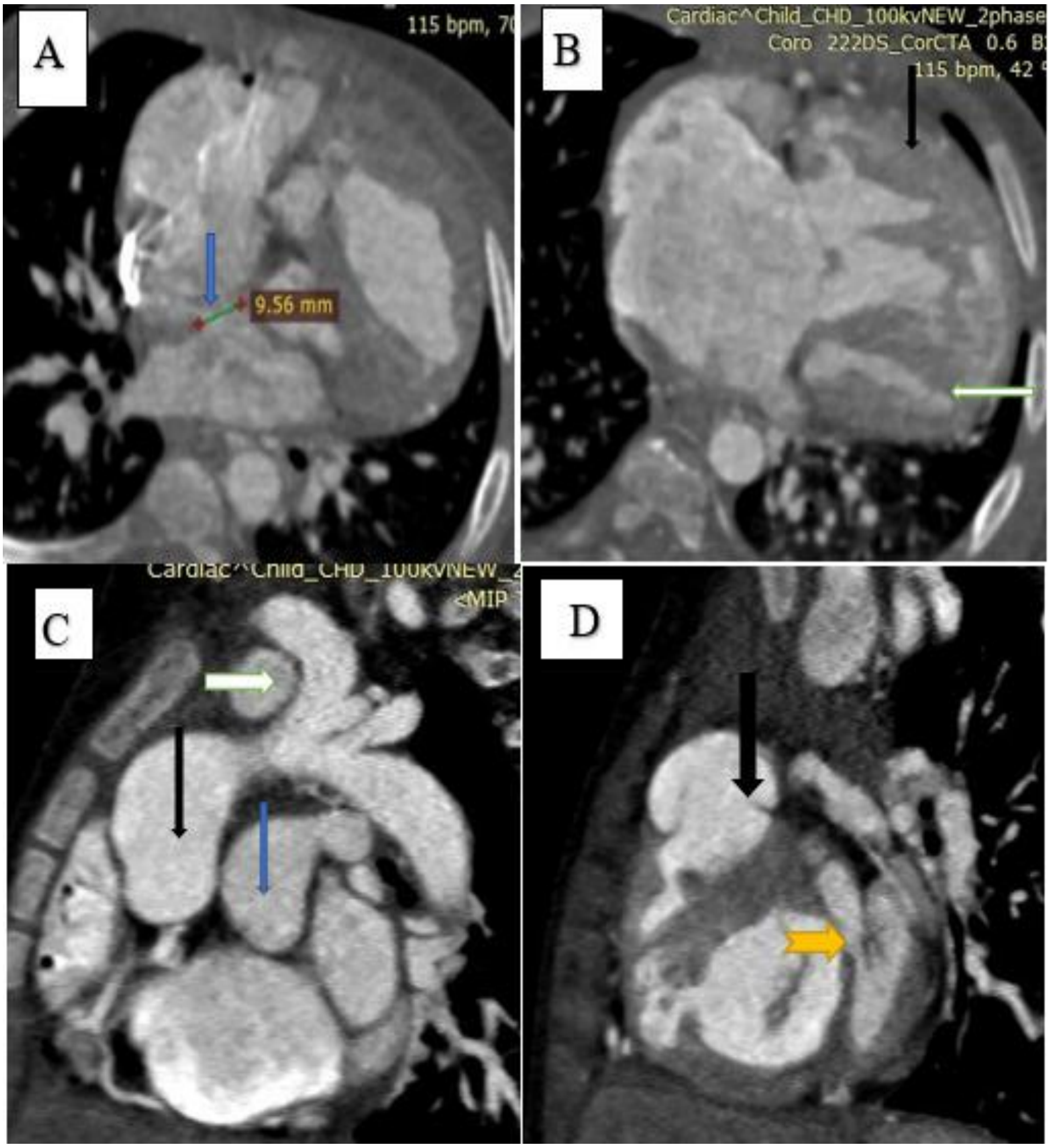

Figure (2): A 7-year-old male child presented by congestive heart failure (tiredness, breathing troubles and poor growth). TTE detected secundum ASD, VSD, dilated right side with pulmonary hypertension.

CT findings: Axial images (A &B): Secundum ASD measures about 10mm (blue arrow). Sinus venosus ASD measures about 11.2mm (black arrow). Outlet VSD measures about 6.1mm (white arrow). **Axial image (C):** Pulmonary hypertension: Dilated pulmonary trunk measures about 30.1mm. Rt pulmonary artery (mid portion): 21.6mm. Left pulmonary artery (mid portion) 21.3mm. **Axial image (D):** Dilated right atrium (64mm) and right ventricle (55mm).

