

Role of Multislice CT in Assessment of Great chest Vessels Anomalies

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ABSTRACT

Background: Multidetector computed tomography (MDCT) is a useful, less invasive technique for diagnosing most types of vascular variations. CT is superior to radiology for identification of normal anatomy, anatomic variants and early abnormalities or pathological processes. **Objective:** The aim of this work was to evaluate the role of MDCT in Assessment of great chest vessels Anomalies. **Patients and methods:** The study included 30 patients in the age group between 2 months up to 30 years with a mean of 3 months. All patients were referred for evaluation Great chest vessels anomalies suspected to be in association with congenital heart disease. **Results:** CT provide an accurate assessment of Aortic vessel (Ascending, Arch and descending parts) four cases diagnosed as moderate to severe Aortic coarctation, two cases diagnosed as supra- and subvalvular aortic stenosis, two cases associated with right sided Aortic Arch, one case with hypoplastic Aortic Arch and another case had tortuous course of the Aorta. Substantial benefit of CTA is depiction of airway compromise owing to aortic rings. In the setting of coarctation, collateral vessels are better displayed. **Conclusion:** It could be concluded that the nowadays ease of the scan acquisition, the high spatial resolution and the accurate assessment of modern CT techniques make CT chest angiography an investigation ideally suited for the great chest vessels anomalies.

Keywords: Multislice CT, Great chest Vessels Anomalies, MDCT.

INTRODUCTION

MDCT is a useful, less invasive technique for diagnosing most types of vascular variations. CT is superior to radiology for identification of normal anatomy, anatomic variants and early abnormalities or pathological processes ⁽¹⁾.

Faster computed tomography (CT) scan, Thinner collimation, and the development of multi detector computed tomography (MDCT), coupled with the increasing capability of computers to process large amounts of data in short periods of time, have led to an expansion in the ability to create diagnostically useful two dimensional (2D) and three dimensional (3D) images within the thoracic inlet. The objectives of the present study were to identify the CT angiographic appearances of vascular system and study the variable appearance of arterial and venous anatomy in thoracic inlet on contrast enhanced, upper chest CT ⁽²⁾. The vascular anomaly is insufficiently demonstrated by conventional radiographic techniques, unless the vascular anomaly is interfered with low attenuation lung field. CT is used because it clearly Demonstrates this area free from superimposition, accurately depicts the size, shape and abnormalities of the thoracic inlet structures Vascular structures are usually readily identified on (CT) scans of the chest with intravenously administered contrast medium. From a single helical scan, vascular structures can be reformatted in any plane or rendered in three dimensions (3D), providing a simplified display of even most complex vascular anatomy ⁽³⁾. More recently, helical CT has been proposed for 3D anatomical visualization in patients with congenital heart disease. Helical technology allows volume acquisition in a short period of time and provides good-quality 3D vascular images, even for neonates and infants. The multi-slice CT technology now available has much faster acquisition times, which

substantially reduces respiratory artifacts. Furthermore, image synchronization with the cardiac rhythm is now possible, and this should reduce problems associated with heart motion. Multi-slice CT with the evolution from 4- to 16- and, very recently, 64-slice technology has rapidly become an important complementary imaging technique for both pre- and post-operative management of patients with congenital heart disease ⁽⁴⁾.

A tremendous progress of CT scan allowed reduction of motion mis-registration artifacts and provided a volume of data that can be processed into thinner sections. The ability of the computer software to transform these thin axial sections free of motion artifacts into two dimensional images in the coronal and sagittal planes and into three dimensional images further expanded the CT applications. The principle of "going as fast as possible" still allows good image quality in neonates with congenital heart disease; furthermore, the short acquisition times minimize respiratory artifacts ⁽⁵⁾. So, CT angiography is promising method for both detection and therapy planning of great vessels anomalies ⁽⁶⁾.

The aim of this work was to evaluate the role of MDCT in Assessment of great chest vessels Anomalies.

PATIENTS AND METHODS

This prospective study included a total of 30 patients referred for evaluation Great chest vessels anomalies suspected to be in association with congenital heart disease, attending at Al-Zahra University Hospitals, Cairo, Egypt.

