

行政院國家科學委員會專題研究計畫 成果報告

以多片(16 排)螺旋式電腦斷層掃描攝影完整評估嬰幼兒複雜性先天性心臟病

計畫類別：個別型計畫

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執行單位：國立臺灣大學醫學院放射線科

計畫主持人：陳世杰

共同主持人：邱英世，王主科

計畫參與人員：陳世杰、邱英世、王主科

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以多片(16 排)螺旋式電腦斷層掃描攝影完整評估先天性心臟病

Integrated Evaluating the Congenital Heart Disease by Multi-detectors (16) Spiral Computed Tomography

計畫編號：NSC 93-2314-B-002-184

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主持人：陳世杰 台灣大學 醫學系 放射科

共同主持人：王主科 台灣大學 醫學系 小兒科

共同主持人：邱英世 台灣大學 醫學系 外科

一、中文摘要

本計劃的目的為以多片(16 排)螺旋式電腦斷層掃描攝影完整評估先天性心臟病的應用。在過去 12 個月中，吾等執行了 305 個電腦斷層掃描攝影檢查的病例(男：女 =188：117；年齡=1 天~71 歲 8 月)。所有的病人都是接受靜脈注射顯影劑之電腦斷層掃描攝影的檢查，且其影像取得皆位於終心舒張期時。重組的 3D 影像採用漸層陰影的表面呈現模式。與電子射束電腦斷層的經驗比較，多片(16 排)螺旋式電腦斷層掃描攝影，仍可以有效的將包括發育不良之肺動脈、肺靜脈之異常回流、肺靜脈阻塞之有無、異常冠狀動脈分枝、合併氣道異常及有無狹窄、異常心內或心外構造之奇特三度空間相互關係... 等異常清楚的呈現出來。再加上以三度空間立體影像呈現出極度複雜的解剖構造及虛擬心臟內視鏡影像完整呈現前所未有的心內異常變化。

關鍵詞：先天性心臟病；三度空間立體影像；電腦斷層掃描攝影。

ABSTRACT

To evaluate the clinical usefulness of multi-detector (16 detectors) spiral computed tomography (MDCT) and its reconstructed 3D imaging in demonstrating

cardiac anatomy in patients with congenital heart disease (CHD). In the past 12 months, 305 cases (male : female = 188 : 117; age = 1 days ~ 71-year-8-month) with CHD were analyzed. All MDCT images were taken at the end-diastolic phase of the cardiac cycle with intravenous injection of iodinated contrast medium. 3D reconstructed EBCT pictures were created with gradient shading surface rendering. In compare to the electron beam computed tomography, MDCT is reliable to well delineate the hypoplastic pulmonary artery, anomalous drainage of the pulmonary vein, where or not the presence of the pulmonary venous obstruction, abnormal branching of the coronary artery, associated tracheobronchial anomalies and stenosis, abnormal intra-cardiac and adjacent unusual three-dimensional spatial relationship. By adding the capability of three-dimensional demonstration and virtual reality cardioscopy, MDCT could show the extremely complex CHD completely and vividly.

Keywords: Congenital heart disease; three-dimension; Computed tomography.

二、BACKGROUND & PURPOSE

Many factors influence the management of an infant with congenital heart disease. Clinically, the most important one thing is the structural abnormality. Indicated surgical correction of the cardiac anomaly in such age

group is a big trauma that does not need second revision at best. Thereafter, comprehensive and complete evaluation of these anomalies before surgical intervention is absolutely mandatory. Echocardiography, cardiac catheterization are routinely used with cardiac magnetic resonance imaging as another alternative , but have their own disadvantage [1,2,3,4].

Our hospital is a major referring center for patient with congenital heart disease. In the past 8 years, our extensive experience in such disease group by electron beam computed tomography revealed usually there are some weak points need to be further clarified even after echocardiography and cardiac angiography in order to make the surgical correction smoothly [5,6,7,8]. Multi-slice spiral computed tomography has rapid rotation X-ray tube and 16 rows detectors. It examines the heart synchronized with ECG by prospective and retrospective scanning. Because of rapid scanning time, one study could be completed only in 3 minutes and has some advantage [5,9]. Moreover, those reconstructed 3D images provide a vivid picture for surgeon to make individualized surgical planning [7,10,11,12]. In this project, we plan to verify the diagnostic power of this new technology in patient with CHD.

三、RESULTS

The diagnostic power of axial imaging

In compare to the previous experience from electron beam computed tomography, the diagnostic capability of MDCT is equal. There unclear points from the precordial echocardiography and the cardio-

angiography include the detail of the hypoplastic pulmonary artery, abnormal pulmonary venous drainage, pulmonary venous obstruction or not, unusual pattern of coronary artery, associated airway abnormality/stenosis, uncommon three dimensional relationship of abnormal intra-/extra-cardiac structures are all well delineated by the MDCT. However, due to the scanning time in one section in MDCT is slightly longer than electron beam computed tomography, the image quality in marginal sharpness is less well than electron beam computed tomography.

