Journal of Cardiology 65 (2015) 17–25

Contents lists available at ScienceDirect

Journal of Cardiology

journal homepage: www.elsevier.com/locate/jjcc

Review

Current concept of transcatheter closure of atrial septal defect in adults

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ARTICLE INFO

Article history:
Received 24 August 2014
Accepted 25 August 2014
Available online 11 October 2014

Keywords:
Atrial septal defect
Three-dimensional imaging
Atrial arrhythmia
Congestive heart failure

ABSTRACT

After the introduction of catheter intervention for atrial septal defect (ASD) in the pediatric population, therapeutic advantages of this less invasive procedure were focused on adult through geriatric populations. The most valuable clinical benefits of this procedure are the significant improvement of symptoms and daily activities, which result from the closure of left to right shunt without thoracotomy and cardiopulmonary bypass surgery. These benefits contribute to increase the number of adult patients of this condition who have hesitated over surgical closure. In terms of technical point of view for catheter closure of ASD, the difficulties still exist in some morphological features of defect, or hemodynamic features in the adult population. Morphological features of difficult ASD closure are (1) large (≥30 mm) ASD, (2) wide rim deficiency, and (3) multiple defects. Hemodynamic features of difficult ASD are (1) severe pulmonary hypertension, (2) ventricular dysfunction, and (3) restrictive left ventricular compliance (diastolic dysfunction) after ASD closure. To complete the catheter ASD closure under these difficult conditions, various procedural techniques have been introduced. These are new imaging modalities such as real-time three-dimensional imaging, new technical modifications, and new concepts for hemodynamic evaluation. Especially, real-time three-dimensional transesophageal echocardiography can provide the high quality imaging for anatomical evaluation including maximum defect size, surrounding rim morphology, and the relationship between device and septal rim. In adult patients, optimal management for their comorbidities is an important issue, which includes cardiac function, atrial arrhythmias, respiratory function, and renal function. Management of atrial arrhythmias is a key issue for the long-term outcome in adult patients. Because the interventional procedures are not complication-free techniques, the establishment of a surgical back-up system is essential for the safe achievement of the procedure. Finally, the establishment of a team approach including pediatric and adult cardiologists, cardiac surgeons, and anesthesiologists is the most important factor for a good therapeutic outcome.

Contents

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http://dx.doi.org/10.1016/j.jjcc.2014.09.002
0914-5087/

Introduction

Atrial septal defect (ASD) accounts for 7% of all congenital heart diseases. The most common ASD is a secundum defect, versus defects located in the septum primum, sinus venosus defects, or unroofed coronary sinus [1]. If left untreated, these defects may result in right-sided heart failure, arrhythmia, and pulmonary hypertension. Although surgical closure of ASD is safe, effective, and time-tested, it requires open heart surgery and hospitalization [2]. Even in the current surgical procedure, complications which are related to surgery or cardiopulmonary bypass have not disappeared.

Clinical feature of ASD in various aged populations

Clinical features of ASD are widely varied from pediatric population through adults [3–6]. The majority of these children are asymptomatic and diagnosed by school physical examination, heart murmur detected by primary care pediatrician, and cardiac echocardiographic screening in the newborn period. If the defect is smaller than 6 mm, spontaneous closure can be expected during newborn to pediatric periods [7]. Operation is scheduled based on children's body size, usually before the elementary school with low incidence of mortality rate. On the contrary, adult patients with ASD are usually symptomatic. Their heart disease may be discovered as a result of palpitation, arrhythmia, or progress of congestive heart failure. In our recent series of adult patients with ASD, they were diagnosed within 3 years before the procedure, meaning that the majority of adult patients could not be diagnosed during the pediatric period under the current medical screening system (Fig. 1) (unpublished data). In 1990 Murphy and colleagues reported the natural course of ASD [2]. In this study, survival rate was significantly deteriorated compared to the general population, if patients did not have surgical closure until age of 24 years and/or there were complications with pulmonary hypertension. However, our current patients' backgrounds are significantly different compared to such studies, rather numerous adult patients are asymptomatic and occasionally diagnosed at the time of detailed cardiovascular evaluation for atrial arrhythmia, congestive heart failure, or stroke (Fig. 2).

