

Role of multi-detector computed tomography in congenital heart diseases

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Abstract

Background: Congenital heart diseases associated with more malformations, complex aortopulmonary collaterals and anomalous coronary artery.

Echocardiography is the initial diagnostic method but this method can be limited in complex congenital heart diseases.

Purpose: To assess the role of MDCT in congenital heart diseases (CHD) diagnosis compare with operative result and interventional angiography.

Methods: 910 patients with congenital heart diseases of 31.000 patients underwent cardiac angiography with 64 and 320 section CT at Medic Medical Center since 09/09/2006 to 30/12/2015.

Results: There are 658 operated cases, most of operated cases demonstrated the exact diagnosis of MDCT in congenital heart diseases.

Conclusions: MDCT is the fast and non-invasive diagnostic method with the high accuracy, overcomes the limit of echocardiography in complex congenital heart diseases diagnosis and provides the panorama and useful informations prior to the operation.

Introduction

Congenital heart diseases effect ~ 1% of all live births in the general population. Complex congenital heart diseases associated with more malformations, complex aortopulmonary collaterals and anomalous coronary artery.

Over the past few decades, the diagnosis and treatment of congenital heart diseases have greatly improved [1-4]. Diagnostic tools: X-ray, ECG, echocardiography, MRI and MDCT. ECG and X-Ray suggest the diagnosis but are not specific. Echocardiography is the initial diagnostic method for patients with suspected CHD but this method can be limited in complex CHD.

The great capabilities of MRI for anatomic and functional assessment of the heart but MRI is time-consuming and may require patient sedation.

Now enable CT to be used as an accurate non-invasive clinical instrument that is fast replacing invasive cine-angiography in the evaluation of CHD [1,5,6]:

- Improves both spatial and temporal resolution.
- Increases scanning speed.
- Improves diagnostic image quality by reducing respiratory artifacts

Purpose

To assess the role of MDCT in congenital heart diseases (CHD) diagnosis compare with operative result and interventional angiography

Material and methods

Subject

910 patients with congenital heart diseases of 31.000 patients underwent cardiac angiography with 64 and 640 section CT at Medic Medical Center since 09/09/2006 to 30/12/2015.

Means and scanning techniques

Medic Medical Center scanned cardiac CT by 64 MDCT Toshiba Aquilion machine and Toshiba Aquilion One (320 MDCT), 0.5mm slice thickness, 0.5mm imaging reconstruction.

- Two phases scanning (Figure 1): Don't inject phase and contrast media injection phase:
 - Phase doesn't inject contrast which help locate and assess coronary artery calcification.
 - Phase inject contrast media: Medicine chasing phase and water chasing phase.
- Contrast pumping machine is double-barreled Stellant (Medrad).

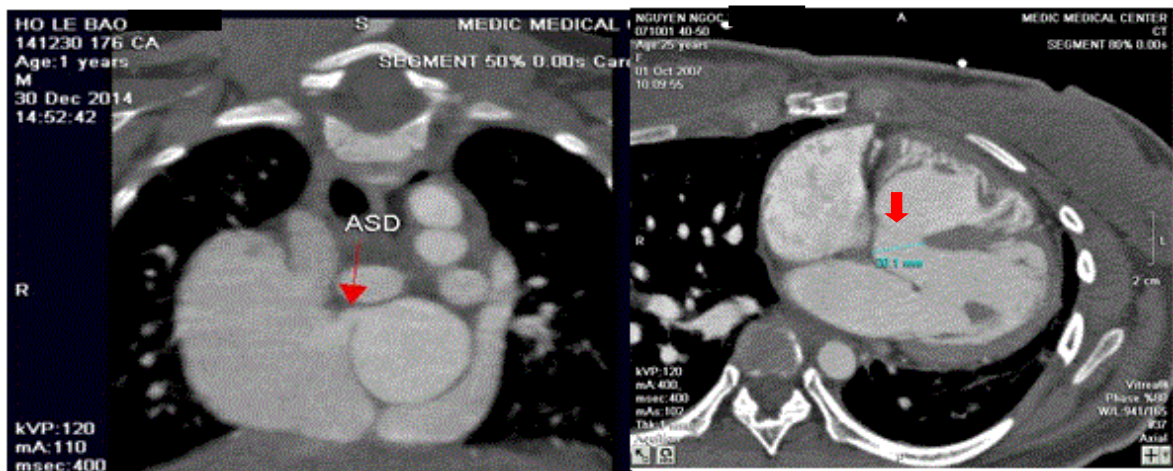
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Figure 1. Two CT scanner



Sinus venosus defect

Membranous defect

Figure 2. Atrial septal defects and Ventricular septal defects.

