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Role of Multidetector Computed Tomography in the Diagnosis of Congenital Thoracic Vascular Anomalies

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ABSTRACT

Background: multidetector row computed tomography (MDCT) provides reliable diagnostic information on the normal anatomy of the aorta, pulmonary arteries & veins and vena cava, as well as congenital anomalies in pediatric and adult patients.

Objective: in this study, we assess the role of multidetector CT scan in the evaluation and its ability to diagnose congenital thoracic vascular anomalies as well as it is importance to recognize these anomalies early for proper treatment and follow up, and also to prevent morbidities and mortalities.

Patients and Methods: the study was done in National Heart Institute, Ministry of health Egypt. It included a total of 80 patients (50 males and 30 females, their age ranged between, 2 days to 64 years and the mean age was 11.6±18 years), who underwent MDCT (using GE 16/64- multislice CT) angiography from December 2018 to June 2019 and had diagnosed of congenital thoracic vascular anomalies, or asymptomatic (incidentally discovered).

Results: a total of 80 patients had done 16/64-MDCT angiograms were considered to be of adequate diagnostic image quality. Twenty-seven patients diagnosed as systemic arterial (aortic) anomalies corresponding to 33.7% in all cases, the right aortic arch anomalies (9 cases) are represented the most frequent cases (11.2 %).

Conclusion: The ability to diagnose congenital vascular thoracic anomalies has evolved tremendously in the past 20 years. Traditional methods of plain radiographs and barium swallow studies as well as invasive angiography have now been supplanted with MR imaging and MDCT, minimally invasive methods that provide superb resolution and a large field of view.

Keywords: Multidetector Computed Tomography, Congenital Thoracic Vascular Anomalies

INTRODUCTION

Congenital vascular anomalies of the thorax represent an important group of entities that can occur either in isolation or in association with different forms of congenital heart diseases. From a clinical viewpoint, they can be totally silent or, because of associated cardiac anomalies or compression of the airway and esophagus, result in cardiovascular, respiratory, or feeding problems that result in morbidity and mortality. It is extremely important to have a clear understanding of these entities, their imaging characteristics, and their clinical relevance [(1)].

The imaging armamentarium available to diagnose these diverse conditions is ample and has evolved from such traditional methods as chest radiography, barium esophagography, and angiography to new modalities that include echocardiography, multidetector row CT (MDCT), and magnetic resonance imaging (MRI). These imaging modalities have added safety, speed, and superb resolution in diagnosis and, as in the case of MDCT, provide additional information about the airway and lung parenchyma, resulting in a more comprehensive examination with greater anatomic coverage [(1)].

Multidetectors CT scan is a noninvasive & rapid technique used for evaluation of the pediatric vascular disease as an alternative to conventional angiography. Three dimensions (3D) images allow excellent display of vascular anomalies that can be used as a vascular road map by surgeons [(2)].

Multidetector row computed tomography (MDCT) has changed the approach to imaging of thoracic anatomy & disease. MDCT with multiplanner & three-dimensional reconstructions has become an important examination in the evaluation of systemic & pulmonary vasculature and the trachea-bronchial tree [(3)].

AIM OF THE WORK

In the present study, we assess the role of multidetector CT scan in the evaluation and its ability to diagnose congenital thoracic vascular anomalies as well as it is importance to recognize these anomalies early for proper treatment and follow up, and also to prevent morbidities and mortalities.

Multidetector CT scan is not only for diagnosis of the congenial vascular anomalies but also for follow up of post- operative sequalae.

PATIENTS AND METHODS

Selection of patients:

The study was done in National Heart Institute, Ministry of health Egypt, included a total of 80 patients (50 males and 30 females, their age ranged between 2 days to 64 years and the mean age was 11.6±18 years), who underwent MDCT (using GE 16/64- multislice CT) angiography from December 2018 to June 2019 and had diagnosed of congenital thoracic vascular anomalies, or asymptomatic (incidentally discovered).

Ethical approval:

The study was approved by the Ethics Board of Al-Azhar University and an informed written consent was taken from each participant in the study.