CASE 3

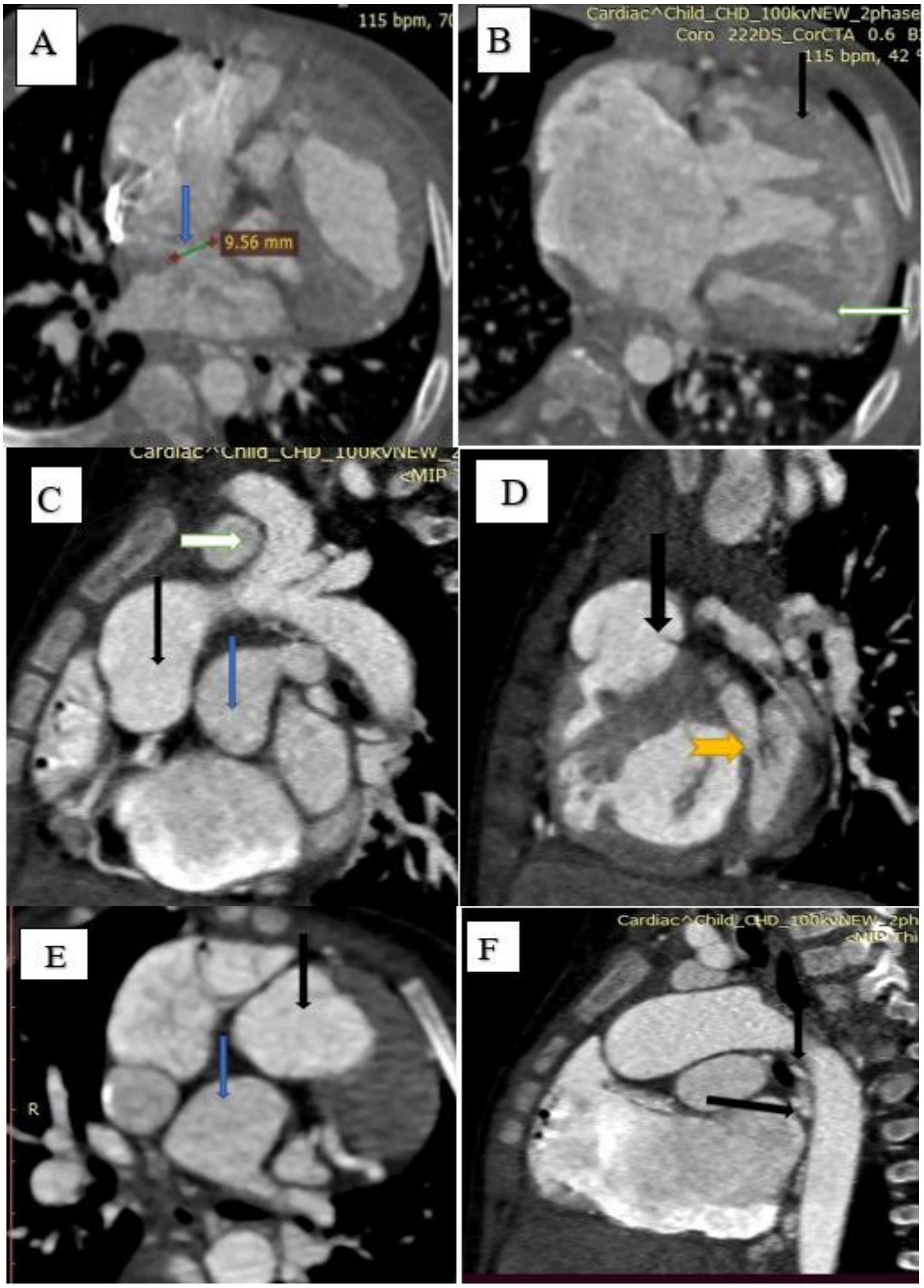

Figure (3): Two weeks old male infant presented by cyanosis and poor feeding. TTE showed D-TGA, ASD and subvalvular pulmonary stenosis.