Although the catheter closure of pediatric or young adults with ASD population has attracted research interest over the past two decades, that of the elderly ASD population has yet to be characterized [8]. Extrapolation of studies on younger patients is not appropriate in the geriatric patients. First, elder patients with ASD acquire comorbid conditions include arrhythmia, hypertension, respiratory distress, kidney disease, etc. that always play a significant role in their heart conditions [4,9]. Second, elder ASD patients may have inherently superior resilience, milder disease, or balanced physiology in contrast to those not surviving to an advanced age. Therefore, elder or geriatric patients with ASD represent a distinct population for which focused studies are needed.

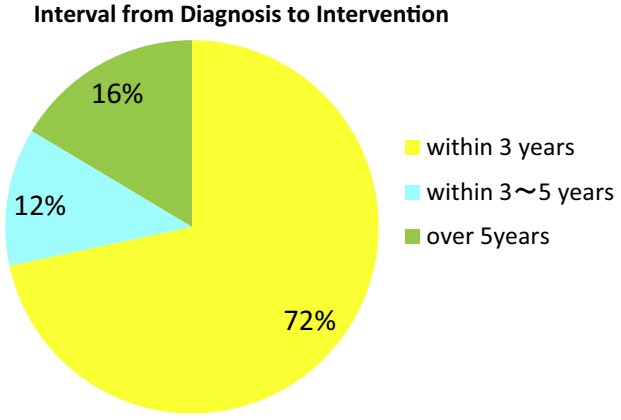

Fig. 1. Interval from the diagnosis of atrial septal defect to intervention in adult patients age older than 40 years. More than 80% of patients were diagnosed within 5 years before the intervention.

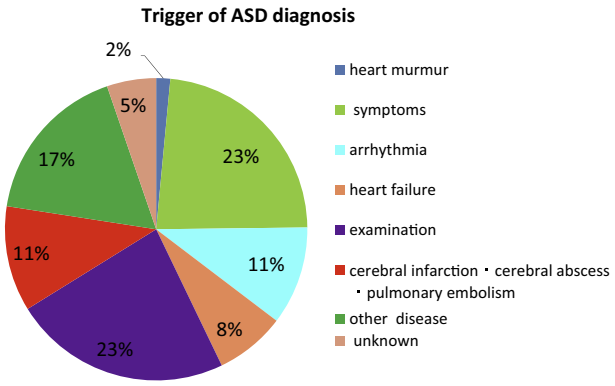

Fig. 2. Trigger of diagnosis of adult patients with atrial septal defect (ASD) age older than 40 years. Symptoms (palpitation, shortness of breath, etc.) and routine physical examination are the most common factors for trigger of diagnosis.

Transcatheter closure of ASD

Transcatheter closure of ASD is associated with low complication rates, short anesthetic times, and short hospitalizations [5]. When conditions are favorable, transcatheter ASD closure has become the treatment of choice rather than surgery in many institutions. Echocardiography, either transesophageal (TEE) or intracardiac, plays a significant role in the guidance of these procedures and in the assessment of the final result. Research efforts are ongoing to examine other imaging modalities, such as computed tomography (CT) or magnetic resonance imaging (MRI), as a means of three-dimensional (3D) imaging prior to transcatheter ASD closure. To date, Amplatzer Septal Occluder (St. Jude Medical, St. Paul, MN, USA) is widely used in the world. This device is suitable for all subtypes of ASD and has successfully closed defects as large as 38 mm in diameter. Much larger sized devices are available, such as Occlutech device (Helsingborg, Sweden) [10] or Lifetech Cera devices (Shenzhen, China) [11]. However, procedural difficulties still exist due to morphological features of septal defect or from a hemodynamic stand point.

Morphological features of difficult transcatheter ASD closure

It is well known that morphological variations of ASD are frequent and appropriate patient selection for transcatheter ASD closure is crucial for successful procedure. ASDs are grouped into four major categories: ostium primum, ostium secundum, sinus venosus, and coronary sinus septal defect. Secundum defect is the most common type of ASDs in which the defect involves the region of fossa ovale, and this type is indicated for transcatheter ASD closure. Coronary sinus septal defect is a rare type, in which a communication occurs between the coronary sinus and the left atrium as a result of unroofed coronary sinus. Primum septal defect and sinus venosus defect are indicated for surgical repair. Regarding coronary sinus septal defect, although surgical repair is the standard treatment for this type of ASD, there are some case reports in which transcatheter closure was successful without any conduction disturbance [12].

In patients with secundum septal defect, two crucial parameters, which are the maximal ASD diameter in order to select a device with the appropriate size and the surrounding rim dimensions to optimize the placement of the device, should be