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Criteria of patients selected for the study:

1. Patients suspected or proved to have congenital thoracic vascular anomalies by any other imaging modalities (e.g., Chest X-ray, Echocardiography, interventional angiography) will be included in the study.
2. Any case with incidentally discovered thoracic vascular anomalies during CT scanning for any other reason will be also included.
3. Patients with post-operative repair of congenital thoracic vascular malformation will be also included.

The following patients were excluded:

1. Patients with impaired renal functions and e-GFR less than 60 mm/min will be excluded.
2. Patients with strong history of atopic disorders because they are more liable to the side effects of the contrast agents.

Study procedures done as work up for these patients as follows:

*I- **Clinical studies:***

Full clinical and family history was taken from each patient as follows:

Name, age, sex, occupation, habits (cigarette smoking, alcoholism, diet), family history for any cardio-vascular disease, clinical history (allergy, chronic disease, previous surgical or intervention procedures), medical treatment.

*II- **Laboratory investigation:***

Renal function tests were done for each patient before performing the study and creatinine clearance is calculated and must be greater than 60 ml/min.

*III- **Imaging studies:***

- MDCT chest angiography.

*IV- **Other studies:***

- Chest X-Ray & Echocardiography ± Cath Lab mainly for patients who have congenital heart disease.

Patient Preparation:

Asthmatic patients will receive prednisolone drug (corticosteroids) & the dosage is taken according to the patient's age as follows:

- Adults: 60 mgs will be taken at the night & morning prior to the examination.
- Children: 1mg/kg will be taken and divided on three days prior to the examination.
- Patient must be fasting four hours prior to the examination.
- Informed consent will be obtained from all patients or guardians for examination.

Scan Preparation:

1. The test was explained for each patient.
2. Nonionic low-osmolarity contrast agent that contains 300 mg of iodine per milliliter or greater is injected via an antecubital vein using a mechanical injector. A saline bolus chase is applied.
3. Have the patient lie supine on the table headfirst.
4. Start IV line; make sure to explain the effects of the contrast to the patient. Even if the patient has had a contrast injection before, reinforcing how he will feel during the scan.

This step is CRITICAL as this will help minimize the patient's (young children & adult) anxiety during the injection of the contrast. Reassuring them that what they will feel during the injection is normal and they should try to remain relaxed during the scan.

5. Define the questions to be answered:

Before performing pediatric thoracic CT angiography, the radiologist must be familiar with the questions that need to be addressed. Direct communication with a referring service or clinician is optimal. This allows the examination to be designed to provide the highest yield.

6. Understand the anatomy:

This is a CRITICAL point in designing the study. This is necessary both for optimizing diagnostic information and the safety of the children. With respect to this latter point, certain admixture lesions or right-to-left shunts are at risk for embolization with improper flushing of the catheter or injection of contrast media. That is, thrombus or air, which is not usually much of an issue with normal anatomy, can potentially have devastating complications. With respect to optimizing the examination, one must also understand the patient's cardiovascular anatomy, and the anticipated course of the contrast material.

One must also know of the location of any metal with respect to the question asked. Streak artifact off a clip may obscure a stenosis of a vessel. Stents, septal occluded devise, coils, valves, and conduits and pacing wires can also cause artifacts.

7. Prior to the scan, the patient must practice the breathing instructions that will be given during the exam.
8. Select scan parameters:

- 16-detector row.
- FOV: small. Note CTDIvol 1.65 mGy and DLP 10.59 mGy.cm for small FOV. Large FOV reads CTDIvol 0.71 mGy and DLP 4.54 mGy.cm (less than half of small FOV), more appropriate dose estimated for a large patient.
- Detector thickness: 16 x 0.625, anticipating multi-planar and three-dimensional reconstruction especially for airway depiction (were not necessary in the end).
- Slice thickness and interval for axial review: 2.5 mm at 2.5-mm reconstruction interval.
- Milliampere: 50-80.
- Kilovolt (peak): 80.
- Gantry cycle time: 0.5 seconds.
- Pitch: 1.375.

