Percutaneous closure of Atrial Septal Defects: Echocardiographic and functional results in elderly patients over 60 years

Jategaonkar: ASD closure in elderly patients

Smita Jategaonkar, MD, Werner Scholtz, MD, Henning Schmidt, MD, Dieter Horstkotte, MD, PhD, FESC, FACC

Department of Cardiology, Heart and Diabetes Center North Rhine-Westphalia, Ruhr University Bochum, Bad Oeynhausen, Germany

Address for correspondence:

Werner Scholtz, MD
Heart and Diabetes Center North Rhine-Westphalia
Department of Cardiology
Georgstr. 11
D-32545 Bad Oeynhausen
Phone: 49-5731-971258
Fax: 49-5731-972194
akohlstaedt@hdz-nrw.de

Word count: 3,160
Subject codes: [41] Pediatric and congenital heart disease, including cardiovascular surgery; [23] Catheter-based coronary and valvular interventions: other
ABSTRACT

**Background** - Percutaneous closure of atrial septal defects (ASD) is well established in children and adults and found to improve symptoms and positively influence right-heart remodelling. The aim of this study was to evaluate the efficacy and long-term outcome in adult patients older than 60 years.

**Methods and Results** - 96 patients in the age group of 60 – 84 years were included in this study. Percutaneous closure was performed effectively in all patients. Functional capacity according to the New York Heart Association (NYHA) and peak oxygen uptake in the cardiopulmonary exercise testing (CPX) improved significantly after ASD closure, especially in patients with a Qp:Qs > 2. Echocardiographic measurements of the right ventricular enddiastolic diameter showed a significant decrease. No device associated complications were observed, but in 16 patients paroxysmal atrial fibrillation (AF) occurred after device implantation.

**Conclusions** - Percutaneous ASD closure can be performed safely and with minimal risk even in elderly patients. They profit in terms of symptom-reduction, improvement of exercise capacity and right-heart remodelling.

**Key words**: Atrial septal defect, left-to-right shunt, interventional closure, elderly patients, exercise capacity, atrial fibrillation
INTRODUCTION

Atrial septal defects of secundum type (ASD) are one of the most common congenital heart lesions in adults. Prevalence of ASD in children is noted to be 11.4% (1) within the congenital heart defects. Spontaneous closure is unusual in adults and most of them develop symptoms like fatigue, dyspnea or paradoxical embolization in the course of time. The development of symptoms, echocardiographic signs of significant shunt volume or shunt related pulmonary hypertension are widely accepted indications for closure of an ASD. Since the first percutaneous ASD closure performed by King and Mills (2) this minimally invasive method has become a well established treatment of secundum type atrial septal defects with hemodynamically significant left-to-right shunt in children and adults. Several studies and our own experience have demonstrated clinical benefits and positive right heart remodelling with reduction of the right ventricular enddiastolic diameter (3-7). However, few studies were published considering the elderly patients over the age of 60 years (8-14). Though surgical and device closure can be performed safely in this age group, little data is published on functional results after device closure. The aim of this study, therefore, was to evaluate the efficacy and long-term outcome of percutaneous ASD closure in patients over 60 years of age.
METHODS

Patients: In this clinical study 96 consecutive patients over 60 years of age (69.9 ± 5.3 y, 30 male) who underwent percutaneous ASD closure between October 1998 and June 2007 were investigated. Indications for closure were significant left-to-right shunt (right ventricular enlargement) detected by echocardiography, shunt related symptoms or pulmonary hypertension. Clinical examination with assessment of the functional capacity according to the New York Heart Association (NYHA) functional class and transthoracic echocardiography were performed in all patients before percutaneous closure. Right ventricular enddiastolic diameter (RVEDD), left ventricular enddiastolic diameter (LVEDD) and left atrial diameter (endsystolic) were assessed by conventional M-mode in parasternal long axis view. Additionally the right ventricular enlargement was semi quantitatively assessed in the apical 4 chamber view. Cardiopulmonary exercise testing (CPX) pre- and postinterventional was available in a subgroup of 35 patients on an ergometer cycle. Starting with 25 Watt the work rate was increased 10 W/min. On patients’ exhaustion the test was discontinued. Beside electrocardiogram and blood pressure the peak oxygen uptake was registered according to a standardized protocol (15). All subjects gave written informed consent to the procedure and planned follow up after 3 and 12 months. The study was approved by the ethical committee of our institution.