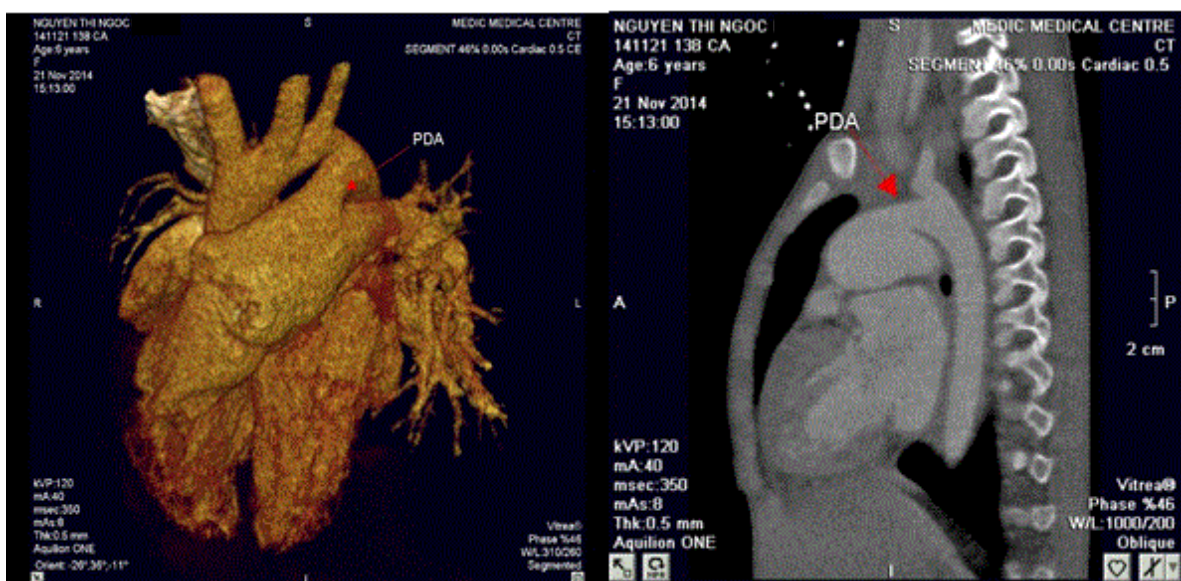


Figure 3. Patent ductus arteriosus; 3D images: Patent ductus arteriosus

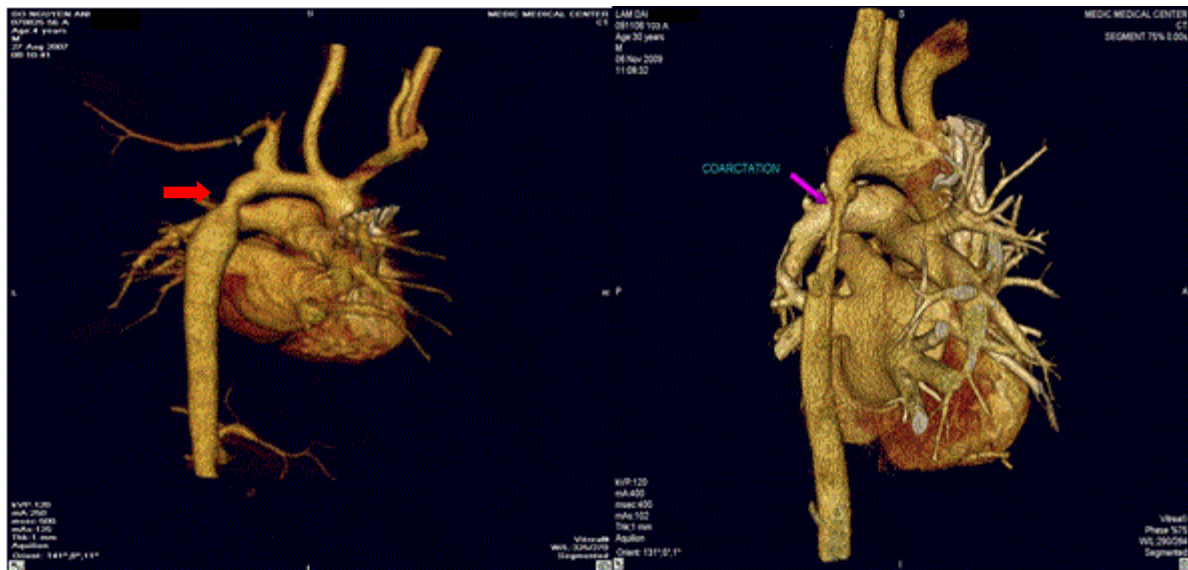


Figure 4. Coarctation of aorta

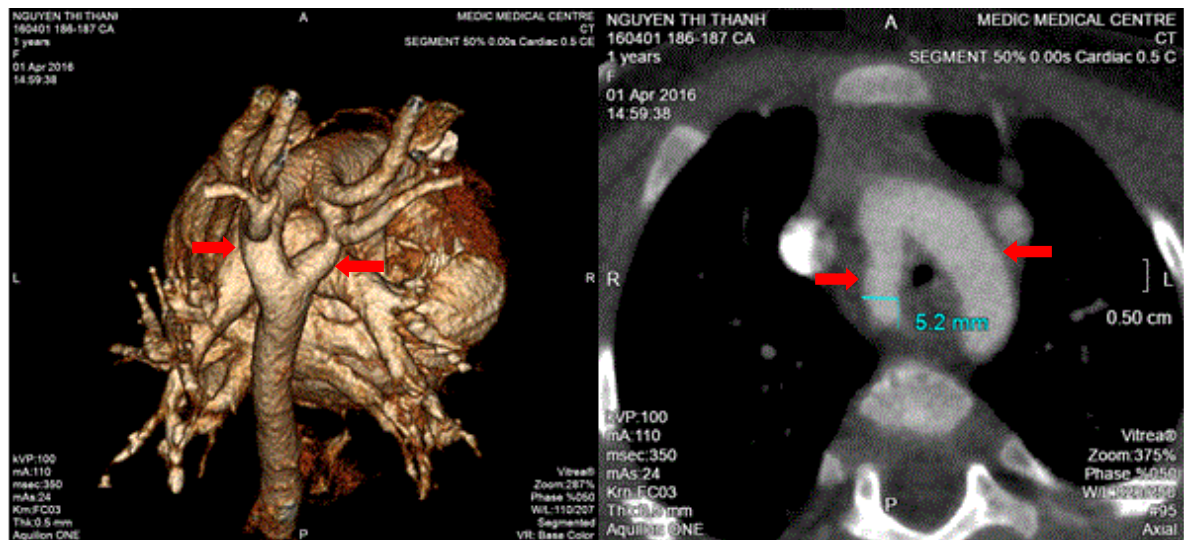


