FULL LENGTH ARTICLE

ASD device closure in pediatrics: 3-Dimensional transthoracic echocardiography perspective

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Objective: **Real-time three-dimensional echocardiography, using both reconstruction methods and RT3D, has been used as an extra helping tool in several forms of congenital heart diseases. Our aim was to understand the relation of the ASD device to all surrounding structures by 3-dimensional echocardiography (3D).**

Methods: **This prospective study included 37 patients diagnosed as ASD secundum by transthoracic (TTE) and transesophageal echocardiography (TEE) referred for transcatheter closure from October 2013 to July 2016. Follow-up for 1 year using 2D and 3D-echocardiography was performed to assess the relations of the device to the surrounding structures.**

Results: **Transcatheter ASD closure and echocardiographic examinations were successfully performed for all patients. By 3D echocardiography, 16 patients (43.24%) had their ASD device close to the aortico-mitral continuity plane without apparent regurgitation, while the rest of our patients (56.75%) the devices were away from this plane. The following variables were significantly different between the two groups; body surface area, atrioventricular rim (AV), device size, left disc size and ratio of left disc to interatrial septum. A cut-off AV rim length not less than 8 mm was found optimal to avoid device encroachment on the sensitive surrounding structures. New Formula was constructed to aid in device choice.**

Conclusion: **Use of 3D before and after ASD closure is of value to determine the device relation to the surrounding structures. AV rim by TEE is an important rim to avoid eventual encroachment on the mitral valve and aorta.**

Keywords: 3-Dimensional echocardiography, Atrioventricular rim, Mitral regurgitation

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Introduction

The use of trans-catheter device techniques has become widely accepted as an alternative therapy to surgery. Device closure is much safer and advantageous compared to surgery [1]. For safe percutaneous ASD device closure, the rims surrounding the defect should be appropriate to allow the device to firmly hang onto the atrial septum. The device should not be deployed if there were concerns about drainage from coronary sinus, vena cava or pulmonary veins, or if there was interference with the function of the atrioventricular valve [2]. In children, the indication for percutaneous treatment is based on the defect diameter/septal length ratio regardless of the device type used. The AV valve rim plus the average size of the ASD (measured in at least two orthogonal views) plus the superior rim equals total atrial septal length. A device where the left atrial disc of the septal occluder is equal to or smaller than the total atrial septal length can be used. To avoid oversizing, a recommendation was not to use devices larger than 1.5 ASD diameter [3]. The device was chosen according to the TEE maximum ASD diameter. The device stent diameter is 4–6 mm and 5–8 mm larger than the TEE maximal diameter, if the defect was <14 mm and $\geq$14 mm, respectively or 1.2–1.5 times the maximal defect diameter provided that the left atrial disc should be always less than the total interatrial septal length [4]. The stop-flow technique should be used when balloon sizing of the ASD was done [5]. However, it is conceded that in some patients who have thin flailing septum primum, balloon sizing may not be easy because the septum is stretched even by gentle inflation of the balloon. Reported erosion of the aortic wall by the Amplatzer device with development of aorta-to right atrium [6] or aorta-to-left atrium [7] fistulae was the basis of the idea of oversizing the device (4 mm larger than the measured stretched diameter) in large defects with deficient aortic rim This is meant to ensure that the device disks straddle and remain flared around the ascending aorta to prevent discrete areas of pressure where erosion may occur. Obviously, when over-sizing the device, care must be taken not to interfere with valve function and/or venous return [8]. The ability to record, to analyze the entire cardiac structure and to display complex spatial relationships are potential advantages of 3D imaging over 2D echocardiography. 3D examination is a potential useful tool in studying the ASD device and its points of contact or pressure. Accordingly, the aim of this current work is to focus on the relation of the ASD devices to the aorta and aortic-mitral plane using three-dimensional echocardiography.

Abbreviations

RT3D	Real time 3 dimension
ASD	Atrial septal defect
TTE	Trans thoracic echocardiography
AV	Atrio ventricular
TEE	Trans esophageal echocardiography
2D	2 dimension
3D	3 dimension
SVC	Superior vena cava
IVC	Inferior vena cava
MV	Mitral Valve
MVP	Mitral valve prolapse
ICE	Intra cardiac echocardiography
FC	Fixed curvature
BSA	Body surface area
RA	Right atrium
RV	Right ventricle
Qp/Qs	Pulmonary to systemic flow ratio

Patients & methods

This prospective study included 37 consecutive patients diagnosed as ASD secundum by transthoracic echocardiography who were referred to Pediatric Cardiac Catheterization Laboratory at Cairo University Specialized Pediatric Hospital from October 2013 to July 2016. Then they were examined by 2D and 3D echocardiography to determine the shape of the defect and visualize the surrounding structures before catheterization, the examination was done with commercially available Vivid 7 ultrasound machine (GE Vingmed, Ultrasound AS, Horten, Norway). For all patients, TEE ultrasound was performed after endotracheal intubation and assisted ventilation under general anesthesia. Dimensions of the defect were measured in various imaging planes. The maximal diameter of the defect was measured using atrial end-diastolic frames in 0°, 45°, 90° and 135°. Two crucial parameters were measured to select patients for trans-catheter ASD closure. First; the maximal defect diameter was chosen and the selected device was usually 2 mm larger than the largest ASD diameter if there is no aortic rim deficiency, while it was at least 4 mm larger in aortic rim deficiency. The second was the tissue rim dimensions all around the defect to optimize the placement of the device. In the absence of gold

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