Approval of the Local Ethical Committee and a written informed consent from all the subjects for the use of their imaging and histopathologic data in future research studies were obtained.

This study was conducted between March 2018 to March 2019. The patients were 18 males and 12 females aged 2 months up to 30 years with a mean of 3 months. They were subjected to: Full clinical history, clinical examination and the following investigations:

- 64-128-slice multidetector CT.
 - Intravenous contrast.
- The angiographic data result in identification of different types and degrees of great chest vessels Anomalies.

Statistical Analysis

Data were coded and entered using the statistic analytical tool of Microsoft Excel 2016 as well as statistical package SPSS (Statistical Package for the Social Sciences) version 23. Data were summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data.

RESULTS

This study included 30 patients (18 males & 12 females) with an age range of 20 Days to 31y years.

Table (1): Sex distribution of the patient population

Male	Female
18	12

The most common Great chest vessels anomalies anomaly were Systemic arterial anomalies which represents 47 % of the cases while the least common anomalies were related to pulmonary arteries & systemic veins and representing only 6.7 % of the cases **Table (2)**.

Table (2): Number of patients according to type of Great chest vessels anomalies

Type of Great chest vessels anomalies	Number of cases	percentage %
Aorto pulmonary anomalies	7	23
Systemic arterial anomalies	14	47
Pulmonary arterial anomalies	2	6.7
Pulmonary venous anomalies	9	30
Systemic venous anomalies	2	6.7

Two cases presented with severe cyanosis diagnosed by CT as Truncus arteriosus. One of them was type 1 as Common pulmonary artery arising from truncus. While the second case was type II as pulmonary arteries arise separately from the posterior aspect of trunk, close to each other just above the truncal valve **Table (3)**.

Table (3): Number of patients according to type of an Aorto pulmonary anomalies

Type of Aorto pulmonary anomalies	Number of cases	percentage %
Truncus arteriosus.	2	29
Patent ductus arteriosus.	3	42
Transposition of great vessels L-TGA DORV	2	29

Three cases of CHD were associated with right sided aortic arch by CT as one case had right sided aortic arch as apart of Situs inversus total is, 2nd case was association with truncus arteriosus type II while 3rd case was association with partial anomalies pulmonary venous return **Table (4)**.

Table (4): Number of patients according to type of Systemic arterial anomalies

Type of Abnormality	Number of cases	Percentage %
Right aortic arch anomalies.	3	21
Aortic coarctation	5	37
Interruption of aortic arch	2	14
aortic Stenosis	2	14
Hypoplastic aorta	1	7
Tortuous aorta	1	7

Two cases presented by unilateral oligemic lung diagnosed by CT as solitary absent right and left pulmonary artery respectively

The two cases of Pulmonary arterial stenosis, one case is diagnosed as idiopathic Pulmonary arterial stenosis as MPA, RPA ,LPA were stenotic while all other chest vessels are normal .2nd case Pulmonary arterial stenosis diagnosed as apart of Tetralogy of Fallot assessment **Table (5)**.

Table (5): Number of patients according to type of pulmonary artery abnormality

Type of Abnormality	Number of cases	Percentage %
1-Idiopathic dilatation of the pulmonary artery trunk.	1	17
2- Absence of a pulmonary artery.	2	33
3- Pulmonary arterial stenosis.	2	33
4-Tortuous Pulmonary arteries	1	17

Nine cases presented with severe to moderate dyspnea five of them diagnosed as TAPVD and four diagnosed as PAPVD **Table (6)**.

Table (6): Number of patients according to type of pulmonary venous abnormality

Type of Abnormality	Number of cases	Percentage %
-Total anomalies pulmonary venous return.	5	56
- Partial anomalies pulmonary venous return.	4	44

Systemic venous anomalies: 2 cases presented with Persistent left superior Vena Cava. Case of Truncus arteriosus type II was associated with Persistent left superior Vena Cava while 2nd case is was associated with PAPVR .

