

Original Article

Safe and effective guidance by intracardiac echocardiography for transcatheter closure in atrial septal defects

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Abstract: The aim of this study was to investigate the clinical outcome of intracardiac echocardiography (ICE) for transcatheter closure of atrial septal defect (ASD) compared with the trans-esophageal echocardiography (TEE) guided method. From May 2010 to April 2011, 46 patients who underwent ICE guided (n = 23) or TEE guided (n = 23) transcatheter closure of ASD were analyzed retrospectively. We compared the demographic characteristic, procedure parameters and outcomes between ICE- and TEE-guided groups. No significant difference was found between 2 groups on demographic characteristics. Fluoroscopy time and procedure time was significantly decreased in ICE guided group than that in TEE-guided group. In addition, no significant difference was found on treatment outcomes, complications between these 2 groups. ICE-guided ASD occlusion is safe and effective method, which provides more accurate anatomical information, shorter fluoroscopy time and procedure time.

Keywords: Intracardiac echocardiography, atrial septal defect, trans-esophageal echocardiography, transcatheter closure

Introduction

As the mainstay of imaging to guide cardiac procedures, the using of fluoroscopy was restricted by several limitations, such as radiation exposure to both patient and physician, poor resolution to soft tissue, and problems caused by using iodinated contrast agents [1]. Other imaging techniques have been developed to guide cardiac procedures. Imaging tools which are currently used in the interventional laboratory can be classified into invasive and non-invasive. Non invasive imaging tools including ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) were mainly employed during the planning stages of intervention procedure [2]. Despite risks inherent to the tools, invasive tools such as transesophageal echocardiography (TEE), intracardiac echocardiography (ICE), intracardiac endoscopy and electroanatomic mapping systems were valuable in guiding cardiac interventions because they can provide excellent real-time detailed images [3].

In clinical practice, transcatheter closure is usually carried out with TEE [4]. TEE is useful

not only in monitoring the procedure but also in evaluating anatomic characteristics of defects [5, 6]. As a new guidance system, ICE has also introduced into transcatheter closure of atrial septal defect (ASD) [7, 8]. However, few reports have been compared ICE guidance with TEE guidance during ASD closure.

Here, we presented a study to investigate the clinical outcome of intracardiac echocardiography (ICE) for transcatheter closure of atrial septal defect (ASD) compared with the trans-esophageal echocardiography (TEE) guided method. And we found that ICE-guided provides more accurate anatomical information, shorter fluoroscopy time and procedure time during ASD closure.

Materials and methods

Patients and study protocol

A total of 46 patients underwent transcatheter closure of ASD at Department of Cardiology of First Affiliated Hospital of Kunming Medical University from May 2010 to April 2011. All the 46 patients were performed under either TEE or