CT findings: Axial image (A): Secundum ASD measures about 9.5mm. **Axial image (B):** Dilated right atrium with dilated hypertrophied right ventricle (black arrow) and small sized left ventricle (white arrow)**. Sagittal images (C&D) & axial image (E): -D TGA:** Aorta (black arrow) arises from right ventricle with bovine arch. Main Pulmonary artery (blue arrow) arises from left ventricle. -Subvalvular pulmonary stenosis (RVOTO) (yellow arrow). -Great vessels Malposition: aorta right and anterior to PA. **Sagittal images** (F): Multiple MAPCAs (black arrows) with one large MAPCA arising from the right aspect of the descending aorta 1.5 cm below the carina. Dilated aortic root, ascending aorta, and arch.

DISCUSSION

The current study compared MDCT findings with previous echo findings in different types of congenital heart diseases of all patients. Some of these vascular findings were confirmed by invasive techniques such as cardiac catheterization and corrective surgeries.

In the current study, MDCT detected unroofed coronary sinus ASD while echo could not detect any case. **Mehlman *et al.*** [8] and **Goo *et al.*** [9] stated that cardiac CT was an excellent diagnostic modality for coronary sinus ASD given its excellent visuospatial capabilities however it can be often missed by TTE.

Our study showed very good agreement between MDCT and Echo for ASD detection (Kappa = 0. 908, P <0.001) with area under the curve was 0.898. **Ali *et al.*** [1] and **Ali *et al.*** [10] agreed with the current study, and they stated that there was very good agreement between MDCT and Echo in detecting ASD, VSD, and combined ASD and VSD where k 0.851. However**,** **Saad *et al.*** [11] demonstrated that Echo was more effective than MDCT at detecting ASD, ASD, and septal aneurysms.

In the current study, the agreement between MDCT and echo for VSD detection was very good (Kappa =0.898, P <0.001) with AUC was 0.968 [MDCT sensitivity (86.05%), specificity (100.0%), PPV (100.0), NPV (90.48) and accuracy (94.0%)]. This was in concordance with **Ali *et al.*** [1] who revealed that there was overall very good agreement between Echo and MDCT in detecting VSD where k measuring 0.80. **Also, Shehata *et al.*** [12] revealed that MDCT was not as effective in diagnosing VSD as TTE. TTE and MDCT, when used to evaluate VSD, had sensitivity, specificity, accuracy, PPV), and NPV of 95.8%, 100%, 98.2%, 100%, and 100%, respectively.

These disagreed with **Saad *et al.*** [11] and **Leschka *et al.*** [13] who reported that echocardiography plays the main role in diagnosing atrioventricular septal defects; while CT has only a minor role and usually misses the small communications. This difference may be attributed to the non-gated CT examination.

In the current study, MDCT and Echo were equal in detecting of other intra-cardiac abnormalities including PFO, AVSD, single atrium, cotri-atrium, single ventricle and RVOTO .These findings agreed with **Öztürk *et al.*** [14] **and Bu *et al.*** [3] they found that the identification of various intra-cardiac anomalies, such as single ventricle, dextrocardia, cor triatrium sinistrum, and RVOTO, did not show any discernible differences between MDCT and Echo.

In contrast **Saad *et al.*** [11] who showed that there were significant differences between MDCT and Echo in detection of other intra-cardiac abnormalities and also **Halim *et al.* study** [15] which stated that, generally, echocardiography outperformed magnetic resonance imaging in the detection of cardiac abnormalities, particularly those involving the atrial septum, such as PFO, ASD, and ASA.

The present study showed that Echo had the upper hand in detecting PFO with good agreement between MDCT and Echo (Kappa =0.737, P <0.001) with area under the curve was 0.813. This agreed with **Saad *et al.*** [11] and **Shehata *et al.*** [12] which revealed that Echo was superior to MDCT in detecting PFO,

Nevertheless, **Kara *et al.*** [16] shown that MDCT was a more practical and effective alternative to TTE for PFO diagnosis, with sensitivity and specificity of 100% and 78%, respectively.

The current study showed that both echo and MDCT were able to detect various arterial anomalies including coarctation of aorta, PDA and over-riding aorta. However, MDCT was superior in diagnosing pseudo coarctation and aortic arch abnormalities. These results agreed with **Öztürk *et al.*** [14] which showed that there was no difference in the accuracy of both MDCT and Echo in coarctation of aorta detection. However, the same study revealed that MDCT was superior to Echo in detecting PDA.

The current study was close to **Abdullah *et al.*** [17] and **Saad *et al.*** [11]. They revealed that there was significant difference between MDCT and Echo in diagnosing of Pseudo-coarctation of aorta however MDCT was superior to echo in the diagnosis of PDA. However, according to **Leschka *et al.*** [13]**,** MDCT has a limited role and TTE is the preferred approach for detecting PDA.