Figure 5. Double aortic arch; 3D images and Axial: Contrast-enhanced CT double aortic arch

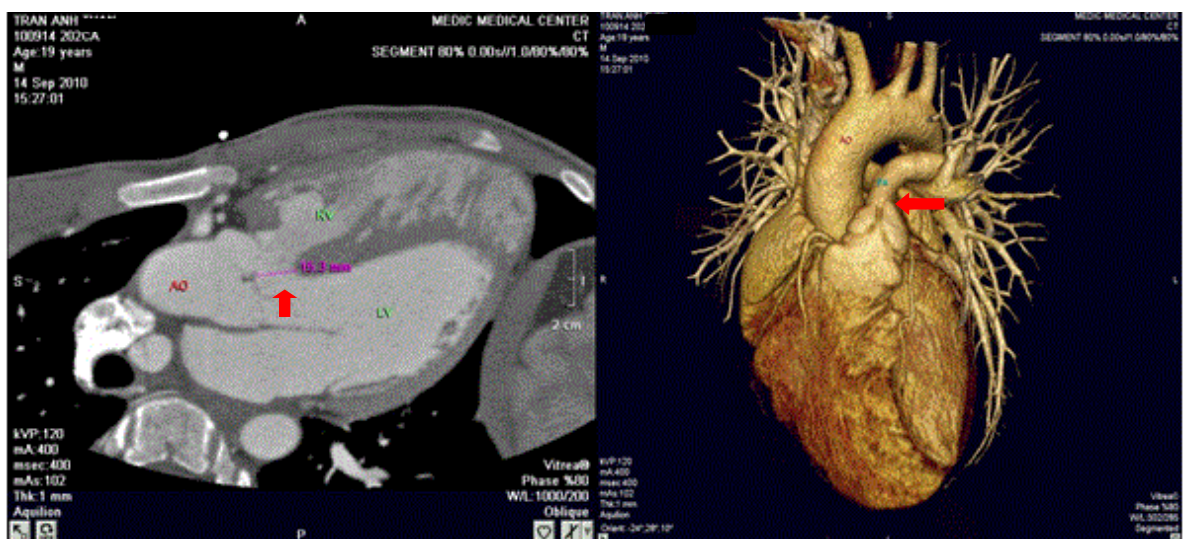


Figure 6. Tetralogy of Fallot; Subaortic ventricular septal defect, over riding aorta and pulmonary artery stenosis