Thoracic Helical Scan Acquisition:

1. **Scout Scans:** Landmark the patient at sternal notch. If the gating is fine, take the scout views (AP and Lat.) make sure to use the Cardiac breathing protocol for the scout scans & all other scans to follow. The scans will be extended from just above the level of the thoracic inlet, so that proximal aspects of the common carotid and subclavian arteries, down to the level of upper abdomen **(Figure 1).**

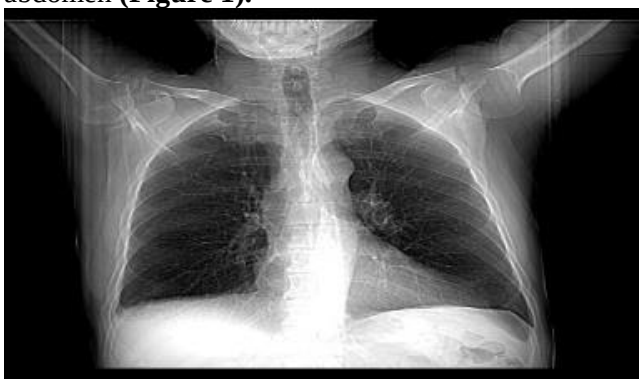

Fig. (1): Scout view thoracic helical scan.

2. The thinnest detector collimation possible is selected. The fastest gantry rotation time possible is selected.
3. Sometimes another scan may be needed porto-venous phase.

Onset of diagnostic scanning:

There are two techniques used to start diagnostic scanning for pediatric CT angiography:

1- Bolus tracking to start the scan.

2- Test bolus.

It is important to release that there are several complex factors that affect the arrival of contrast at the optimal location. The location of the catheter, injection rate (which is unknown with manual injection), cardiac output, anatomy of the lesion to be assessed, and other unknown factors conspire to make the timing of scan onset a potentially complex issue in children. With small volume of administration (i.e., 5 ml or less), there is not, as with adult, a sustained or prolonged of period of enhancement, this makes the timing issues in children more important to address.

Bolus tracking is a very useful and preferred method for thoracic CT angiography in children. I use Smart Prep (GE health). With this technology serial isolevel slices are obtains at a predetermined level and scanning is initiated based on the arrival of contrast at the desired location. One technical tip that I found useful is to begin the bolus tracking series before the contrast injection starts. This then means that everyone to three seconds, depending on the interval selected, an image appears.

The initial image may take longer, however, because of current hardware delays. This duration may be longer than the arrival time of the contrast and the opportunity may be missed to scan at the optimal enhancement. By starting the bolus tracking and contrast at the same time I found early in my experience that the contrast was at least as far as the right side of the heart by the time the 1st image arrived. In addition, it takes at most a few seconds to begin the scanning, including moving the patient to proper starting position. Together, these delays mean that there may be a six or a seven seconds delay from the desired start of scanning to the actual onset of scanning. Again, with small total volumes of contrast, this may mean missing optimal contrast enhancement of the desired structure. One could, with experience, anticipate this delay and begin scanning slightly earlier than the tracking indicates is ideal.

This scan initiation based on bolus tracking is generally useful for larger children and opacification of major chambers or vessels. In addition, I have not found it useful to measure enhancement (HU) of the vessels or chambers but simply to determine when contrast arrives at the desired location (one or two images where the chambers of vessel of interest is opacified) to start the scan. The trigger, then is based on visual clues rather than actual metrics.

The 2nd method that I have found very useful in small children with complex anatomy is to use a test bolus. In general, a test bolus of about 10% of the total volume administered is sufficient. This means with a total scan dose of 5 ml/kg, that a 0.5 ml test bolus can be tracked. The technique here is to administer the small test bolus in a small syringe being sure that, again, the contrast material is not trapped in a dead space. I begin the bolus tracking with appearance of monitoring slices and when the 1st image appears, the test bolus should be given as fast as possible. I count the number of seconds from the administration of the test bolus to the arrival in the desired location, such as the right or left ventricles. This, then, service as the foundation for the delay in the diagnostic scanning. With adult CT angiography, there is a several second delay from the arrival of the test bolus that is added to this time given the dynamics of the enhancement curve of a contrast dose. In children, given the small volumes, no more than one or two seconds added to the arrival bolus is indicated. It should be remembered that an injection of 5 ml total dose given at ml/second only lasts 2.5 seconds.