The current study matched with **Shehata *et al.*** [12]**, Ali *et al.*** [10] and **Ou *et al.*** [18] who stated that the recommended imaging method for aortic abnormalities was MDCTA.

The current study showed good agreement between MDCT and echo for Coarctation of aorta detection (Kappa =0.754, P <0.001) with area under the curve was 0.813. **Ali *et al.*** [1] **revealed** that there was overall moderate agreement between Echo and MDCT in detecting Aortic abnormality where k measuring 0.535 with overall sensitivity of MDCT (100%) which was higher than Echo (91%).

Shehata *et al.* [12] and **Saad *et al.*** [11] revealed that there were not significant differences between MDCT and Echo in detection of heart-vascular communication impairments. And also detect aberrant subclavian artery only detected by MDCT not by Echo. This agreed with our study. However, **Abdullah *et al.*** [17] showed that MDCT was superior to TTE in diagnosing transposition of great vessels.

For MAPCAs, the present study showed moderate agreement between MDCT and Echo (Kappa = K(p) =0.516* (0.004*) with AUC of 0.908). MDCT not only detected these collaterals, but it also added information about number, course and definite measurement of the detected collaterals. This agreed with **Ali *et al.*** [1] and **Goitein *et al.*** [19] who reported that MDCT yielded additional diagnostic information in case of MAPCAs by 92%. Good agreement between the two modalities was demonstrated by **Ali *et al.*** [(10)] in favor of MDCTA, where the latter found 10 instances while TTE detected only 7 cases (kappa value of 0.7).

In this study MDCT was superior in detecting APVR than echo, with echo sensitivity (20%), specificity (100%), PPV (100%), and NPV (91.84%). This Matches with **Osama** [(20)] who reported that MDCT was superior in diagnosis of anomalous venous return with sensitivity 100%, and specificity 100%. The specificity of echocardiography was 50% for these findings.

The current study, there was fair agreement between MDCT and Echocardiography in detecting PLSVC. **Ali *et al.*** [(11)] who showed that MDCT found moderate agreement between MDCT and Echocardiography in detecting SVC (Kappa =0. 474). However, **Bu *et al.*** [(3)] showed that both MDCT and Echo were able to diagnose persistent left superior vena cava equally.

Our study showed moderate agreement between MDCT and Echocardiography in diagnosis of left sided SVC (Kappa =0.435, P =0.004, with AUC of 0.976). This was close to **Abdullah *et al.*** [(17)] and **Ali *et al.*** [(10)] who showed that MDCT was superior to TTE in diagnosing SVC anomalies.

Our study showed that MDCT could identify the exact origin and course in all cases while echo was unable to identify proximal course abnormalities, this agreed with **Nie *et al.*** [(21)] who found that MSCT displayed the origin and course of all anomalous vessels with 100% sensitivity. And also close to **Bu *et al.*** [(3)], **Shehata *et al.*** [(12)] and **Elshimy *et al.*** [(22)] who showed that MDCT was superior to TTE in diagnosing Anomalous origin of coronary artery.

The current study was limited by relatively small sample size and loss of follow up of some patients, as well as not all the patients underwent catheterization or invasive procedure. To support our findings, more comparison research with bigger sample sizes and longer follow-up are required.

CONCLUSION

An important non-invasive diagnostic method for the assessment of congenital cardiac and extra cardiac great vessels is ECG gated MDCT. Cardiovascular MDCT is an adjunct to cardiac echocardiography, particularly in complicated heart problems. MDCT is mandatory before any intervention as it provides more details than Echo in different types of CHDS.