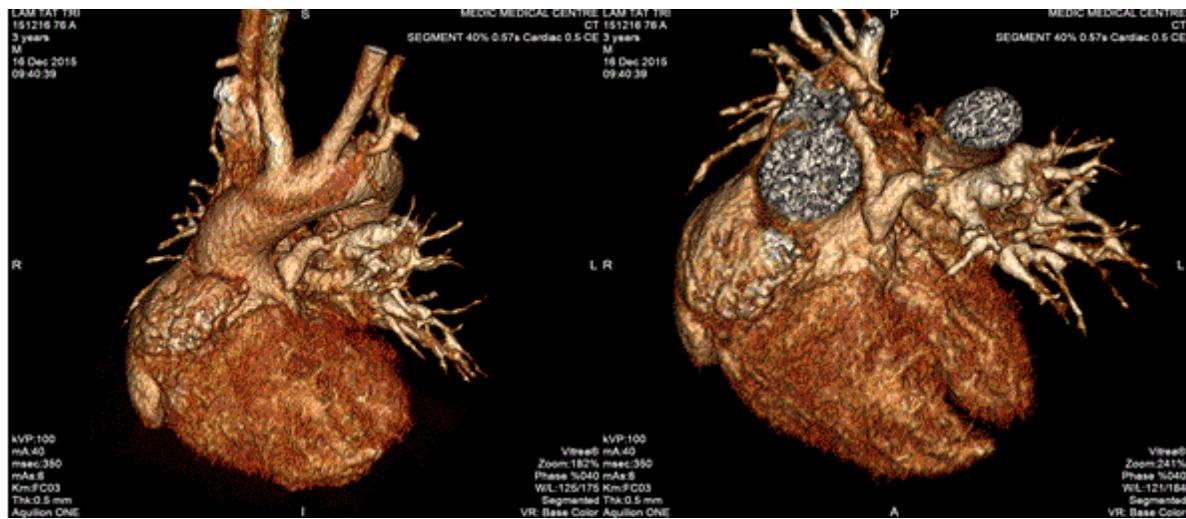


Figure 7. Pulmonary atresia with ventricular septal defect; Pulmonary atresia with ventricular septal defect and confluence of pulmonary artery

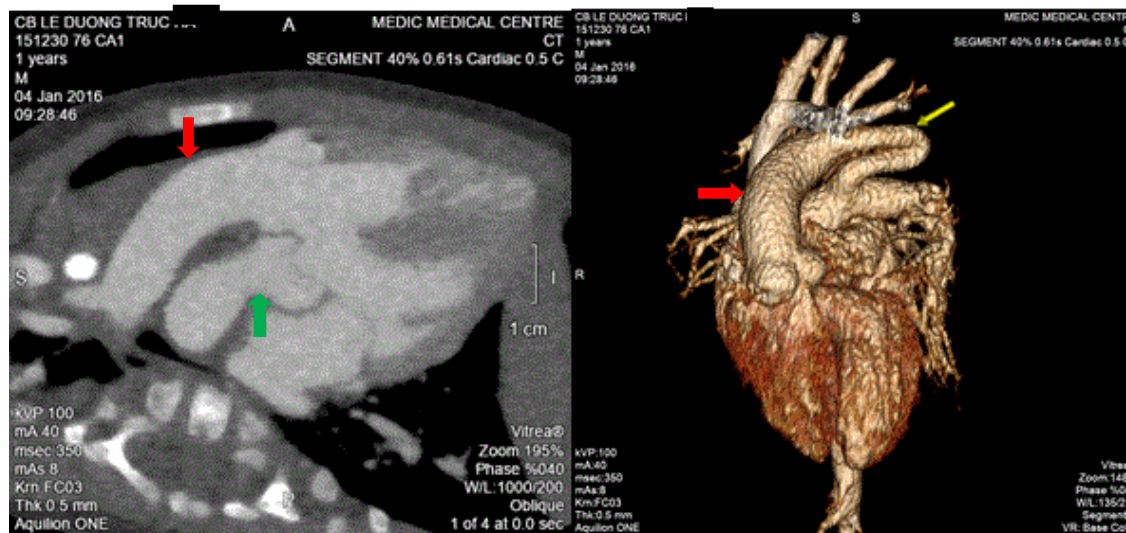


Figure 8. Transposition of great vessels; Aorta and pulmonary artery in parallel; 3D image : Aorta and Pulmonary artery switched, aorta in front of pulmonary artery