Statistical methodology:

Analysis of data was done by IBM computer using SPSS (statistical program for social science version 12) as follows:

- **Description** of quantitative variables as mean, SD and range.
- **Description** of qualitative variables as number and percentage.
- **Chi-square** test was used to compare qualitative variables between groups
  - P value >0.05 insignificant
  - P<0.05 significant
  - P<0.01 highly significant

RESULTS

The present study included 80 patients in the efficacy analysis. It comprised 50 males and 30 females aged from 2 days up to 64 years. The mean age was 11.6 ± 18 years.

Table (1): Distribution of the studied group as regard general data.

Variables	No	%
Age		
≤5	39	**48.8%**
6-20	23	28.8%
21-35	9	11.3%
≥36	9	11.3%
Mean±SD (range)	11.6±18	(2d-64yrs)
Gender		
Male	50	62.5%
Female	30	37.5%

This table shows that majority of the studied cases were aged below 5 years with arrange from 2 days up to 64 years, more than 62% of them were males and females represent 37.5%.

In all patients, the examination was successfully done and completed without complications.

In our study, 28 patients have congenital heart disease which represent about 35% of the cases, 7 patients have stridor to rule out vascular ring, 9 patients are asymptomatic, 3 patients are known case of William, Digeorge, Down's & Arteritis syndromes, 12 patients are symptomatic as birth asphyxia, meconium aspiration, persistent hypoxia, cyanosis & cough, 4 patients for follow up and 9 patients have other abnormalities (**Table 2**).

This table shows the most frequent presentation was CHD represented about 35% of the studied cases.

Table (2): Distribution of the studied group as regard clinical data.

Variables	No	%
Asymptomatic	9	11.2%
Birth asphexia	2	2.5%
Meconium aspiration	2	2.5%
Persistent hypoxia	1	1.4%
CHD	**28**	**35%**
Stridor to R/O Vas. ring	7	9%
Digeorge syndrome	4	5%
William	3	3.8%
Non William	3	3.8%
Down's syndrome	1	1.4%
Arteritis syndrome	2	2.5%
Cyanosis	3	3.8%
Cough	4	5%
Follow up	4	5%
Others	7	9%

In our study, Echocardiography was done for 46 patients and revealed, 12 patients had aortic arch anomalies which were represented highest percentage 26%, 8 patients had pulmonary artery abnormalities, 4 patients had TGA, 2 patients had PDA, 2 patients had single ventricle, 12 patients done as routine study and 6 patients had native findings which were represented 13%. This table shows that more than 26% of the studied cases had aortic arch abnormalities, while 13% had native findings **(Table 3).**

Table (3): Distribution of the studied group as regard echocardiography findings.

Variables	No	%
Negative	6	**13%**
PDA	2	4.3%
Aortic arch abnormalities	12	26%
TGA	4	8.6%
LV dilatation & single ventricle	2	4.3%
PA abnormalities	8	17.4%
Others	12	26%

13 patients were done chest X-ray, most of them (8 patients) showed lung opacities which represent >61%, two showed prominent hilar shadow of about 15%, and the rest of the chest X-ray showed different abnormalities as mediastinal widening, pleural effusion and bronchiectasis that represent 7.6% for each.

Table (4): Distribution of the studied group as regard chest X-ray findings.

Variables	No	%
Negative	0	**0**
Lung opacities	8	61.5%
Suspected bronchiectasis	1	7.6%
Mediastinal widening	1	7.6%
Prominent hilar shadow	2	15.3%
Pleural effusion	1	7.6%

This table shows that more than 62% of the studied cases had different lung opacities.