Association: 40% of the examined cases were associated with ASD, 20% were associated with VSD, 6.7% were associated with Ductus DIVERTICULUM. 6.7% also were associated with polysplenia while only 3% associated with pericardial eff and lymphadenopathy respectively.

DISCUSSION

In this study the role of helical CT scan in the evaluation of Great chest vessels anomalies was assessed. The study used two CT imagers done with multi-slice 4-row detectors CT scanner and 64-row detectors CT scanners.

The study included 30 patients in the age group between 2 months up to 30 years with a mean of 3 months. All patients were referred for evaluation Great chest vessels anomalies suspected to be in association with congenital heart disease.

The used CT technique included dual phase examination of the heart using early mid venous (right-sided opacification) and mid arterial (left-sided opacification) phases to ensure good opacification of all cardiac chambers and connected vessels. The early phase provided excellent initial idea about the atrioventricular and ventriculoarterial connections (e.g. best diagnostic of double outlet, TGA, and shunts as VSD and PDA), showed atretic vessels and stenotic vessels. The delayed phase allowed confirmation of the data obtained in the early phases, gave a window for stenotic and atretic vessels to fill through their collateral system allowing excellent delineation of these collaterals, ruled out possibility of a thrombus in a vessel , cardiac chamber, stent (post-operative cases) and provided better delineation of the pulmonary veins. No need for repetition of the examination was required in any of the patients.

Jurik and Albrechtsen ⁽⁷⁾ reported that is with helical CT timed acquisition of volumetric

data in arterial or venous phases became possible with the ability to study different segments of the vascular system in multi-planar and three-dimensional patterns. Widely available software programs provide angiographic images using the maximum intensity projection technique, shaded surface display and color encoded volume renderings.

ECG gated acquisition were used with all examinations done on 64-row detectors CT. It helped in the improvement of axial image quality with the avoidance of cardiac motion artifacts that partially degrades the reconstructed images. On 4-row detectors CT, the ECG gated was a rather time consuming with prolongation of the sedation and acquisition time, so it was not used in the studies done with it.

Mao et al. ⁽⁸⁾, stated that is with technical improvements like ECG gated acquisition even the problem of imaging of the beating heart could be solved. This gating however was useful mainly in the evaluation of adult heart.

All patients received calculated dose of non-ionic contrast medium. The volume of the contrast medium was calculated according to patient weight and all patients received non-ionic contrast medium to ensure more safety. CT angiography in all patients performed with a dose of 2ml/kg. This dose ensured optimum enhancement in both phases of the technique.

Frush and Herlong ⁽⁹⁾ in their study stated that is one of the principle benefits of multidetector CT has been the ability to perform CTA with contrast doses that are lower than have been generally used in cardiac catheterization.

Scan delay technique was optimum in CT angiography examinations in all of our patients. Ten to twelve seconds scan delay before acquisition started was adequate for early enhancement of the right side of the heart. A pre-set second phase was subsequently followed ensuring good opacification of the left side of the heart with rather homogenous opacification of all chambers. The automated tracking system using threshold to trigger examination was of no great value, and time consuming in pediatric patients with congenital heart disease as most patients had left to right shunts e.g. VSD, ASD, double outlet, TGA.

In our study 9 cases were associated with ASD, 3 were associated with VSD and 3 were associated with both VSD and ASD.

Ohnesorge et al. ⁽⁵⁾ reported that with 4-slice CT, the thorax can be scanned in 3–4 s. The images are of higher quality than those obtained using a slice thickness of 1 mm, which requires longer acquisition times associated with thinner collimation, and thus more respiratory artifacts. Very short acquisition times (≤ 5 s) allow apnea in intubated patients, and the images obtained are free of respiratory artifacts.

The system of assessment of Great chest vessels anomalies used in this study depended on thorough tracing of each unit of the vascular pedicle of the heart, defining its cardiac connection, measure the relative cross sectional and longitudinal diameters and to check for cardiac situs and concordance.

