# Assessment of cardiovascular structural changes and position of device following transcatheter closure using three-dimensional computerized tomography

# 以三度空間影像評估心房中隔缺損關閉器對於靜脈系統以及房室瓣膜之影響

Jou-Kou Wang, MD, Shi-James Chen, MD, Mei-Hwan Wu, MD, Yiu-Hwa Li, MD, Shen-Kou Tsai, MD, Hung-Chi Lue, MD.
Grant support : NSC 90-2314-B-002-158

Departments of Pediatrics, Radiology and Anesthesiology, National Taiwan University Hospital, Medical College, National Taiwan University

Correspondence to: Jou-Kou Wang, MD,
Department of Pediatrics,
National Taiwan University Hospital
No. 7, Chung-Shan South Round, Taipei, Taiwan.
FAX:886-2-23412601
E-Mail: jkw@ha.mc.ntu.edu.tw

計畫主持人: 王主科　　協同主持人: 陳世杰
國科會計畫編號: NSC 90-2314-B-002-158

# 中 文 摘 要

本研究目的在於評估以關閉器關閉心房中隔缺損後，關閉器之位置，心臟血管之結構是否受影響。我們使用電腦斷層，研究卅一例在本院接受以關閉器關閉心房中隔缺損之病人，在手術後 6 個月至 3.3 年後做電腦斷層檢查。 這卅一例當中在 7 例接受 Sideris 關閉器, 10 例以 Starflex 關閉器及 14 例 Amplatzer 關閉器並在電腦工作站重組三度空間的影像，觀察關閉器位置肺靜脈及體靜脈系統是否通暢，二尖瓣及三尖瓣是否受影響。 結果: 四例有部份肺靜脈迴流阻塞, ( 2 例爲 Sideris 關閉器, 1 例 Starflex，另一例使用 Amplatzer 關閉器 )，其中有一例使用 Sideris 關閉器者，發生一個金屬框架 (Arm) 滑入肺靜脈。 另一例也是 Sideris 關閉器使用者，框架移入下腔靜脈，另一例 Starflex 之框架穿過心房室中隔膜。無任何一例有上腔靜脈及矢狀竇之壓迫以及無一例關閉器會阻礙二尖瓣及三尖瓣之功能。 並以心臟超音波作爲比較，並無一例有肺靜脈或上腔靜脈迴流處阻塞的情形，但有四例可看到殘留的缺損及分流。 結論: 電腦斷層影像可用於評估以關閉器關閉心房中隔缺損後，關閉器之形狀及位置以及肺靜脈及上下腔靜脈是否有阻塞，比超音波還要精確。

關鍵字: 心房中隔缺損，經心導管關閉心房中隔缺損，電腦斷層影像

# Abstract

We conduct the study to assess device position, cardiovascular structure and morphology in patients who underwent transcatheter closure of atrial septal defect (ASD).

*METHODS:*

Electron-bean computerized tomography (CT) was performed in 31 patients who had undergone transcatheter ASD closure in this institution. The interval between ASD closure and CT imaging study ranged from 6 months to 3.3 years. Of the the 31 patients, Sideris device was deployed in 7, Starflex device in 10 and Amplatzer device in 14 patients. Three-dimensional reconstruction of the CT images was performed to evaluate the device position, patency of systemic and pulmonary venous pathway and morphology atrioventricular valves.

*RESULTS:*

Partial obstruction of a pulmonary vein was observed in 4 patients (2 with Sideris device, 1 with Starflex device and 1 with Amplatzer device). Migration of one arm to a pulmonary vein was observed in 1 with Sideris device. Migration of one arm to inferior vena cava was found in one with Sideris device. Impingement on atrioventricular septum by one arm of Starflex device was found in 1. One had one arm of Starflex device penetrating atrioventricular septum. One had residual shunt. None had systemic vena cavae or coronary sinus obstruction. None had impingement of device on mitral or tricuspid valve leaflets. Cross-sectional and Doppler echocardiographic studies in the 31 patients showed none had significant pulmonary or systemic venous pathway obstruction. A small left ventricle to right atrial shunt was found in the patient who had impingement on the atrioventricular septum. Trivial-to-mind residual shunt was found on the echocardiogram in 4 with Sideris device.