Follow up. All patients were examined three months after percutaneous closure including clinical and echocardiographic examination as well as a transesophageal contrast echocardiographic examination with valsava manoeuvre for detection of residual shunt or thrombus formation on the device. The subgroup of 35 patients with CPX before ASD closure underwent this examination as well.

Implantation procedure. Percutaneous closure of the atrial septal defect was performed from the femoral vein under local anaesthesia and analgosedation and
fluoroscopic and multiplane transesophageal echocardiographic (TEE) guidance. In patients with risk factors for coronary heart disease or angina pectoris a coronary angiogram was performed before device closure. Shunt volume was determined by stepwise oxymetric measurements of superior, inferior vena cava and pulmonary artery blood sample using the Fick principle and expressed as percent of pulmonary blood flow (%). Before entering the left atrium 100 IE per kg body weight intravenous heparine was injected. Native and balloon sizing diameters (“stop-flow technique”) of the ASD were measured in TEE examination and by fluoroscopy. Depending on the sizing diameter the size of the device was chosen. A long sheath (9-12F) was positioned through the ASD in the left atrium near the left superior pulmonary vein. The device was introduced through this sheath and deployed under TEE guidance. After confirming a secure position by pull-and-push manoeuvre the device was released from the delivery system and the final position was documented by TEE and fluoroscopy. Postinterventional treatment consisted of 100 mg acetylsalicylic acid once daily for 6 months and 75 mg clopidogrel once daily for two months. For periinterventional prophylaxis the patients were given one dose of cefazolin (1.5g iv) during the catheter procedure. Standard endocarditis prophylaxis was recommended for one year.

Statement of responsibility: The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Statistics: Statistical analysis was carried out with the SPSS statistical package (Version 15.0; SPSS Inc.). In the following sections, continuous variables are expressed as mean and standard deviation after checking for normality of distribution. Differences between baseline and follow-up were analyzed by the paired sample t-test. A p-value less than 0.05 was considered statistically significant.
Correlation between changes in right and left ventricular diameter was analyzed with Pearson bivariate correlation.

RESULTS

Patient characteristics, clinical and hemodynamic data are listed in Table 1. 14 patients did not report any adverse symptoms despite significant left-to-right shunt and were classified as NYHA I, 48 patients were classified as NYHA II and 27 as NYHA III. Two of the patients (2.1%) had an ischemic stroke as an indication for interventional closure, the others a hemodynamic indication. Chronic AF was present in 21 patients of which all received oral anticoagulation therapy. Elevated lipoproteins were found in 44 patients and 54 patients were treated medically for arterial hypertension. 51 patients underwent a coronary angiogram just before the device implantation, out of which 21 patients had a coronary artery disease. Three of them had significant coronary artery stenosis and were treated by percutaneous coronary intervention in the same procedure.

Implantation procedure. The atrial septal defect was multifenestrated in 8 patients. The mean defect diameter measured by transesophageal echocardiography was 14.8 ± 5.8 mm, the sizing diameter 20.8 ± 5.8 mm. The mean shunt volume was 48.7 ± 12.6%. Mean pulmonary arterial pressure was 25.1 ± 7.8 mmHg, mean pulmonary vascular resistance (PVR) was 174 ± 103 dyn /s/cm⁵. Percutaneous ASD closure was performed successfully in all patients using an Amplatzer septal occluder device (ASO, AGA Medical Corp, Golden Valley, Minnesota) in 95 patients and Cardia-Star device in one patient. Median device size was 21.9 ± 5.7 mm, range 11 to 38 mm. In one patient the septum secundum teared during the balloon sizing, wherein a larger device was subsequently necessary for closure. One patient who underwent coronary angiography in the same procedure required surgical vascular repair due to groin hematoma at the puncture site. 2 patients developed mild symptoms of
pulmonary congestion directly after implantation. Both improved shortly after diuretic treatment.

