Diagnostic Accuracy of CT Angiography in Evaluation of Congenital Pulmonary Arterial and Venous Anomalies

IBRAHIM I. E. SHALABY, M.Sc.*; AHMED F. YOUSEF, M.D.*; AMANY M. EL-KHARBOUTLY, M.D.* and ASHRAF M. ABD EL-RAHMAN, M.D.**
The Department of Radiology, Faculty of Medicine, Banha* and Mansoura* * Universities

Abstract

Introduction: CT Angiography (CTA) has an important role in assessment of congenital heart disease; it can be used for accurate depiction of complex anatomical details of extra-cardiac pulmonary vascular structure.

Material & Methods: Non ECG gated CTA were done to 50 patients. 2D, MIP, and Volume Render (VR) images were analyzed and reported with correlation against conventional catheter angiography and surgical details to evaluate the diagnostic accuracy of CT angiography as 1st baseline assessment of arterial and venous pulmonary anomalies.

Results: Calculated diagnostic accuracy was 100% of non ECG gated CT angiography as 1st baseline diagnosis and this because the diagnostic conventional catheter angiography and operative details were the same as CT angiography results.

Conclusion: CT angiography is the 1st choice in morphological evaluation and baseline provisional diagnosis of extra-cardiac congenital vascular pulmonary anomalies, VR images have major roles in understanding the complex anatomical structure, but still conventional catheter angiography is still the golden standard for preoperative evaluation.

Key Words: CT angiography – Pulmonary atresia – Congenital.

Introduction

CT Angiography (CTA) has an important role in assessment of congenital heart disease. It can be used for accurate depiction of complex anatomical details of extra-cardiac systemic and pulmonary vascular structure [1]. Catheter directed cardiac angiography is considered as golden imaging technique for evaluation of congenital pulmonary vascular anomalies, but is still limited by its 2D nature and difficulties in simultaneous evaluation of systemic pulmonary vascular system [2].

Material and Methods

This study was conducted from January 2015 to January 2016 at private center (Tibia) at Mansoura, it included 50 patients (26 male, 24 female) with their age range from 7 days to 4 years with mean age one year. Patients were referred from different pediatric cardiologists with highly suspected of congenital vascular pulmonary anomalies with ECHO and clinical reports.

CT scanner is 16 slices scanner (Pihillips Medical System, Cleveland, USA) all exam were non ECG gated, the tube effective current was 300 mAs, tube voltage was set 100-12-KV depending on the estimated body mass index, tubal feed 25 mm/rotation and tubal rotation time 280ms/rotation.
Before CT examination, all patients are fasting for 4 hours; sedation was done for all patients. Chloral hydrate (in a dose of 25-50mg/kg body weight, not exceeding maximum dose of 2000mg) was used in 41 patients. Intravenous protocol was given by anesthesiologist for 19 patients in a dose of 1-2mg/kg body weight for induction and the dose was increased in some cases to maintain sedation.

Non ionic low osmolar contrast media were given at flow rate 3ml/sec by a mechanical injector with dose 2ml/kg, scanning on supine position with field of interest extent from base of neck till the level of L2. Images were reconstructed at slice thickness 5mm. Timed injection method was used, and examination was started after injection of 70% of total volume of contrast (other factors affecting time of start of examination were site of injection and expected underlying cardiac condition).

CT angiography images were analyzed by two 15-year-experienced pediatric radiologist by reviewing 1st axial images at original DICOM images, then reconstructed images followed by axial, coronal, sagittal and curved MIP images and lastly VR images and reporting the finding to structure report specific for congenital heart disease.

Conventional catheter angiography and operative details were gold standard to measure the percentage of diagnostic accuracy of CT angiography as 1st baseline of assessment of extra-cardiac pulmonary and venous anomalies.

The collected data was analyzed using SPSS software with diagnostic accuracy was calculated using ANOVA test.

**Results**

CT angiography images analysis of 50 cases showed different vascular pulmonary anomalies. Pulmonary arterial atresia was the most common disorder 28 cases (56%) at our study pulmonary atresia was classified into different subtypes according to the presence of PDA Fig. (1), aorto-pulmonary collaterals, post-operative or without PDA or collaterals. Pulmonary atresia with PDA is the commonest (11) cases (22%).