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REFERENCES

1. **Ali M, Mohammed Y, Abdel Rahman M (2017):** Role of Electrocardiogram-Gated Multidetector Computed Tomography in Diagnosis of Congenital Heart Disease. The Egyptian Journal of Hospital Medicine, 68:1368-73.
2. **Alam T, Munir M, Hamidi H (2019):** congenital heart disease frequency in children undergoing MDCT angiography; a 4-year tertiary care hospital experience from Kabul, Afghanistan. BJR Open, 1:20180032. doi: 10.1259/bjro.20180032
3. **Bu G, Miao Y, Bin J *et al.* (2016):** Comparison of 128-slice low-dose prospective ECG-gated CT scanning and trans-thoracic echocardiography for the diagnosis of complex congenital heart disease. PloS One, 11:e0165617. doi: 10.1371/journal.pone.0165617
4. **Enaba M, Hasan D, Alsowey A *et al.* (2017):** Multidetector computed tomography (CT): in evaluation of congenital cyanotic heart diseases. Polish Journal of Radiology, 82:645-59.
5. **Goo H (2010):** State-of-the-art CT imaging techniques for congenital heart disease. Korean Journal of Radiology, 11:4-18.
6. **Paul J, Rohnean A, Sigal-Cinqualbre A (2010):** Multidetector CT for congenital heart patients: what a pediatric radiologist should know. Pediatr Radiol., 40:869-75.
7. **Saravanan K, Anusha V, Sulaiman F (2019):** Segmental approach to imaging of congenital heart disease. European Congress of Radiology, 19: 3276. doi: 10.26044/ecr2019/C-3276
8. **Mehlman A, Swearingen S, Derbas L *et al.* (2022):** Unusual Color Flow Leads to Diagnosis of Unroofed Coronary Atrial Septal Defect. Circulation, 146(1):11183.
9. **Goo H, Siripornpitak S, Chen S *et al.* (2021):** Pediatric cardiothoracic CT guideline provided by the Asian Society of Cardiovascular Imaging Congenital Heart Disease Study Group: part 2. contemporary clinical applications. Korean Journal of Radiology, 22(8):1397-415.
10. **Ali S, Amin D, Khattab R (2020):** Intramodality agreement between TTE and low kVp ECG-gated MDCTA in diagnosis of complex CHD in pediatrics. Egyptian Journal of Radiology and Nuclear Medicine, 51:1-11.
11. **Saad M, Abdul Fattah A, Abd El Halim A (2021):** Role of Cardiac CT in the Assessment of Congenital Heart Disease in Children. Fayoum University Medical Journal, 8(1):8-18.
12. **Shehata S, Zaiton F, Warda M *et al.* (2017):** Value of MDCT as a non-invasive modality in evaluation of pediatric congenital cardiovascular anomalies. The Egyptian Journal of Radiology and Nuclear Medicine, 48:467-78.
13. **Leschka S, Oechslin E, Husmann L *et al.* (2007):** Pre-and postoperative evaluation of congenital heart disease in children and adults with 64-section CT. Radiographics, 27(3):829-46.
14. **Öztürk E, Tanıdır İ, Kamalı H *et al.* (2021):** Comparison of echocardiography and 320-row multidetector computed tomography for the diagnosis of congenital heart disease in children. Revista Portuguesa de Cardiologia, 40(8):583-90.

15. **Halim A, Mohammad A, Abd Allah Abbas A *et al.* (2021):** Role of Cardiac CT in Evaluating Vascular versus Cardiac Congenital Heart Diseases in Children. The Medical Journal of Cairo University, 89:2617-31.
16. **Kara K, Sivrioğlu A, Öztürk E *et al.* (2016):** The role of coronary CT angiography in diagnosis of patent foramen ovale. Diagnostic and Interventional Radiology, 22(4):341-6.
17. **Abdullah M, Hussain I, Nawaz A *et al.* (2022):** Comparison of Cardiac Computed Tomography and Echocardiography for the Diagnosis of Congenital Heart Diseases. Pakistan Heart Journal, 22:1-5.
18. **Ou P, Celermajer D, Calcagni G *et al.* (2007):** Three- dimensional CT scanning: a new diagnostic modality in congenital heart disease. Heart, 93:908-13.
19. **Goitein O, Fuhrman C, Lacomis J (2005):** Incidental finding on MDCT of patent ductus arteriosus: use of CT and MRI to assess clinical importance. American Journal of Roentgenology, 184(6):1924-31.
20. **Osama L (2015):** Role of multi-slice CT angiography in the evaluation of conotruncal anomalies. The Egyptian Journal of Radiology and Nuclear Medicine, 46(2):371-7.
21. **Nie P, Yang G, Wang X *et al.* (2014):** Application of prospective ECG-gated high-pitch 128-slice dual source CT angiography in the diagnosis of congenital extra cardiac vascular anomalies in infants and children. PLoS One, 9(12):115793. doi: 10.1371/journal.pone.0115793
22. **Elshimy A, Khattab R, Hassan H (2021):** The role of MDCT in the assessment of cardiac and extra-cardiac vascular defects among Egyptian children with tetralogy of Fallot and its surgical implementation. Egyptian Journal of Radiology and Nuclear Medicine, 52(1):1-9.