In this study confident detection and exclusion of Great chest vessels anomalies was possible and when the abnormality was present high level of accuracy of its anatomic description was achieved. In all cases no technique related significant complications were encountered during or after the examination procedure. Diagnostic confidence was high with abnormalities of the aorta, pulmonary arteries , pulmonary veins

Regarding aortic abnormalities, **Frush and Herlong** ⁽⁵⁾ stated that CT angiography provides a global assessment of the aortic arch that is not always afforded by echocardiography. Disorders that are well-depicted by CTA include the aortic rings (right-sided aortic arch with aberrant left subclavian artery, left-sided aortic arch with aberrant subclavian artery, the diverticula that may be associated with these rings), aortic artery atresia, Hypoplastic Aortic Artery ,tortuous Aorta and both native coarctation and aortic interruption.

In the current study CT provide an accurate assessment of Aortic vessel (Ascending, Arch and descending parts) four cases diagnosed as moderate to severe Aortic coarctation, two cases diagnosed as supravalvular and subvalvular aortic stenosis, two cases associated with right sided Aortic Arch, one case with hypoplastic Aortic Arch and another case had tortuous course of the Aorta. Substantial benefit of CTA is depiction of airway compromise owing to aortic rings. In the setting of coarctation, collateral vessels are better displayed.

Saha et al. ⁽¹⁰⁾, stated that CTA clearly identifies LSVC, and all CTAs in patients with CHD should be investigated for presence/ absence of LSVC. They reported that a concomitant right superior vena cava (RSVC) may present with a horizontal innominate vein connecting the LSVC and RSVC.

Our study agrees with that of **Lee** ⁽¹¹⁾, one case is diagnosed as Situs inversus totalis (SIT), two cases are heterotaxy and one case was associated with polysplenia.

In his study, **Siegel et al.** ⁽¹²⁾ showed that the complex curving anatomy of the pulmonary veins is also well suited to CT angiography and that three-dimensional volume-rendered images are valuable in studies of malformations such as pulmonary arteriovenous malformations and anomalous venous return. He proved that multiplanar and 3D volume rendering is valuable in evaluation of anomalous pulmonary venous return, because the course of these obliquely oriented vessels can be better shown than on transverse images.

CT clearly delineated the course and connections of anomalous veins. In our study, 4 cases were examined by CT for suspected anomalous pulmonary venous drainage on clinical examination and by echocardiography. CT confirmed the diagnosis of partial anomalous pulmonary venous drainage in the 4 cases one of those cases diagnosed as scimitar syndrome in which partial anomalous pulmonary venous drainage of the right lung to the inferior vena cava (IVC). It could delineate clearly the type and the course of anomalous pulmonary veins. CTA excluded the diagnosis of anomalous pulmonary venous drainage in 2 cases suspected to have anomalous pulmonary venous drainage. CT agreed with echocardiography in the diagnosis of 5 cases of total anomalous pulmonary venous drainage. Two cases diagnosed as total anomalous pulmonary venous drainage cardiac type , Two cases diagnosed as mixed cardiac and supra-cardiac type while one case diagnosed as supra cardiac type.

Genoni ⁽¹³⁾ in his study reported that CT assessment of the altered vascular anatomy is valuable for follow-up after complex surgical repair

In our study one case had been assessed after fallot repair presented with symptoms of pulmonary arterial hypertension. CT revealed marked dilatation the pulmonary arteries due to oversurgical correction.

Johnson ⁽¹⁴⁾ in his study reported that CT provides excellent morphological evaluation of Conotruncal Anomalous such as the Fallot tetralogy, double-outlet right ventricle, transposition of the great vessels.

In our study we reported case of case of fallot tetralogy ,double-outlet right ventricle, and transposition of the great vessels and truncus arteriosus type II.

CONCLUSION

The associated examination of the lungs included in the field of the study allowed

determination of the extent and degree of involvement of lung infections (important for operative schedule of the patient). It provided essential information about the lung vascularity, pulmonary branching patterns, MAPCAs arborization and exclusion of AVMs. It helped in delineation of tracheobronchial tree with determination of the points of compromise in cases of vascular rings and branching pattern in cases of isomerism.

The nowadays ease of the scan acquisition, the high spatial resolution and the accurate assessment of modern CT techniques make CT chest angiography an investigation ideally suited for the great chest vessels anomalies.

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