**Follow up.** 7 Patients were lost to clinical follow up. The three months follow up after device closure (108 ± 53 days) including transesophageal contrast echocardiography demonstrated a tiny residual shunt through the device in 15 patients (16.9%). In the long term follow up (median: 33.6 ± 31.2 months, range 2.8 to 100.1 months) no device associated complications such as thrombus formation on the device or device embolization or malposition were observed. NYHA functional class improved in 62 patients (69.7%). Three patients reported clinical worsening and 24 patients reported no change in their functional capacity (see Figure 1). Despite gender (21 female, 6 male) there were no other obvious differences between responders and non-responders regarding age, shunt, PA pressures or preinterventional VO2max. 7 (7.3%) patients reported of paroxysmal atrial fibrillation prior to device closure and were treated by oral anticoagulation. New paroxysmal AF occurred in 16 (17.9%) patients after device closure. 10 of them received new oral anticoagulation therapy, the other 6 had only one short episode of AF within the first 3 months after ASD closure and no further recurrence and hence weren’t treated with phenprocoumon. Within the subgroup of the patients with paroxysmal AF 3 reported deterioration and 8 no change of their NYHA functional class. Residual shunting did not influence the functional outcome, 11 patients improved in their NYHA functional class, 2 remained unchanged and 2 worsened.

Peak oxygen uptake increased overall by 10 % (17.1 ± 5.5 vs. 18.8 ± 5.4 ml/kg/min, p < 0.05), see Figure 2. A larger increase of VO2max could be measured in patients with a Qp:Qs > 2 than in those with a Qp:Qs < 2. 18 patients with CPX met the criteria of Qp:Qs > 2 (see Figure 3). The increase of VO2max was significant in this
group (17.1 ± 5.7 vs. 19.8 ± 5.9 ml/kg/min, p< 0.05). The other 17 patients with CPX had a Qp:Qs < 2 and showed a slight increase in their VO2max after ASD closure which was statistically not significant (17.1 ± 5.5 vs. 17.7 ± 4.8 ml/kg/min, n.s.).

Right ventricular enlargement (RVEDD > 30mm) was present in 77 of 96 patients, 19 patients showed no significant enlargement of the right ventricle. After ASD closure a significant reduction of the RVEDD (38.9 ± 8.7 vs. 32.3 ± 8.6, p< 0.05) could be measured in the echocardiographic assessment. 23 of 77 patients with RVEDD enlargement (29.9 %) reached normal RVEDD (< 30mm) after 3 months. The LVEDD increased significantly (46.2 ± 6.8 vs. 50.5 ± 6.9, p< 0.05) and the left atrial diameter did not change (49.3 ± 9.4 vs. 48.1 ± 9.6, n.s.), see Figure 4. A significant correlation between decrease in RVEDD and increase in LVEDD could be detected (r=0.505 p<0.01; Figure 5).
DISCUSSION

Percutaneous device closure is nowadays a routine treatment of hemodynamically significant atrial septal defects in children and adults. Symptom reduction, improved exercise capacity and right heart remodelling have been demonstrated in the past.

The aim of this study was to evaluate the efficacy and long-term outcome of percutaneous ASD closure in elderly patients over 60 years of age. Since only 4 patients out of 96 showed complications due to the procedure it can be concluded that this intervention can be performed safely and at low risk also in elderly patients.

Decrease or even normalization of right ventricular size could be observed in the majority of patients within the first three months after ASD closure. Cardiac remodelling is an early postinterventional effect and appears during the first months after ASD closure (16, 17). Significant improvement of NYHA functional class and exercise capacity in the majority of patients could be proved in this study. Especially patients with a Qp:Qs > 2 seem to profit by this treatment. Minimal residual shunting after 3 months does not influence their outcome since further endothelialisation with complete elimination of residual shunt can be expected in long term. However, the outcome was influenced if the patient developed paroxysmal AF. A significantly higher percentage of patients with paroxysmal AF after device closure reported of unchanged or deteriorated functional capacity. Whereas patients with chronic AF before ASD closure showed an improvement of the NYHA functional class after device closure, 68.7 % of patients with new paroxysmal AF showed no change or even worsening of their NYHA functional class. The majority of the patients were symptomatic and improved in their functional capacity after ASD closure. Even in asymptomatic elderly patients a device closure may induce positive right ventricular remodeling and hence should be performed in this age group as well.
ASD closure with abolishment of left-to-right shunt leads to augmented left ventricular filling by increased LV preload and therefore to improved LV stroke volume (18). The rise in LV stroke volume may explain the increase in peak oxygen uptake and increase of functional capacity. Especially in this age group where impaired diastolic function is common, this may explain the functional improvement.