A total of 80 patients had done 16/64-MDCT angiograms were considered to be of adequate diagnostic image quality. Twenty seven patients diagnosed as systemic arterial (aortic) anomalies corresponding to 33.7% in all cases, the right aortic arch anomalies (9 cases) are represented the most frequent cases (11.2 %), then the left aortic arch & double aortic arch (6 for each) are the next frequently (7.5%) for each, and lastly the aortic coarctation (3 cases) & aortic pseudocoarctation, cervical & interrupted aortic arch (one patient for each) represented 3.8% & 1.4% respectively. 12 patients diagnosed as pulmonary arterial anomalies corresponding to 15% in all cases, the most frequent cases were diagnosed as pulmonary artery stenosis (6 cases) about (7.5%), then interrupted or absent pulmonary artery is the second frequent cases (4 cases) about (5%), idiopathic dilatation of MPA &

aberrant pulmonary artery with sling (one case for each) represented (1.4%). The systemic venous thoracic anomalies (10 cases) which represented the most frequent venous thoracic anomalies included the persistent left SVC & interrupted IVC with azygous/hemizygous continuation corresponding to 12.5% in all cases, then the second frequent venous thoracic anomaly is pulmonary anomaly which was represented 8.7% in all cases about 7 cases, divided into total & partial anomaly pulmonary venous return, the PAPVR is the most common cases than the TAPVR (6:1). Other 7 patients had aortopulmonary anomalies represented 8.7% also in all cases, included TGA, PDA & TA corresponding to 5% (4), 2.5% (2) & 1.4% (1), respectively. 4 patients had pulmonary arteriovenous malformation (AVM)) represented 5% in all cases. The sequestration is the least frequent group, only one case of about 1.4% in all cases. Finally 12 patients had combined anomalies follow up represented about 15% in the all cases.

Table (5): Distribution of the studied group as regard CT scan findings**.**

Variables	**No**	**%**
Double aortic arch abnormalities	6	**7.5%**
Right side aortic arch anomalies.	9	11.2%
Left side aortic arch	6	7.5%
Aortic Coarctation	3	3.8%
PDA	2	2.5%
TGA	4	5%
Persistent LSVC	6	7.5%
Azygous continuation	4	5%
Intralobar sequestration	1	1.4%
Pulmonary AVM	4	5%
Pulmonary venous anomalies	7	8.7%
Aortic pseudocoarctation	1	1.4%
Interruption of aortic arch	1	1.4%
Cervical aortic arch	1	1.4%
Idiopathic Dilatation of Pulmonary trunk.	1	1.4%
Interrupted or absent Pulmonary artery.	4	5%
Pulmonary artery stenosis	6	7.5%
Aberrant Pulmonary artery	1	1.4%
Follow up + combined anomalies	12	15%
Truncus Arteriosus	1	1.4%

This table shows that systemic arterial (aortic) anomalies are considered the most frequent and pulmonary arterial anomalies.

Thirty-six patients were done operation and MDCT is required for postoperative assessment or for another associated anomalies. The most frequent operations are Conduit correction, Glenn, coarctation & PAVC repair, and pulmonary stent which represent 13.8% for former one and 11.1% of the rest operations, respectively.

Table (6): Distribution of the studied of main groups as regard CT scan findings.

Variables	**No**	**%**
Aortopulmonary anomalies	7	8.75%
Systemic arterial anomalies.	27	33.75%
Pulmonary arterial anomalies	12	15%
Pulmonary venous anomalies	7	8.75%
Pulmonary arteriovenous malformation (AVM)	4	5%
Systemic venous anomalies	10	12.5%
Sequesteration	1	1.25%
combined anomalies	12	15%

This table shows that systemic arterial (aortic) anomalies are considered the most frequent and pulmonary arterial anomalies.

Table (7): Distribution of the studied of systemic arterial anomalies group as regard CT scan findings.

Variables	**No**	**%**
Left aortic arch with aberrant right subclavian artery	6	22.2%
Double aortic arch	6	22.2%
Right aortic anomalies	9	33.3%
Aortic coarctation	3	11.1%
Aortic pseudocoarctation	1	3.7%
Interruption of aortic arach	1	3.7%
Cervical aortic arch	1	3.7%

This table shows that right aortic arch anomalies are considered the most frequent anomaly.

Table (8): Distribution of the studied of thoracic venous anomalies group as regard CT scan findings.

Variables	**No**	**%**
Partial anomaly pulmonary venous drainage (PAPVR).	6	35.3%
Total anomaly pulmonary venous drainage.	1	5.8%
Persistent left superior vena cava	6	35.3%
Azygous/Hemiazygous continuation of inferior vena cava	4	23.5%

This table shows that PAPVR and persistent left SVC are considered the most frequent anomalies of thoracic venous anomalies.