*CONCLUSION:*

CT images can be useful in the assessment of device position and systemic and pulmonary venous pathway in ASD patients following transcatheter closure.

## INTRODUCTION:

Since the report of successful transcatheter closure of atrial septal defect (ASD) by King & Mills, a varieties of device have been evolved for transcatheter closure included were Rashkind device, sideris device, Angel wing, Amplatzer septal occluder, of which and CardioSeal have been widely used. With the advent of device and improvement in deployment technique, transcatheter closure of atrial septal defect (ASD) has been increasingly performed with a high success rate and low complication rate. Transthoracic echocardiography is the most common imaging tool used to evaluate the morphologic changes following of cardiovascular structure ASD closure. Changes in cardiovascular structures could be readily assessed with echocardiography. However, the effect of device closure on the systemic and pulmonary venous pathways was sometimes difficult to be evaluated with transcatheter echocardiograply. The position of the device particularly the arms and skirts was also difficult to be assessed. In the current study, we investigate the effects of ASD septal occluder on the morphology of systemic and pulmonary venous pathways using computerized tomography.

## METHODS:

During a 3.5-year period, 65 patients underwent transcatheter closure of ASD in this institution. All the patients underwent a diagnostic catheterization and angiography. The stretched diameter of the atrial septal defect was measured with balloon catheter. Before May 1999, a Meditech sizing balloon was used and after that an AGA sizing balloon was used to measure the stretched diameter. The diameter of the device closer equaled to the stretched diameter in Amplatzer device, 1.5~2 times of stretched diameter for sideris and CardioSeal device. The technique of transcatheter closure of the 3 devices was similar to those reported in the literature. All patients received aspirin 3-5mg/kg/day for 3-6 months following deployment of device. All patients underwent echocardiographic follow-up at 3 months, 6 months, 12 months and annually afterward. Electron-bean ultrafast computerized tomography (CT) was performed in 31 patients who agree to participate the study. The CT images were enhanced by injection of contrast media. The study protocol was approved by ethical committee in this hospital. The interval between ASD closure and CT imaging study ranged from 6 months to 3.3 years. Of the the 31 patients, Sideris device was deployed in 7, Starflex device in 10 and Amplatzer device in 14 patients. CT images were performed to evaluate the device position, patency of systemic and pulmonary venous pathway.

Three-dimensional reconstruction of CT images was performed in selected cases where device impingement on cardiac structures, pulmonary or systemic venous

system was suspected on cross-section images. The CT images were analyzed independently by one radiologist and two pediatric cardiologists.

**RESULTS:**

Of the 31 patients, 5 patients who underwent ASD closure with 3 sideris device 1 CardioSeal and 1 Amplatzer device had frequent migraine. No one had cardiomegaly on CT images. Partial obstruction of a pulmonary vein was observed in 4 patients (2 with Sideris device, 1 with Starflex device and 1 with Amplatzer device). Migration of one arm to a pulmonary vein was observed in with Sideris device in which pulmonary venous obstruction was en sued 1. Migration of one arm of a counter occluder of a sideris device to inferior vena cava was found in 1. Impingement of atrioventricular septum by one arm of Starflex device was found in 1. One had residual shunt. None had systemic vena cavae or coronary sinus obstruction. No one had compression of aortic root by the device. None had impingement of device on mitral or tricuspid valve leaflets. Cross-sectional and Doppler echocardiographic studies in the 31 patients showed none had significant pulmonary or systemic venous pathway obstruction. No one had impairment of mitral or tricuspid valve function as evaluated on echocardiography. A small left ventricle to right atrial shunt was found in the patient who had impingement on the atrioventricular septum. Arivial-to-mild residual shunt was found on the echocardiogram in 4 with Sideris device.