Potential risk of transient pulmonary congestion was described especially in elderly patients with impaired diastolic function after ASD closure (19). Pathophysiologically this phenomenon can be explained with augmented left atrial pressure after abolishment of left-to-right shunting by ASD closure. In our series 2 patients developed mild symptoms of pulmonary congestion directly after implantation. Both improved shortly after diuretic treatment and presented with stable functional status in long term follow up.

In general, the results of the present study confirm other published clinical observations with few patients undergoing surgical repair (9,10) or smaller study groups after device closure (13). In comparison to surgical ASD treatment, patients’ functional recovery is faster in the interventional group (16) probably due to the effects of thoracotomy and heart lung machine. Especially older patients were at higher risk during surgery and often have delayed recovery.

Hence interventional closure of secundum type atrial defects with moderate or severe left- to- right shunt can be recommended in older patients over 60 years with good functional results in the majority of patients.

**Study limitations:** Potential limitation may occur by missing CPX data during follow up in some patients and lacking comparison to surgically treated patients.
CONCLUSION

Percutaneous closure of atrial septal defects can be performed safely and at minimal risk also in elderly patients over 60 years of age. They benefit by symptom reduction, improvement functional exercise capacity and positive right heart remodelling.

Conflict of interests disclosures: None
REFERENCES


(14) Yalonetsky S, Lorber A. Percutaneous Closure of a Secundum Atrial Septal Defect in Elderly Patients. J Invas Cardiol 2007;19:


FIGURE AND TABLE LEGENDS

Table 1  Patient characteristics and periprocedural data

Figure 1  NYHA functional class at baseline and follow up (white bars: improvement; black bars: no change or deterioration)

Figure 2  Peak oxygen uptake at baseline and follow up

Figure 3  Peak oxygen uptake at baseline and follow up. Percentage of improvement of peak oxygen uptake in patients with Qp:Qs > 2 (*p < 0.05) and in patients with Qp:Qs > 2 (n.s.)

Figure 4  Comparison of baseline echocardiographic data (RV diameter (A), LA diameter (B) and LV diameter (C)) before and after percutaneous ASD closure

Figure 5  Correlation of decrease in RVEDD and increase in LVEDD after ASD closure
Table 1: Characteristics of patients with ASD > 60 years

<table>
<thead>
<tr>
<th>Patient group (n = 96)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>69.9 ± 5.3 years</td>
</tr>
<tr>
<td>Gender</td>
<td>66 f / 30 m</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>73.7 ± 14.5</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166.5 ± 9.3</td>
</tr>
<tr>
<td>Shunt volume (% of Qp)</td>
<td>48.7 ± 12.6</td>
</tr>
<tr>
<td>Balloon sizing diameter (mm)</td>
<td>20.8 ± 5.8</td>
</tr>
<tr>
<td>Native diameter (mm)</td>
<td>14.8 ± 5.8</td>
</tr>
<tr>
<td>Fluoroscopy time (min)</td>
<td>8.4 ± 5.1</td>
</tr>
</tbody>
</table>
$p < 0.05$

VO2 max (ml/min/kg)

pre  

3 months later  

*
Percutaneous Closure of Atrial Septal Defects: Echocardiographic and Functional Results in Elderly Patients over 60 Years
Smita R. Jategaonkar, Werner Scholtz, Henning Schmidt and Dieter Horstkotte

Circ Cardiovasc Interv. published online February 20, 2009;
Circulation: Cardiovascular Interventions is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2009 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-7640. Online ISSN: 1941-7632

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circinterventions.ahajournals.org/content/early/2009/02/20/CIRCINTERVENTIONS.108.814046

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Cardiovascular Interventions can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Interventions is online at:
http://circinterventions.ahajournals.org//subscriptions/