Illustrative Cases

CASE 1

Three months old child, a known case of truncus arteriosus type I with pulmonary band. MDCT

angiography was recommended to assess pulmonary arteries. Axial MIP and 3D volume rendering (VR) images demonstrate the aorta and MPA arising from main arterial trunk.

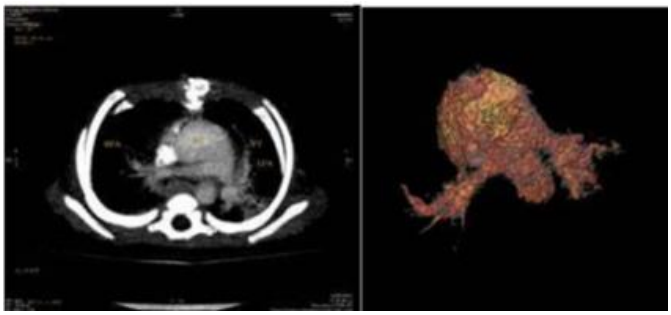

Fig. (2): a & b – axial MIP and 3D VR images show aorta & MPA arise from main arterial trunk.

CASE 2

Five months year old female child with a known of pulmonary atresia, VSD & non confluent pulmonary arteries, Echo showed non visualized right pulmonary artery (RPA). CT angiography was recommended to evaluate Pulmonary arteries. Axial cuts & 3D volume rendering (VR) demonstrated right aortic arch, RPA is not visualized & right lung supplied by systemic collaterals from descending aorta, left pulmonary artery (LPA) is visualized by patent ductus Arteriosus (PDA).

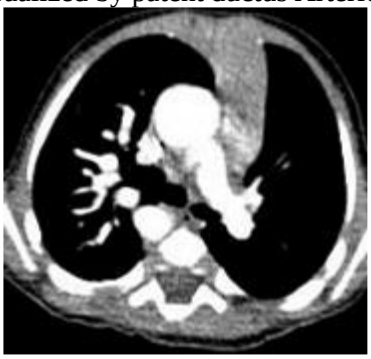

Fig. (3): ***a***- axial image demonstrate right aortic arch, visualized LPA.

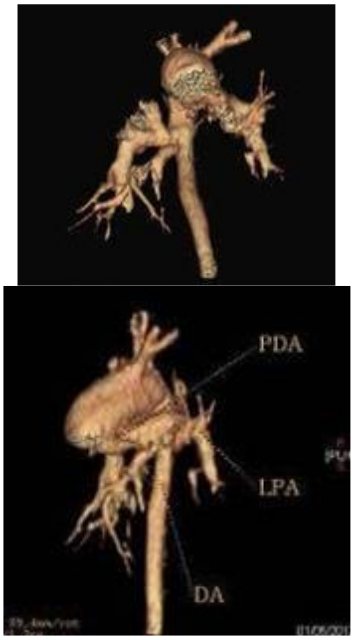

Fig. (4): b & c: 3D VR demonstrate visualization LPA by PDA & right side systemic arterial supply of right lung from descending aorta.

CASE 3

Twenty years old male patient, complaining from acute chest pain cardiac catheterization is applied showed resistant & difficult thorough the aorta, the patient shifted to CT department, MDCT aortic angiography was performed axial cuts & 3-dimentional volume rendering (3D VR) showed aortic coarctation, multiple collaterals and rib notching.

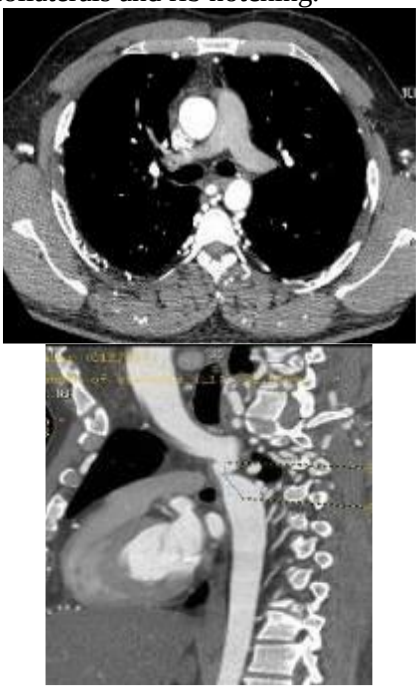

Fig. (5): (a, b) axial & sagittal oblique reformatted demonstrate aortic coarctation with multiple systemic collaterals.

