ROLE OF HELICAL CT IN THE ASSESSMENT OF VASCULAR ANOMALIES AND CONNECTIONS IN PEDIATRIC PATIENTS WITH CONGENITAL HEART DISEASE

THESIS

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BY

RANIA ZAKARIA ABO EL EZZ

M.B., B.CH., M.Sc
(Cairo University)

UNDER SUPERVISION OF

Dr.Magdy Ibrahim Bassiouni

Professor of Radiodiagnosis

Faculty of Medicine

Cairo University

Dr. Mohamed A. Latif Shahin

Lecturer Of Radiodiagnosis

Faculty of Medicine

Cairo University

Dr. Wael Nabil Lotfy

Assistant professor Of Pediatric

Faculty of Medicine

Cairo University

Faculty of Medicine

Cairo University

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ABSTRACT

Congenital heart disease (CHD) is a common health problem. ***(Goo, 2003)*** To plan effective management of congenital heart disease, one needs the clearest understanding of the anatomy and the complex cardiovascular morphology present, especially the extra-cardiac morphology. Echocardiography and cardiac catheterization are the traditional imaging modalities used to diagnose congenital heart disease. ***(Haramati et al., 2002)*** Echocardiography is partly limited by the small field of view. Cardiac catheterization is an invasive modality ***(Berdon, 2000)*** Helical computed tomography (CT) especially with multi-slice CT technology allows volume acquisition in a short period of time and provides good-quality 3D vascular images, even for neonates and infants. ***(Ohnesorge et al, 2007)***

Key words: *Congenital heart disease, Echocardiography, Cardiac catheterizatin,Computed tomography*

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INTRODUCTION

Congenital heart disease (CHD) is a common health problem. Its prevalence is approximately 8 cases per 1, 000 live births. Pediatric care for patients with congenital heart disease, over the past 25 years, has been so outstanding that as many as 85% of these children now survive into adulthood. This number is increasing with time due to improvements in health care technology, better surgical techniques and neonatal care; allowing more of these patients to be diagnosed and managed early in life so they can survive to adulthood***. (Goo, 2003)***

To plan effective management of congenital heart disease, one needs the clearest understanding of the anatomy and the complex cardiovascular morphology present, especially the extra-cardiac morphology. A thorough preoperative understanding of complex cardiovascular anatomy in patients with congenital heart disease facilitates a directed and prepared surgical approach. ***(Tonkin, 2000)***

Echocardiography and cardiac catheterization are the traditional imaging modalities used to diagnose congenital heart disease. ***(Haramati et al., 2002)***

Echocardiography with Doppler continues to be the preferred modality for imaging intra-cardiac anatomy and hemodynamics; however, it is partly limited by the small field of view, variable acoustic window, inability to penetrate air and bone, and difficulty in delineating extra-cardiac vascular structures in their entirety. Moreover, it is operator dependent. ***(Haramati et al., 2002)***Cardiac catheterization is an invasive modality that yields important hemodynamic data while clearly defining anatomy in vessels

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2D	Two dimensional
3D	Three dimensional
AA	ascending aorta
Ao	Aorta
AP	anteroposterior
AS	aortic sac
ASD	atrial septal defects
AVSD	atriventricular septal defect
AV	Atrio-ventricular
AVC	atrio-ventricular canal
AVS	atrio-ventricular septum
B-T	Blalock Taussing
CA	carotid artery
CHD	Congenital heart disease
CMR	Conventional Magnetic Resonance
CT	Computed Tomography
CTA	Computed Tomography Angiography
CW	continuous-wave
DA	ductus arteriosus
DAo	dorsal aorta
DILV	double inlet left ventricle
DORV	double-outlet right ventricle
DOT	distal outlet tract
ECM	extracellular matrix
EDC	endocardial cushion
IVC	inferior vena cava
Kg	Kilogram
LPA	left pulmonary artery
LSVC	left superior vena cava
LV	left ventricle
mA	milliampere
MAPCAs	major aorta-pulmonary collateral arteries
MDCT	Multidetector row computed tomography
mg	Milligram
MinIP	minimum intensity projection