ICE in transcatheter closure in ASD patients

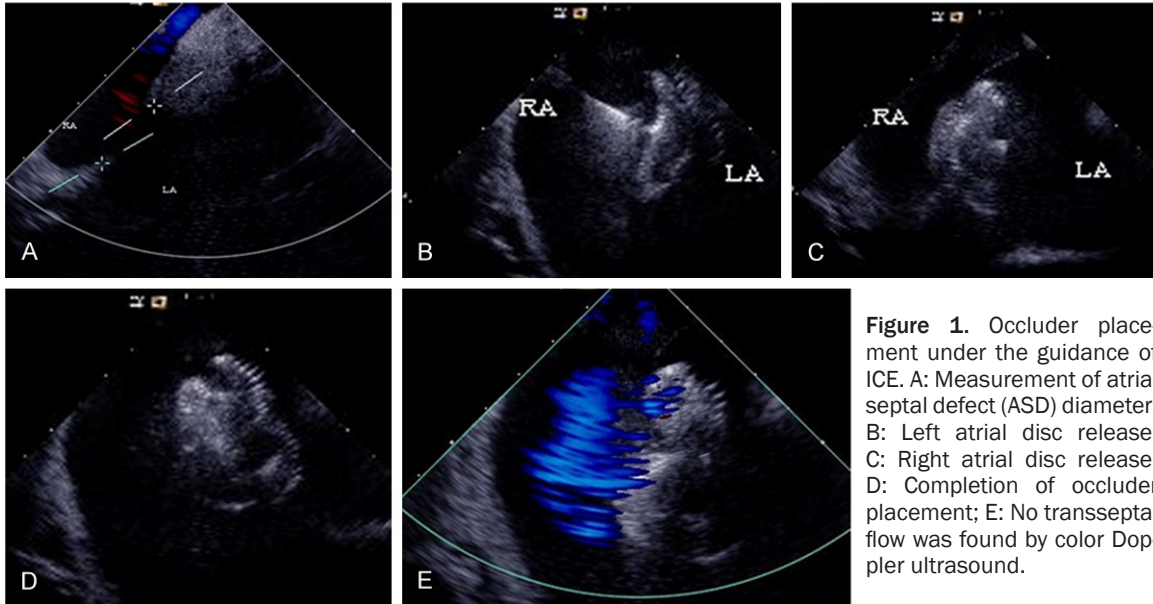


Figure 1. Occluder placement under the guidance of ICE. A: Measurement of atrial septal defect (ASD) diameter; B: Left atrial disc release; C: Right atrial disc release; D: Completion of occluder placement; E: No transseptal flow was found by color Doppler ultrasound.

ICE guidance. The patients were divided into 2 groups according to guidance modality: group 1, TEE; and group 2, ICE. The medical records of these patients were retrospectively analyzed and the demographic data, treatment results, and complications were compared in each group. The protocol was approved by Ethics Committee of the hospital. Written informed consent was provided by the patients.

TEE guidance protocol

For TEE, Philips echocardiography equipment (Phillip Agilent sonos 5500) with a transducer frequency between 2.5 and 3.5 MHz was used. Hemodynamic state was verified via diagnostic catheterization, and TEE was performed under general anesthesia with endotracheal intubation. All echocardiography was carried out according to the standards of the American Society of Echocardiography [9].

ICE guided ASD closure

The ICE group, along with the TEE group, underwent diagnostic catheterization. If the patient was considered as a candidate for ASD closure, an ICE catheter was inserted and transcatheter closure of ASD was performed under ICE guidance. The ACUSON AcuNavTM 8-Fr ultrasound catheter (Issaquah, WA, USA) with an 8- or 8.5-Fr short sheath catheter introducer was used in all ICE group patients. In all patients, the short sheath catheter introducer was inserted

through the left femoral vein. The ICE catheter was placed at the right atrium through the femoral vein. After confirming the tricuspid valve at the home view position, the anatomical characteristics were confirmed, steering the probe rightward and posterior to bicaval view and long axis view. The ACUSON AcuNavTM 8-Fr ultrasound catheter, which was used in our catheterization laboratory, is a single-use, multifrequency (5.5-10-MHz), 64-element, linear phased array, ultrasound catheter, and this catheter is capable of tissue penetration of up to 10 cm and 4-way head articulation to allow multiple angle imaging. All patients had diagnostic cardiac catheterization to verify hemodynamic state, and transcatheter closure of ASD was performed only when the ratio of pulmonary blood flow to systemic flow (Q_p/Q_s ratio) was > 1.5 . In order to select the most appropriate device size, echocardiographic imaging was used and, concurrently, balloon occlusive diameter or stop flow diameter was measured through balloon occlusion, and the surrounding rim lengths of the ASD were also measured. All the devices used in the current study were Amplatzer septal occluder® (ASO) (Figure 1).

Statistical analysis

All the statistical analysis were performed using SPSS version 18.0 (SPSS, Chicago, IL, USA). Continuous variables are expressed as mean \pm SD. Student's T-test or Fisher's exact test was employed to analyze the variables.

ICE in transcatheter closure in ASD patients

Table 1. Patients' demography

	TEE group (n = 23)	ICE group (n = 23)	P value
Age (Mean ± SD, yrs)	41.8 ± 18.7	46.9 ± 18.2	0.614
M/F	12/11	12/11	1.000
Weight (kg)	54.5 ± 11.6	60.1 ± 10.3	0.874
Height (cm)	163.7 ± 9.1	164.9 ± 7.7	0.429
BSA (Kg/m ²)	1.2 ± 0.2	1.3 ± 0.2	0.819

TEE: transesophageal echocardiography; ICE: intracardiac echocardiography; BSA: body surface area.