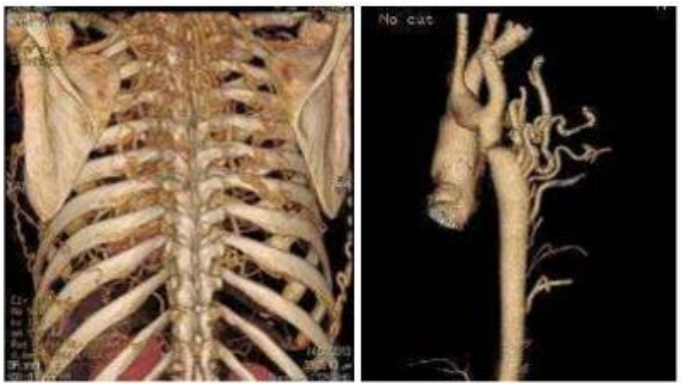

Fig. (6): c & d: 3D VR show Aortic coarctation, systemic collaterals & rib notching.

CASE 4

Four years old child, a known case of L-TGA with double arterial switch and Glenn operations, follow up echocardiography showed increased pressure gradient of MPA above pulmonary valve. MDCT angiography was recommended to assess pulmonary arteries. Coronal MIP and 3D volume rendering (VR) images demonstrate MPA narrowing, patent Glenn (SVC-RPA) and normal PA branches.

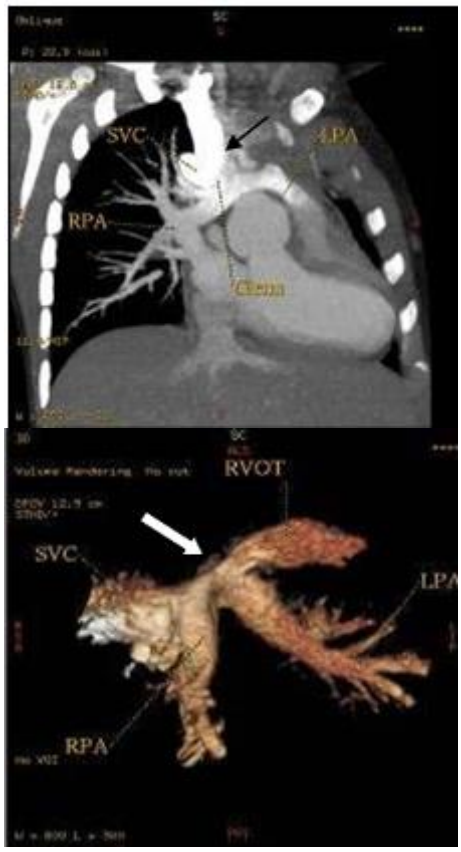

Fig. (7): ***a*** & b – Coronal MIP and 3D VR images show MPA narrowing (white arrow), patent Glenn (SVC-PA) (black arrow).

DISCUSSION

The incidence of congenital thoracic vascular anomalies has been increasing steadily (approximately 12-14 per 1000 live births) **(4).**

Congenital vascular anomalies of the thorax represent an important group of entities that can occur either in isolation or in association with different forms of congenital heart diseases. From a clinical viewpoint, they can be totally silent or, because of associated cardiac anomalies or compression of the airway and esophagus, result in cardiovascular, respiratory, or feeding problems that result in morbidity and mortality. It is extremely important to have a clear understanding of these entities, their imaging characteristics, and their clinical relevance **(1).**

