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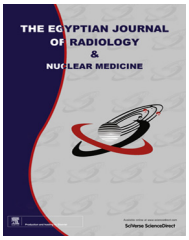

ORIGINAL ARTICLE

Role of multi-slice CT angiography in the evaluation of pulmonary venous anomalies

Ayman Osama *

Radiology Department, October University, Egypt

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KEYWORDS

Multi-slice;
CT;
Pulmonary;
Venous;
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Abstract *Purpose and aim:* To assess the role of MSCT angiography in evaluation of extra-cardiac vascular abnormalities in pulmonary venous anomalies and compare it with echocardiography.
Materials and methods: This study included 26 patients with an age range of 15 days–25 years. All of these patients underwent MSCT angiography and echocardiography. Only 10 patients underwent cardiac catheterization.
Results: Our initial experience showed that MSCT is capable of complementing echocardiography and replacing diagnostic cardiac catheterization for anatomical delineation if performed with an optimum technique.
MSCT angiography proved to be a worthy primary investigation tool in patients whom ECHO has been able to clearly identify the intracardiac anatomy, but not the extra-cardiac vascular anatomy.
Conclusion: MDCT correctly depicted the TAPVR (Total anomalous pulmonary venous return) and PAPVR (Partial anomalous pulmonary venous return) types of pulmonary venous anomalies with sensitivity 100%, and specificity 100%. The specificity of echocardiography was 50% for both findings. Inspite of the risk of ionizing radiation and contrast medium injection the adoption of our minimal invasive, low radiation, non-ECG gated protocol greatly reduces the time, radiation dose, and contrast medium volume needed to perform an optimum CT angiographic technique. Thus, paving a clear road map for pre and post operative assessment of patients with pulmonary venous anomalies.

1. Introduction

The traditional method of diagnosis of congenital heart disease has been catheter angiography. While effective in diagnosis, angiography is an invasive procedure. Evaluation of right and left sided defects may require both venous and arterial punctures (1).

Echocardiography (ECHO) is the mainstay of diagnosis of congenital heart disease. Its strength includes an absence of radiation, the ability to evaluate intra-cardiac structure and

* Tel.: +20 1066656622; fax: +20 225171116.
E-mail address: ayman_kamel1@yahoo.com.
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function and the ability to perform hemodynamic assessment. However, it is limited in the evaluation of certain portions of the aorta (particularly the ascending aorta and the transverse arch), the distal pulmonary arteries, the right ventricle, and the pulmonary veins (2).

The development of multi-slice spiral computed tomography (MSCT) has increased the clinical use of cardiac CT imaging in patients with pulmonary venous anomalies. Multi-slice CT has the advantages of fast scan speed; high spatial resolution, enabling the acquisition of isotropic volume data; and simultaneous evaluation of airways and lung parenchyma, thus increasing the ability to answer most clinical questions about structural abnormalities in patients with congenital heart disease (3).

Our aim is to assess the role of MSCT angiography in evaluation of extra-cardiac vascular abnormalities in pulmonary venous anomalies and compare it with echocardiography.

2. Patients and methods

This study included 26 patients suspected or diagnosed of having pulmonary venous anomalies on examination and echocardiography. The patient population consisted of 15 males and 11 females. They ranged in age range from 15 days old to 25 years. All patients were referred from pediatric cardiologists in the period from (April-2007) to (February-2010).

Echocardiography examination was performed for all patients prior to CT.

Diagnostic cardiac catheterization was performed in 10 of our patients before performing CT and correlation between the findings was performed.

All patients were referred in order to perform further CT angiography examination of the heart and thoracic vessels and were fitting with the following inclusion and exclusion criteria.

- **Inclusion criteria:**
  1. Limited, incomplete or failure of visualization of pulmonary venous anomalies during echocardiography examination.
  2. Difficulty in demonstrating pulmonary arteries by echocardiography for determination of their presence, size and branching pattern.
  3. Difficulty in visualization of peripheral pulmonary arteries' branches by cardiac catheter in the presence of proximal branches' stenosis.
  4. Identify normal and pathologic pulmonary venous anatomy and drainage not adequately visualized by echocardiography especially in patients with unexplained pulmonary hypertension.
  5. Recognize the associated airway, and pulmonary parenchymal findings.

- **Exclusion criteria:**
  1. Clinically unfit patients e.g. Severe asthma.
  2. Contrast hypersensitivity or serum creatinine level > 2 mg/dl.

2.1. CT angiography of the heart performed included

- Study planning.
- Patient preparation.
- Technique of Examination.
  - ○ Data acquisition.
  - ○ Image reconstruction and post processing.
- Image interpretation.

2.1.1. Study planning

- Consultation with the referring physician was attempted prior to the study to discuss the clinical background of the case and delineate specific questions raised by the physician in order to understand the reason for referral and expectations of the physician from the study. These questions usually included problems encountered with the physician during echocardiography or cardiac catheterization such as failure to delineate the pulmonary vascular tree, the effect of cardiovascular structures on the major airways or lung aeration, as well as the status of the upper abdomen to look for situs abnormalities spleen.
- Review of echocardiographic findings and cardiac catheter reports if available.
- Checking renal functions to exclude patients with a creatinine level above 2.
- History taking from the parents and patients.

2.1.2. Patient preparation

- Fasting for 4–6 h in all patients.
- Venous catheters (21–24-gage) were placed in an upper limb vein or the peripheral vein of the foot.
- Sedation by minor general anesthesia was used for patients. The examination was done without the need for sedation in two patients.
- Description of the Procedure to the parents with their reassurance.

2.1.3. Technique of examination

2.1.3.1. Data acquisition.

- ***Scanner:***
  - All studies were performed using a dual-source CT system (SOMATOM Definition, Siemens, Forchheim, Germany).
  - The patient lies on the CT table in ***supine*** position.
  - ***A scanogram*** is obtained.
  - ***Scan range:*** from the root of the neck including the proximal aspects of the common carotid and subclavian arteries down to the level of the portal vein inferiorly. This range is important to detect associated aortic arch branch anomalies, situs inversus, situs ambiguous, abdominal aorta coarctation and infra-diaphragmatic type of total anomalous pulmonary venous drainage.
  - ***ECG gating:*** was performed in cases above 18 years of age and in case of suspected aortopulmonary windows. In the rest of the cases ECG gating was not performed to avoid unnecessary excess radiation exposure by the patient.

- ***Contrast injection:***
  - ○ Non-diluted, Non-ionic contrast material was used. (Omnipaque 300–350; Nycomed Amersham, Princeton, NJ).
  - ○ ***Rate of injection:***2–3 ml/kg.