Table 2. Procedure parameters

	TEE group (n = 23)	ICE group (n = 23)	P value
BOD/SFD (mm)	22.2 ± 3.6	22.6 ± 4.6	0.265
Device size (mm)	22.4 ± 3.9	22.9 ± 4.4	0.367
Qp/Qs	2.5 ± 0.6	2.3 ± 0.7	0.538
Fluoroscopy time (min)	14.7	14.3	0.288
Procedure time (min)	94.1	67.6	< 0.01
GEA	23	0	< 0.01

NS: Not significant; TEE: transesophageal echocardiography; ICE: intracardiac echocardiography; BOD, balloon occlusive diameter; SFD, stop flow diameter; Qp, pulmonary blood flow; Qs, systemic blood flow; GEA, general endotracheal anesthesia.

Table 3. Outcome and complications

	TEE group (n = 23)	ICE group (n = 23)	P value
Mortality (%)	0	0	1.000
Complications, n (%)			
Hematoma	2 (8.7%)	1 (4.3%)	0.550
Complete closure (%)			
At discharge	82.6%	86.9%	0.681
Latest follow-up	95.6%	91.3%	0.550

TEE: transesophageal echocardiography; ICE: intracardiac echocardiography.

Results

Forty-six patients were enrolled in the study and divided into TEE group (n = 23) and ICE group (n = 23). As shown in **Table 1**, no significant difference was found on age, gender, weight, height and body surface area (BSA).

As shown in **Table 2**, no significant difference was found on mean balloon occlusive diameter (or stop flow diameter), Qp/Qs ratio and fluoroscopy time between TEE and ICE group. However, the total procedure time was significantly

decrease in ICE group than TEE group (94.1 vs. 67.6 min, $P < 0.01$). In addition, all the patients in TEE group while none of patients in ICE group needed to process general anesthesia with endotracheal intubation ($P < 0.01$).

As shown in **Table 3**, no mortality was found in both groups. Two cases of hematoma were found in TEE group while 1 case was found in ICE. The complete closure at discharge was 82.6% and 86.9% in TEE and ICE group, respectively. And the complete closure at latest follow-up was 95.6% and 91.3% in TEE and ICE group, respectively.

Discussion

In present study, we retrospectively analyzed the 46 patients who underwent transcatheter closure of ASD by TEE or ICE guided method and found that ICE was superior to TEE because a significant decreasing on procedure time and no need to perform the anesthesia with endotracheal intubation.

Imaging techniques other than fluoroscopy, such as echocardiography, is critical in procedure completion and good clinical outcomes during interventional treatment for ASD [10]. Previous report has been described successful device closure in children with clear transthoracic echo-window under the transthoracic echocardiographic guidance with the advanced echocardiographic support such as TEE or ICE [11]. Furthermore, some reports suggested that in some circumstances, transcatheter closure of ASD can be achieved with only echocardiographic guidance and without fluoroscopy [12]. These reports assert that echocardiographic guidance plays an important role during the whole procedure.

TEE is considered as the gold standard for echocardiographic guidance in device closure of ASD [13]. Furthermore, the evolvement of TEE has continuously processed, which has established basis in the field of interventional cardiology for congenital heart disease. The inferior vena cava rim which is hard to be seen on TEE now can be visualized by technical modifications [14]. Most recently, 3-D TEE has been more popular because it can provide abundant, anatomical information during intervention

[15]. Although there has been vast improvement in TEE technology, an obvious disadvantage is the need for endotracheal intubation during TEE guided transcatheter closure of ASD. Consequently, additional personnel are required, including anesthesiologists, echocardiologists, and associated nurses. The procedure time will be prolonged and additional equipment will be needed for endotracheal intubation and general anesthesia. Furthermore, it can also affect hospitalization duration, resulting in a higher number of hospital days in TEE-guided patients than ICE-guided patients. We also found a significant decreased procedure time in ICE guided method here and no general anesthesia was needed.

As the most frequently used ICE system for ASD device closure, the AcuNav catheter system has shown its benefits and usefulness [16]. The avoidance of general anesthesia reduces the need for additional associated personnel and the cost of ICE is not much higher than TEE. Furthermore, radiation exposure in the ICE-guided group was lower in this study, which may be an advantage for both patient and physician.

In conclusion, our study suggested ICE-guided ASD occlusion can be used safely and effectively in transcatheter closure of ASD, which provides more accurate anatomical information, shorter fluoroscopy time and procedure time. However, due to the limited number of patients, further confirmation is still needed to check with more patients to make sure the results.

Disclosure of conflict of interest

None.

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