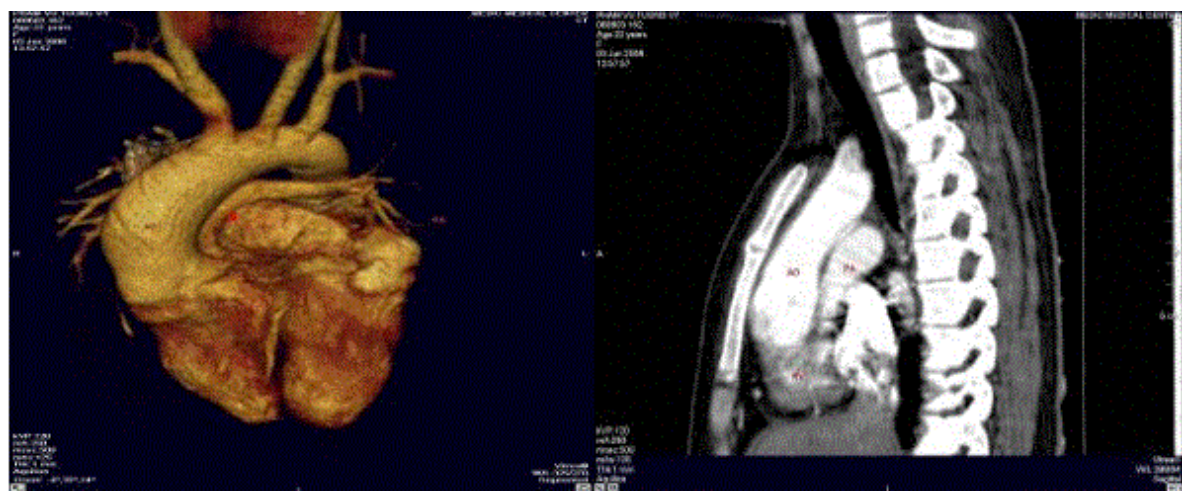


Figure 9. Double outlet right ventricle; Both of great arteries (aorta and pulmonary artery) arise from right ventricle and aorta is in front of pulmonary artery

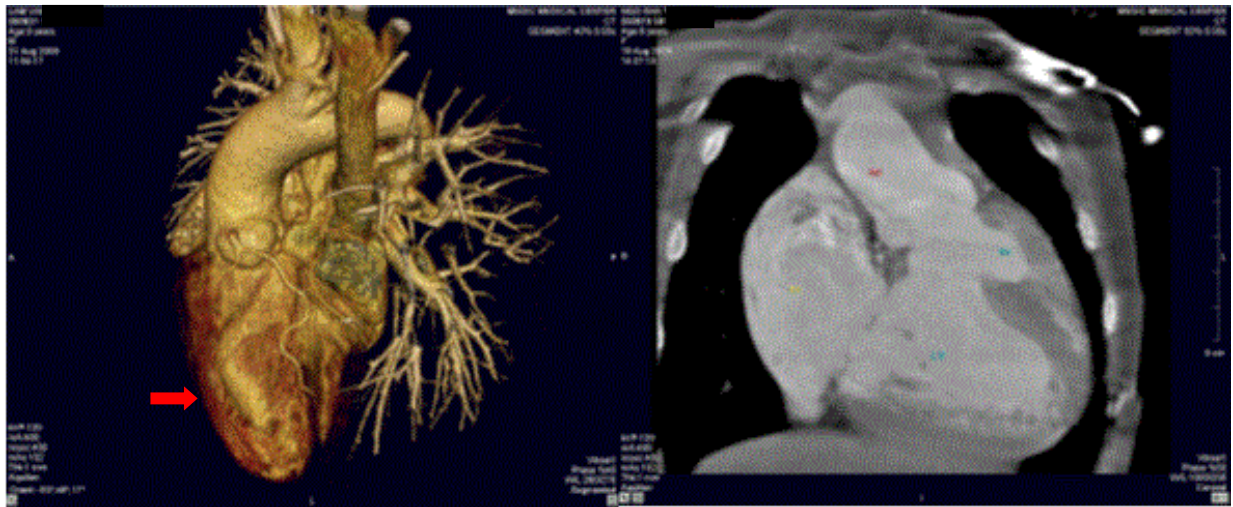


Figure 10. Single ventricle; Single ventricle– main right ventricle and left hypoplastic ventricle

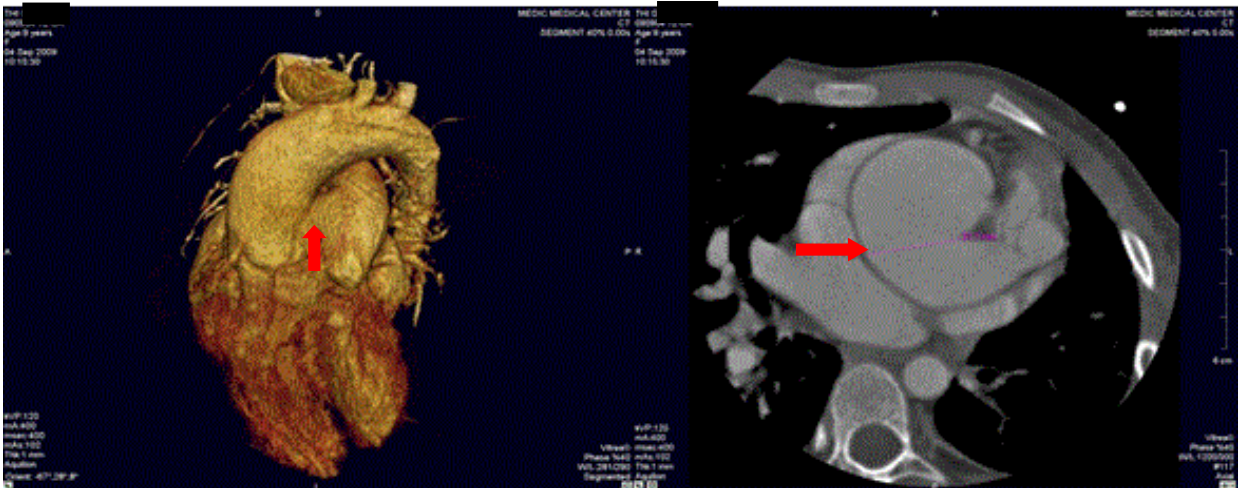


Figure 11. Aortopulmonary window; Axial view: A hole between aorta and pulmonary trunk