**DISCUSSION:**

Since the first report by Kings & Mill, transcatheter closure has become an alternative to surgery in the treatment of ASD. A variety of devices were evolved for transcatheter closure, including Rashkind device, Sideris device, CardioSeal device, Amplatzer device and Helex device. Among them, CardioSeal and Amplatzer device are the currently most common device used. The attempt success rate and complete closure rate were high with the Amplatzer device. Immediate complications of device deployment have been reported of which arrhythmia, device embolization or malposition, thrombus formation and vascular injury were most commonly seen. There were late complications of device closure of ASD reported including pericardial effusion and sudden death. Since the cardiac chambers dimension deceased in most patients during follow-up, the edge or sharp end of the device could have impinged on cardiac structures. In this study, mild degree of pulmonary venous obstruction was seen in 4 patients: 2 with button device and one with CardioSeal device and one with Amplatzer device. Late migration of one arm to pulmonary vein and inferior vena cava was observed in one with Sideris device each. For those with

deficient superior-anterior rim, two disk of device splayed on aortic root. Compression of aortic root by the device was a major concern but, in the current study, no patient had evidence of compression to the aortic root. One had complicated with left-ventricule-to-right-atrial shunt because one arm of a CardioSeal Device impinged on the septum. Therefore, Amplatzer septal occluder seems to be safe in those with deficient superior-anterior rim. No patient had pericardial effusion during follow-up. Three-dimension CT is more sensitive than echocardiography in the detection of pulmonary and systemic venous obstruction. Although, late migration of impingement or Cardiovascular structure was not uncommon following transcatheter closure of ASD, no one developed related symptoms. We should keep observation on the potential damage to cardiovasalar structure from device closure.

**CONCLUSION:**

CT images can be useful in the assessment of device position and systemic and pulmonary venous pathway in ASD patients following transcatheter closure.

# Figure Legends

Figure 1. A 3-dimensional CT image showed the Amplatzer device sitting on the atrial septum with out impingement on cardiovascular srutures.

Figure 2. A 3-dimensional CT image showed late migration of one arm of a counter occluder of a sideris device to inferior vena cava.

Figure 3. A cross-section of CT image showing one arm of a sideris device migrated to right upper pulmonary vein causing obstruction.

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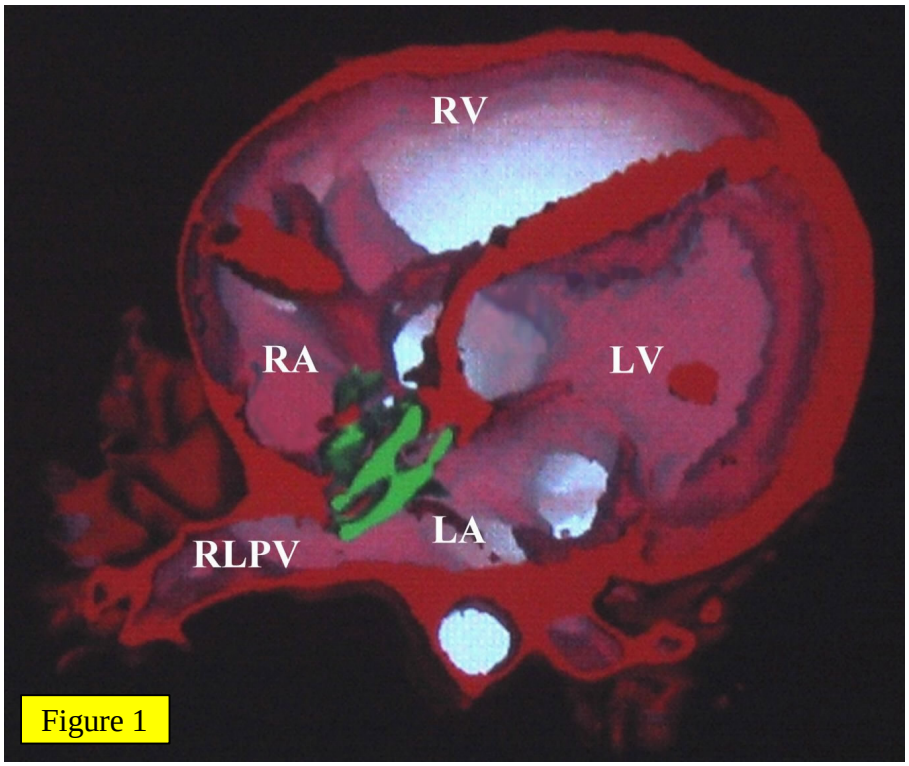