Conventional imaging of congenital thoracic vascular anomalies has been based on digital subtraction angiography and duplex Doppler ultrasound, which have the disadvantage of being invasive and operator-dependent, respectively. Recent years have seen exciting new developments in magnetic resonance angiography (MRA) and CTA, and these two techniques are increasingly utilized as the non-invasive imaging modality of choice in vascular anomaly visualization as well as coronary and peripheral vascular disease. With its capacity for fast data acquisition in high resolution, MDCT has greatly increased the quality of thoracic vascular imaging. MDCT provides reliable diagnostic information on the normal anatomy of the aorta, pulmonary and vena cava, as well as congenital anomalies in pediatric and adult patients. MDCT angiography is now the modality of choice for non- invasive assessment of vascular pathologies of the chest, because it allows for the evaluation of the vascular structures and the lung parenchyma as well as well. 2D- and 3D-imaging, such as MPR, MinIP, and VRT gain more and more importance, and these kinds of multidimensional post-processing often help to demonstrate complex vascular anatomical structures as seen in vascular congenital anomalies of the chest **(4).**

Echocardiography is a great modality for initial assessment of congenital heart disease and associated thoracic vascular anomalies; however, it may not be the perfect diagnostic tool because it is usually limited by the acoustic window, spatial resolution and the subjective interpretation of the operator. An incorrect echo diagnosis might result in the wrong operation and the risk of avoidable mortality, a mistake that could potentially have been corrected by MDCT. In the present study MDCT diagnosed correctly 6 cases with inconclusive echocardiography and in other 12 cases MDCT modified the insufficient or incorrect diagnosis of the echocardiography.

Results of the present work showed good images of MDCT with MIP & 3D volume rendering (VR) added safety, speed, superb resolution in diagnosis, and provide additional information about the airway and lung parenchyma, resulting in a more comprehensive examination with greater anatomic coverage. We agree with **Thomas *et al.*** **(4)** that 3D is more important to demonstrate complex vascular anatomical structures as seen in vascular congenital anomalies of the chest and used as a vascular road map by surgeons.

The scan parameters used in our study were similar to those used by **Kussman *et al.*** **(5),** who used slice thickness and interval for axial review of 2.5 mm during data acquisition while during reconstruction he utilized slice thickness of 0.625 mm. In our study the commonest thoracic venous anomalies were PAPVR and persistent left superior vena cava accounting for 35% of the cases of the thoracic venous anomalies and accounting 8.75% in all cases of congenital thoracic vascular anomalies. **Oh *et al.*** **(6)** **and Ayman** **(7),** stated that TAPVR supracardiac type accounted for 50% and 31% of pulmonary venous anomalies. Recognition of systemic venous anomalies especially left SVC is of importance if a left superior venous approach to the heart is considered in patients undergoing pacemaker or defibrillator placement, and in the use of retrograde cardioplegia for surgical procedures requiring cardiopulmonary bypass **(8).**

In current study the commonest systemic arterial anomalies were right aortic arch anomalies which coincided with that obtained by **Maldonado** et al. (1) who found that right aortic arch with aberrant left subclavian artery is the most common right arch anomaly and the second most common cause of vascular ring after double aortic arch.

CONCLUSION

MRA does not contain ionized radiation and can be performed without contrast media. However, it is

time consuming, requires prolonged sedation, and creates difficulties in imaging of the patients with severe illness or inability to cooperate. With its volumetric imaging quality, multidetector CTA clearly demonstrates the aorta, vena cava, and pulmonary artery and their branches. Moreover, it requires shorter imaging time and shorter sedation. It is also a non-invasive method, providing a scanning chance for patients that cannot tolerate MRI.

CTA has a radiation risk; however, in severely ill patients, prolonged sedation risk is more critical than radiation damage, and thus CTA is preferred because of its fast imaging quality at a low dose. We believe that because of these advantages, use of multidetector CTA in the evaluation of vascular thoracic pathologies will continue to increase in importance.

The ability to diagnose congenital vascular thoracic anomalies has evolved tremendously in the past 20 years. Traditional methods of plain radiographs and barium swallow studies as well as invasive angiography have now been supplanted with MR imaging and MDCT, minimally invasive methods that provide superb resolution and a large field of view. Physicians involved in the performance of these studies must have a clear understanding of the large variety of arterial and venous anomalies included in this diverse group of entities. Specific imaging strategies must be prescribed to better delineate the relevant anatomy so that proper care can be instituted.

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