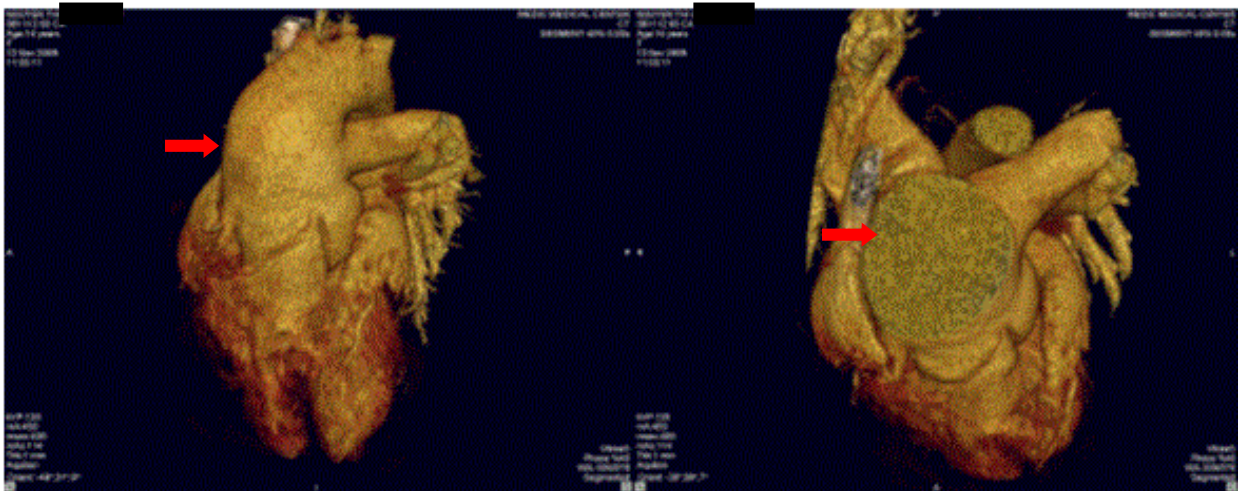
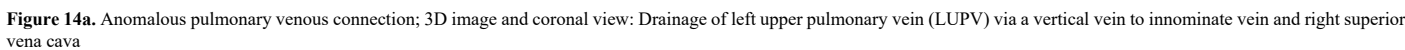
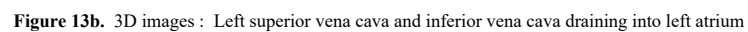
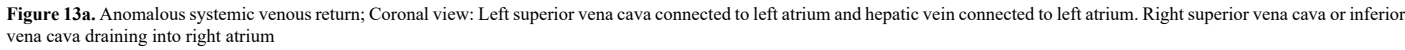


Figure 12. Truncus arteriosus; 3D images: Right and left pulmonary arteries arise from lateral aspects of truncal root reasonably distant from each or