Figure 1

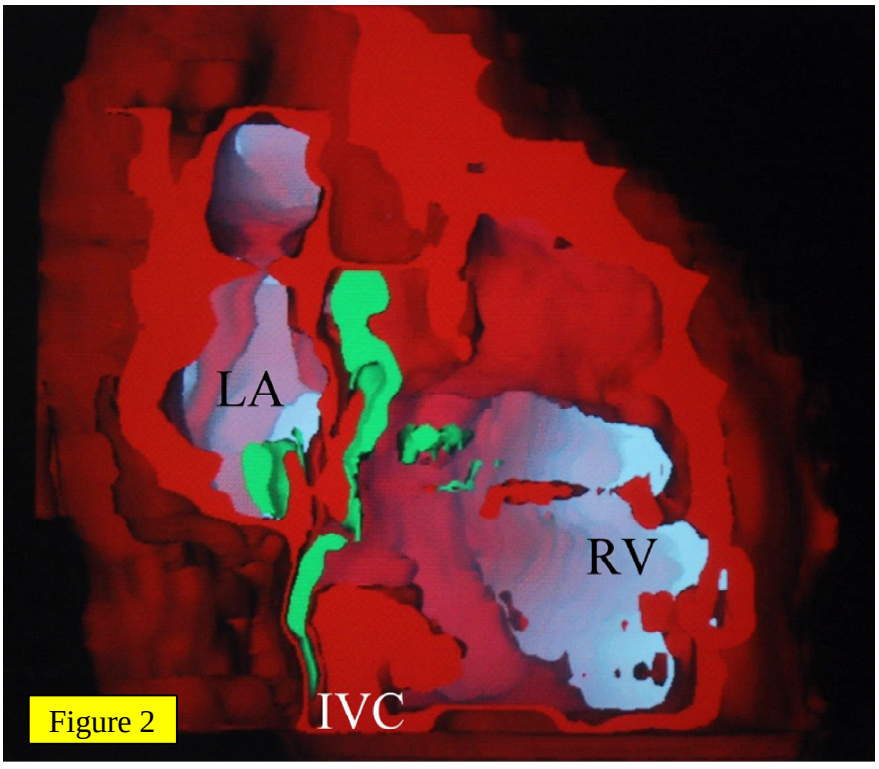

Figure 2

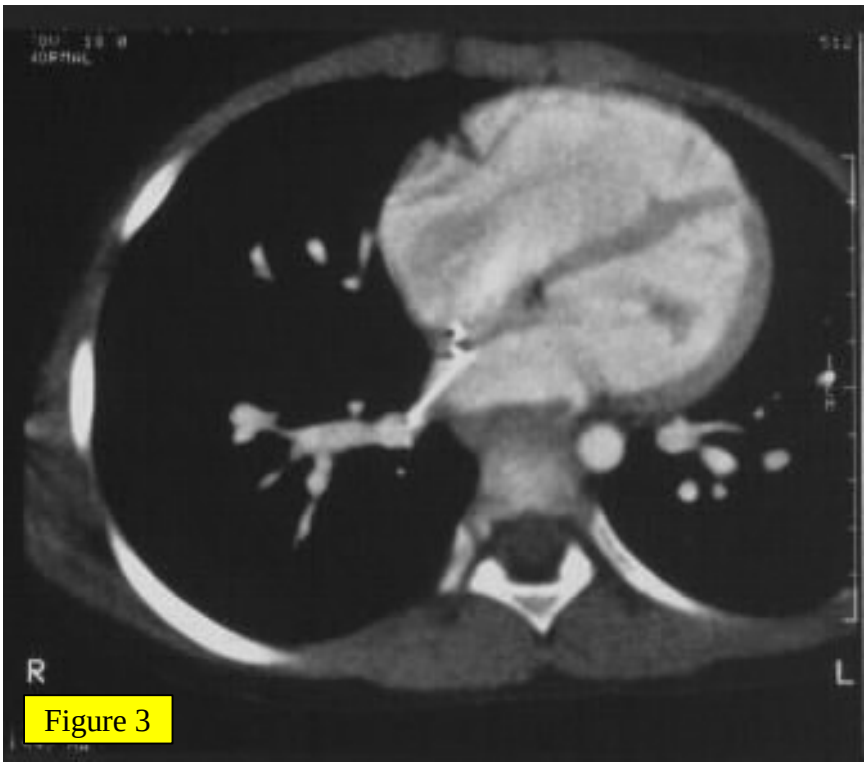


Figure 3