MIP	maximum intensity projection
MPR	Multiplanar reformation
MRI	Magnetic Resonance Imaging
OT	Outlet Tract
PA	Pulmonary artery
PAPVC	Partial anomalous pulmonary venous connection
PAPVD	Partial anomalous pulmonary venous drainage
PDA	Patent ductus arteriosus
PF	Primary fold
Ph A	Pharyngeal arch arteries
PVOT	proximal ventricular outlet tract
PT	pulmonary trunk
PW	pulsed-wave
RA	right atrium
RAIV	Retroaortic innominate vein
RCA	right coronary artery
RPA	right pulmonary artery
RV	right ventricle
SA	sinuatrial ring
SSD	Surface shaded display
SV	sinus venosus
SVC	superior vena cava
TA	truncus arteriosus
TAPVC	total anomalous pulmonary connection
TAPVD	total anomalous pulmonary venous drainage
TGA	Transposition of great arteries
TOF	Fallot Tetralogy
US	ultrasound
VIS	ventricular inlet segment
VOS	ventricular outlet segment
VR	volume rendering
VSD	ventricular septal defect

that are accessible to catheterization. However, angiography often gives only indirect information regarding venous connections and arterial anatomy distal to high-grade stenosis or atresia. It also uses high doses of ionizing radiation and is limited by the risks inherent to iodinated contrast material. ***(Berdon, 2000)***

Despite the dominant role of echocardiography and angiography in imaging patients with congenital heart disease, still the condition is frequently considered a diagnostic challenge. Various imaging modalities can play an important and complementary role in surgical planning for patients with congenital heart disease. MR imaging and CT are especially useful in demonstrating extra-cardiac anatomy, including the evaluation of the aorta, central and peripheral pulmonary arteries and aorto-pulmonary collateral vessels. Recent improvements in imaging equipment allow very short imaging times and avoid sophisticated reconstruction with both CT and MR imaging**.** ***(Donnelly et al., 2001)***

The decision to image with CT versus MR imaging should be based on institutional equipment, scheduling, and availability as well as the patient's ability to cooperate. The need to tailor the examination to answer the specific questions being asked may also guide the choice of CT versus MRI. ***(Haramati et al., 2002)***

MRI appears, on initial consideration, to be an ideal technique because there is no radiation burden, which is a substantial advantage, especially in neonates and young children. However, it also suffers various limitations: the major one being the need for prolonged sedation and close monitoring, especially of infants with cyanotic heart disease, whose condition is often unstable. Also, the spatial resolution of MR

images is lower than that of CT images, which can be a drawback for visualization of small anatomical structures. ***(Ohnesorge et al, 2007)***

More recently, helical CT has been proposed for 3D anatomical visualization in patients with congenital heart disease ***(Lee et al., 2004).***

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 shorter 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 ***(Ohnesorge et al., 2007)***

CT has the advantages of easy availability and very short scanning times. Introduction of contrast enhanced helical CT scan with precise timing allows for accurate extracardiac arterial and venous vascular imaging. The enhanced preoperative understanding of congenital heart disease provided by CT simplifies surgical decision making and consequently may improve outcome. ***(Kawano et al., 2000)***

Multiplanar reformation of CT images is currently readily available, decreasing the inherent disadvantage of CT image acquisition exclusively in the transaxial plane. Because of the development of helical CT, CT angiography with 3D reconstruction is becoming more useful in patients with suspected vascular anomalies e.g. aortic coarctation. This technique is becoming promising method for the preoperative evaluation of blood vessels and could be used also as a noninvasive postoperative

technique for follow up after surgical repair ***(Schaffler et al., 2000)***

Some patients with congenital heart disease present with clinical problems related to airway compression by anomalous extracardiac vascular channels. CT has the advantage of delineating the relation between the tracheobronchial tree and the anomalous vessels***. (Chan et al., 2005)***

Multi-detector row computed tomography (CT) with multiplanar and three-dimensional reconstruction has also changed the approach to imaging of thoracic anatomy and disease in the pediatric population and become an important examination in the evaluation of systemic and pulmonary vasculature and the tracheobronchial tree***.(Siegel , 2003)***

The reported drawbacks of CT include patient exposure to ionizing radiation and the risks of iodinated contrast material. Adjustment of specific technical factors as increasing the pitch and setting the lowest tube current has been shown to minimize the radiation dose in children undergoing CT. The Adverse effects of contrast material have been reduced by world- wide use of non-ionic contrast material***. (Donnelly et al., 2001)***

Helical CT with its different capabilities represent a reliable, non invasive diagnostic tool that may become an alternative method to angiography and complementary to other non invasive technique in the evaluation of extracardiac anomalies in infants with complex congenital heart disease. ***(Kawano et al., 2000)***