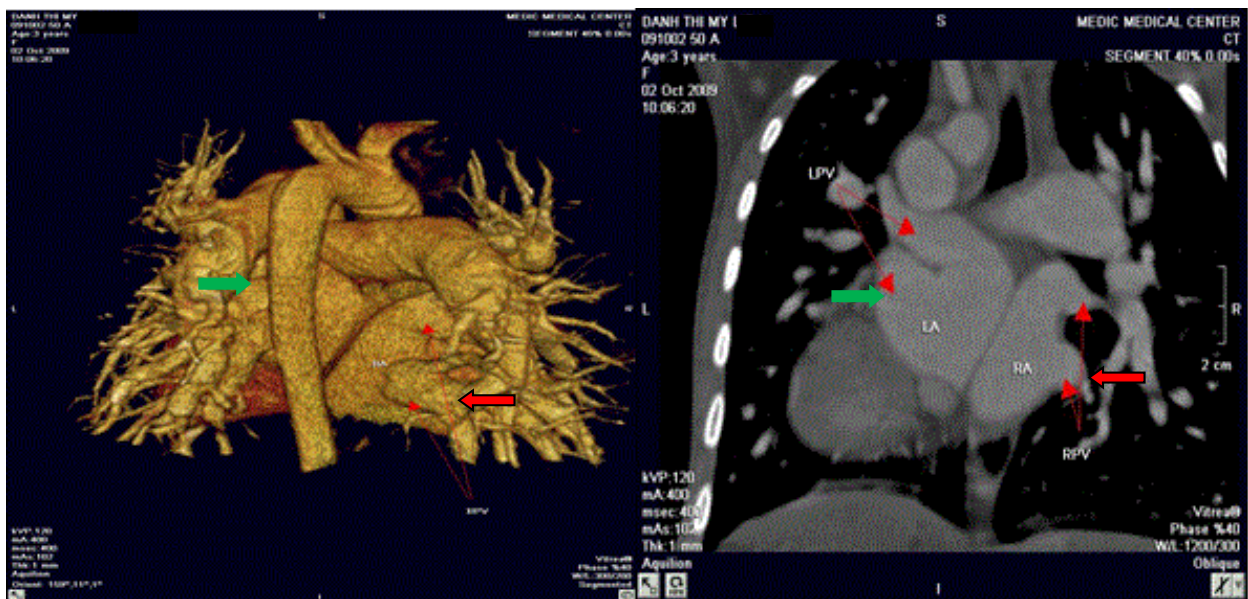


Figure 14b. 3D images: Drainage of right upper and lower pulmonary vein to right atrium

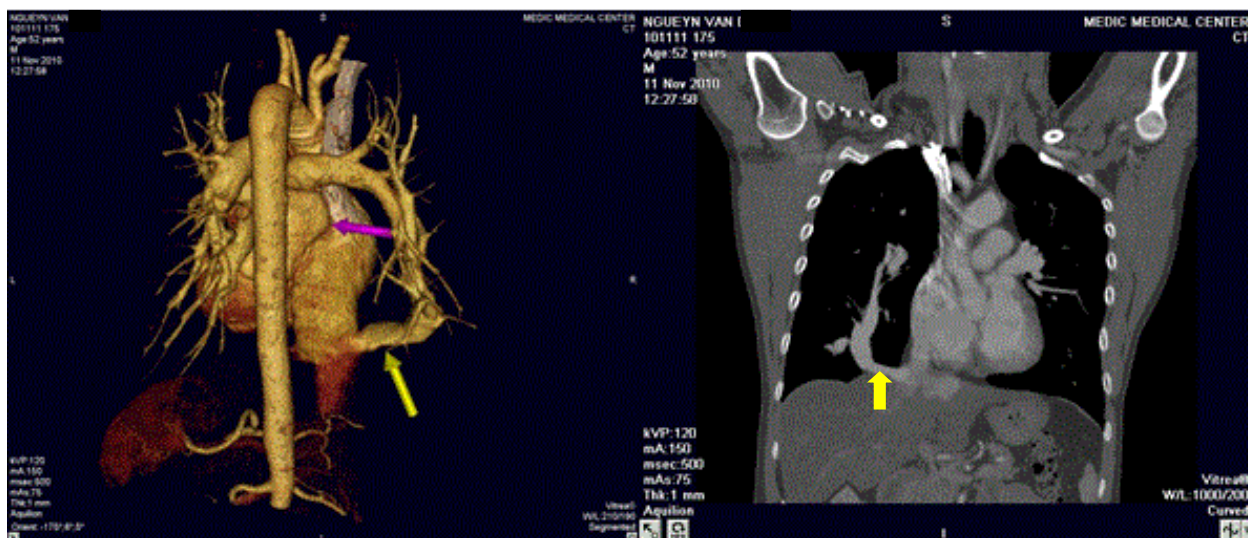


Figure 14c. 3D images: Drainage of right lower pulmonary vein (RLPV) to inferior vena cava (IVC)