5 cases only had pure pulmonary venous anomalies with no other disorder, (4) cases had PAPVR Fig. (2) two cases showed supra-diaphragmatic drainage and two cases showed infra-diaphragmatic drainage. One case was accessory left pulmonary vein.

Post-operative evaluation were in two cases, 1st was post-operative TGA (transposition of great vessels), the other was after repair of pulmonary artery stenosis and both showed recurrent arterial stenosis. Rest of CT angiography results were listed at (Table 1). Calculated diagnostic accuracy was 100% of non ECG gated CT angiography as 1st baseline diagnosis and this because the diagnostic conventional catheter angiography and operative details were the same as CT angiography as regard 1st baseline provisional diagnosis with no false negative or positive results in corresponding to diagnosis.

<table>
<thead>
<tr>
<th>Anomalies</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary artery atresia without PDA or collaterals</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>Pulmonary artery atresia with PDA</td>
<td>11</td>
<td>22%</td>
</tr>
<tr>
<td>Pulmonary artery atresia with aorto-pulmonary collaterals</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>TOF with pulmonary atresia</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>Large PDA with no other anomalies</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Post-operative correction of TGA with stenosis of pulmonary artery</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>TGA</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>PAPVR with no complex anomalies</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Idiopathic dilation of pulmonary artery</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>scimitar</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Truncus arteriosus</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Hemitruncus arteriosus</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Post-operative pulmonary stenosis</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Absent left pulmonary artery</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Accessory of left pulmonary vein</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Vascular ring between ascending aorta and main pulmonary artery</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Complex cardiac, arterial and venous anomalies</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

Total 50 100%
Fig. (1): 2 years old female patients (A) VR image (B) coronal oblique reformatted MIP, both showed significant stenosis seen at confluence of pulmonary arteries with large PDA seen connected the arch of aorta with proximal portion of right pulmonary artery.

Fig. (2): Male patient of 6 months years old. (A,B) Coronal and axial MIP images showed partial anomalous pulmonary venous return as the right superior pulmonary vein seen daininge to superior vena cava (black asterix).

Fig. (3): Male patient one year old with vascular ring. (A) Coronal reformatted image with lung window showed long segment of stenosis of right main bronchous seen compressed below the right main pulmonary artery (B) VR image showed tight stenosis at proximal right main bronchous.
Discussion

The role of CT angiography in congenital thoracic vascular anomalies varies from the only reliable method as vascular ring (Fig. 3), total anomalous pulmonary venous return or patients whom MRI is totally contraindicated [8].

CT in intra-cardiac anomalies now is very promising especially 128 slice MDCT scanners with ECG gated that gives functional data with more delineation of complex vascular anomalies, however in our study at 16 slice with non ECG gated morphological data is only available data and have a very high diagnostic accuracy of 1st baseline provisional diagnosis reach in our results 100% compared to conventional catheter angiography and operative details but no functional data can be used as prognostic value or accurate determination of the severity of the condition.

However compared to old generation, 16 slices has a very good temporal and spatial resolution with newly developed softwares give high quality of MIP and 3D VR reconstructed images. VR images give more information about complex vascular anatomy [5].

Our results of diagnostic accuracy of 100% in determined morphological provisional diagnosis of complex pulmonary vascular anomalies agreed with Lee et al., [9] which detection 53 of 54 anomalies with complex heart disease, also totally agreed with Vaishnav et al., [8] study of 20 patients, the findings of CT angiography were compared with Echo. CT pulmonary angiography was superior to Echo in visualization of the morphology of the congenital anomaly and its associated findings. The intraoperative findings were consistent with the pulmonary angiographic findings.

CT is more sensitive than transthoracic ECHO in pulmonary venous stenosis and anomalies of return and is totally noninvasive compared to catheter angiography. CT also, has the greatest essential role in post-operative follow-up for early detection of complication as recurrent stenosis.

The two major drawbacks of non ECG gated MDCT angiography is lack of functional data and need of very highly experienced radiological team in evaluation of cases as regard wide range of anomalies and even single anomaly has many appearance.

Conclusion:

CT angiography is the 1st choice in morphological evaluation and baseline provisional diagnosis in extra-cardiac congenital vascular pulmonary anomalies, VR images has a major role in understanding the complex anatomical structure, but still conventional catheter angiography is still the golden standard in preoperative evaluation.

References