Useful post-processing imaging

With the accompanied advanced software, MDCT provides better and more function in post-processing of the raw data and results in much more applications. Figure 1 demonstrates the use of the multi-plane reformatted image. Figure 2 clearly shows the status of the peripheral pulmonary arteries by computed tomographic angiography. Figure 3 delineates the application of the thick-slab image to prevent the partial volume effect. Figure 4 reveals the classical usage of the three-dimensional image. Figure 5 creates the virtual cardioscopy image that is impossible in reality.

四、DISCUSSION

Using axial images by EKG-gated MDCT, this project has proved the comparative diagnostic reliability to electron beam computed tomography in detecting cardiac pathology that was poor or hardly disclosed by echocardiography or cardioangiography. In adding the information from three-dimensional reconstruction and/or virtual reality in the intra-cardiac viewpoint, surgeon can make a better planning in real intervention. We conclude that 16 rows detector MDCT

could be used to replace the electron beam computed tomography in diagnosis of the congenital heart disease. And, with the advanced post-processing software, more and more images by three-dimensional reconstruction and/or virtual reality can be applied easily and practically.

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Three-dimensional helical CT of pulmonary arteries in infants and children with congenital heart disease. AJR. American Journal of Roentgenology. 173(1):109-15, 1999 J

六、SELF-EVALUATION

The result of this project revealed very consistent with the original proposal. Investigators have established a good protocol for perform the scanning of the MDCT and the post-processing procedures for three-dimensional and/or virtual reality reconstruction of the internal cardiovascular structures. The expected goal has successfully achieved by setting up a practical guideline and vivid delineation for diagnose different kinds of cardiac pathology in CHD. The clinical application of this result is great. Because this information will provide surgeon a clear road map of diseased heart before operation that help them decide a better manipulations.

七、FIGURES



Figure 1. Curved reformatted image in disclosing the status of the pulmonary artery of this patient after right side Glenn's shunt and central Sano's shunt. Focal stenosis in the proximal right pulmonary artery and intimal hyperplasia of the Sano's shunt are recognized.

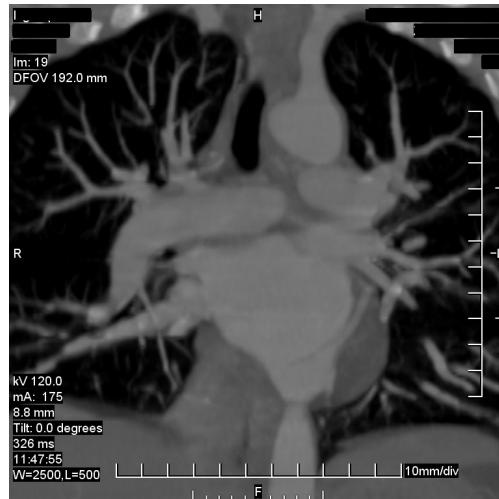


Figure 2. Computed tomography pulmonary angiography in coronal projection reveals the normal branching of the bilateral peripheral pulmonary arteries and veins. The distal coronary sinus is dilated with an un-roofing communication upward to the floor of the left atrium.



Figure 3. Thick-slab computed tomography image in axial projection shows the free end of the implanted Button device atrial septal defect occluder penetrates through the dorsal wall of the left atrium.

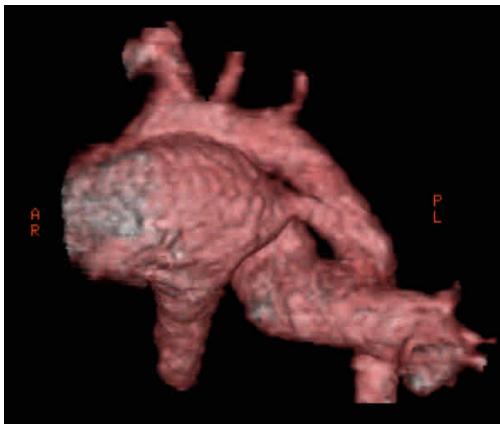


Figure 4. Surface-shaded rendering three dimensional volume reconstruction of the pulmonary artery and the aorta delineates the presence of a patent ductus arteriosus as well as the unusual right sided origin of the left pulmonary artery.

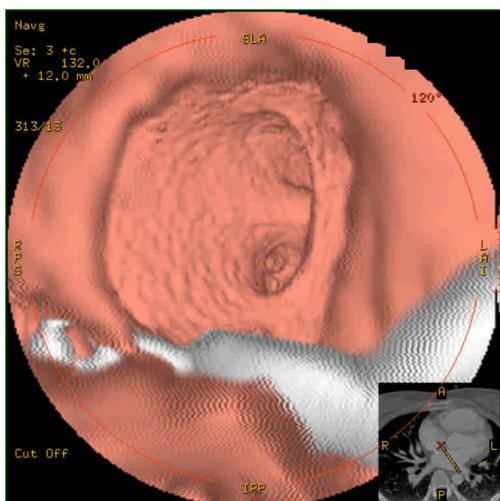


Figure 5. Virtual cardioscopy in a patient with a residual atrial septal defect. She received an atrial septal defect occluder months ago, but a residual shunt was suspect by cardioechography. This virtual cardioscopy is viewing from the right atrium into the left atrium through this round residual defect. The two orifices in the center of this image are the orifices of the left upper & lower pulmonary veins. The white shadow in this virtual cardioscopy is the malposition of this occluder device.