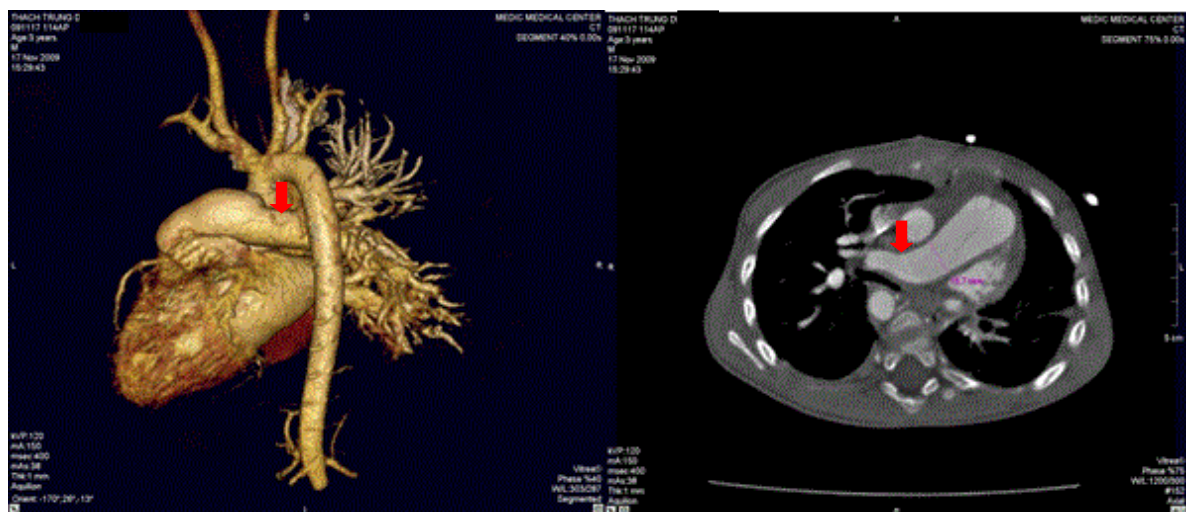


Figure 15. Single pulmonary artery; 3D image and Axial view: Seeing right pulmonary artery and absent left pulmonary artery

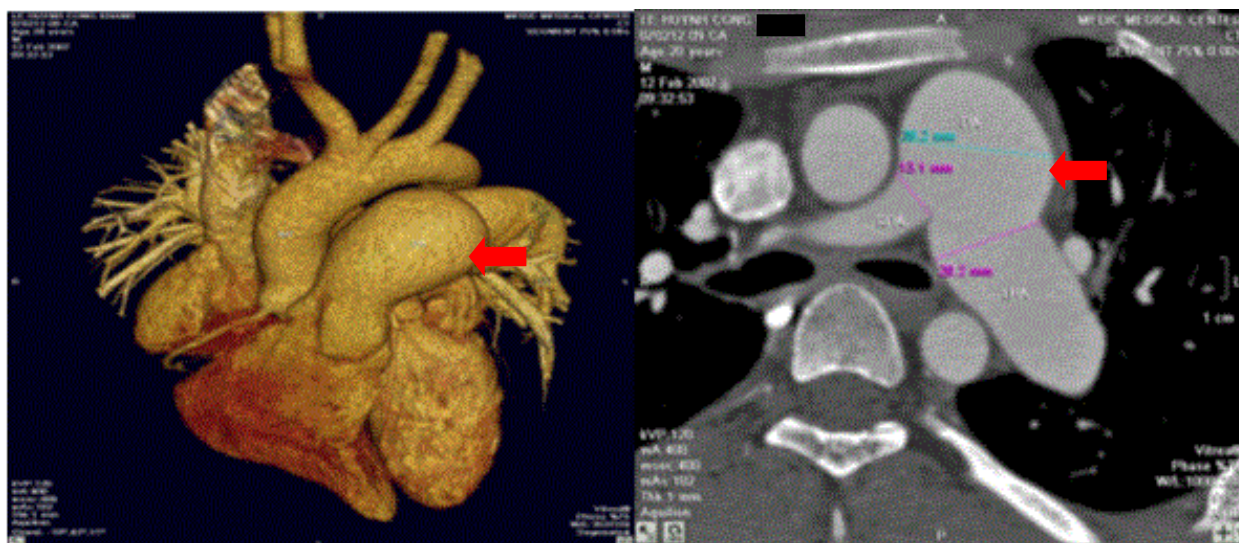


Figure 16. Pulmonary artery trunk aneurysm; D image and Axial view: Pulmonary artery trunk and left pulmonary artery aneurysm



Figure 17. Congenital pulmonary arteriovenous malformation; 3D view: Right-to-left shunt between the pulmonary and vein

- To inject contrast by intravenous right hand.
- Contrast dose used 1mL / kg.
- Drug pump speed depends on patient status and disease.
- Vitrea software: Reconstructed images by MPR, MIP and VRT.
- Effective radiation dose is low (320-MDCT is 3.69 ± 0.61 mSv; 64-MDCT is 12-14 mSv).

Data analysis

- The prospective study and case series report compare with operative and interventional angiography.
- Data collection at the HCM city Heart Institute, Tam Duc Heart Hospital and Medic medical centre.

Results

There are 658 operated cases, most of operated cases demonstrated the exact diagnosis of MDCT in congenital heart diseases (Figures 2-17).

Discussion

Congenital heart diseases associated with more malformations, complex aortopulmonary collaterals and anomalous coronary artery.

Echocardiography is the initial evaluative method for pre- and postoperation congenital heart diseases but this method can be limited in complex cases.

Multi-detector computed tomography overcomes the limit of Echocardiography by multiplanar reconstruction (MPR) and volume rendered techniques (VRT) reconstruction.

Volume rendered techniques (VRT) reconstruction clearly demonstrates the relationship between the heart and great vessels.

Conclusion

Multi-detector computed tomography is the fast and non-invasive diagnostic method with the high accuracy. Overcomes the limit of Echocardiography in complex congenital heart diseases. Provides the panorama and useful information's prior to the surgery.

References

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