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The atrial septal defect diagnosed in the senility – the benefit of the transcatheter closure (RCD code: IV-2B.1)

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Abstract

Objective: Closure of the atrial septal defect in the elderly patients is controversial. The aim of the study was to evaluate the outcomes of transcatheter closure of secundum atrial septal defect (ASD) in elderly patients. Methods: From a total of 488 patients with ASD who underwent transcatheter closure 15 pts over 70 years (10 females, 5 males) with a mean age of 75.3 ±12.7 (70–79) were analyzed. All patients had an isolated secundum ASD with a mean Qp:Qs: 3.01 ±1.9 (2.6–3.9). A symptom-limited treadmill exercise tests with respiratory gas exchange analysis and transthoracic color Doppler echocardiographic study as well as Quality of life (QoL) measured using the SF36 questionnaire (SF36q) were repeated in all patients before procedure and after 12 months of follow-up. Results: The atrial septal occluder (ASO) device was successfully implanted in all patients (procedure time 29.7±6.5 (14–59) minutes, fluoroscopy time 13.2 ±9.3(6–40) minutes). There were no major complications. The defect echo diameter was 21.7± 15.8 (18–33) mm. The diameter of the implanted devices ranged 20 – 36 mm. After 12 months of ASD closure, all the patients showed a significant improvement of exercise capacity parameters. Seven QoL parameters (except mental health) improved at 12 months follow up compared to their baseline data. The right ventricular dimension decreased ($p<0.005$), parameters of exercise capacity improved – oxygen consumption increased ($p<0.001$). Conclusions: Closure of ASD in elderly patients caused a significant clinical and hemodynamic improvement after percutaneous treatment, which is maintained to long-term follow-up what justified this procedure in old age. JRCD 2015; 2 (5): 144–149

Key words: septuagenarian, occluder, congenital heart diseases, cardiopulmonary exercise test, quality of life

Introduction

Atrial septal defect (ASD) may, not uncommonly, remain undiagnosed until adulthood. The most common presenting symptoms at adult age are palpitations and exercise intolerance manifested as either exertional dyspnoea or fatigue, which increased with age [1-3]. More serious complications are typically seen in older patients with previously unrecognized ASDs who have been exposed to large left-to-right shunting for a long period [4,5]. Closure of an ASD in patients with hemodynamically significant shunt has become standard of care in recent years [1-3]. Correction of ASD prevents the development of pulmonary hypertension, cardiac arrhythmia and heart failure [1-4]. The indications for ASD closure in elderly patients are ambiguous. The most controversial issue is selection of candidates for ASD closure who are over 40–60 years of age, with normal pulmonary artery pressure, absent or negligible clinical symptoms [5-9]. The aim of the study was to evaluate the outcomes of transcatheter closure of secundum ASD in elderly patients.

Methods

Patient population

Out of a total number of 488 consecutive patients with interatrial communication who underwent transcatheter closure over 10 years in our department 15 patients (10 females, 5 males) with a mean age of 75.3 ±12.7 (70–79) were analyzed. All patients had an isolated secundum ASD with a mean left-to-right shunt (ratio

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of pulmonary to systemic blood flow or Qp:Qs: 3.01 ±1.9 (2.6–3.9) in echo examination. All those patients had the coexisting impairment of physical status or enlargement of right heart cavity or pulmonary hypertension.

The major demographic characteristics of patients are summarized in Table 1.

Table 1. The demographic characteristics of patients

	Patients (n = 15)
Smoking	7 (46.6%)
Obesity	7 (46.6%)
Diabetes mellitus	2 (13.3%)
Hypertension	12 (80%)
Dyslipidemia	10 (67%)
Coronary Artery Disease	10 (67%)
Pulmonary Hypertension*	2 (13.3%)
Atrial Fibryllation	7 (46.6%)

* Measured in the right-heart catheterization

Protocol

A detailed description of the transcatheter closure technique has been given previously [4,5]. The procedure was performed under local anesthesia. A complete haemodynamic evaluation was performed as well as the coronary angiography.

All procedures were performed with continuous transesophageal echocardiographic examination.

Complete ASD closure was defined as no residual shunt, a color Doppler signal width of less than 1 mm was considered trivial shunting.

After procedure the patients were treated with 75 mg acetylsalicylic acid and 75mg clopidogrel once daily for 1 month and then 325 mg acetylsalicylic acid 11 months to provide an antithrombotic protection until full device endothelialization.

The assessment was made in compliance with the following constraints:

- **clinical study** – within 7 days before the procedure and then at 1, 6 and 12 months after, respectively
- **transthoracic echocardiographic examination** – within 7 days before the procedure and then at 1, 6 and 12 months after, respectively
- **cardiopulmonary exercise test** – within 7 days before the procedure and then at 6 and 12 months after, respectively
- **quality of life measurement** – within 7 days before the procedure and then at 12 months after.

Clinical study

The clinical study was based on subjective opinion of the patients concerning their functional capacity. We assess the frequency of the dyspnoe incidences and palpitations.

Transthoracic echocardiographic examination

The transthoracic echocardiographic examination (TTE) study was performed using a Toshiba Power Vision machine with a 5.0-MHz multiplane probe, according to a standard protocol including color flow Doppler data. After a comprehensive echocardiographic study right ventricular, right atrial major and minor dimensions, left ventricular dimensions were measured in end-diastole. M-mode echocardiography from the parasternal long-axis view was used to measured right ventricular dimensions. The apical four-chamber view was used to measure the right atrial and the right ventricle size. The major axis of right atrium was measured from the tricuspid annulus to the atrial superior wall and the minor axis was measured perpendicular to the major axis at half of the length of the latter. Each measurement was averaged from 5 consecutive cardiac cycles. Two independent cardiologists trained in echocardiography agreed the measurements. Follow-up included a complete echocardiographic study with a precise location and measurement of any residual shunt as well as position of device.

Cardiopulmonary exercise test

In order to objectively assess the clinical and functional status of the patients in all the cases we performed 8.

cardiopulmonary exercise tests. Maximal cardiopulmonary testing was performed on an ergometer cycle. Peak oxygen uptake, carbon dioxide production, and minute ventilation were measured with a computerized breath-by-breath analyzer (V-MAX 29, Sensor-Medics). Patients performed a maximal exercise test using a 1-min incremental bicycle protocol with a work rate increment of 10 W/min. Criteria for test ending were considered patient exhaustion or a respiratory exchange ratio ≥1.09. A 12-lead electrocardiogram was also monitored throughout the study, and cuff blood pressure was determined manually every 2 min. Standard equations were used to generate predicted values for baseline spirometric and peak exercise parameters.

Quality of life

This objective study was completed with the subjective opinions of the patients concerning their clinical status. In each case we assessed the quality of life using the SF36 questionnaire. The patients filled up the questionnaire SF36 – the best-known questionnaire in measuring health status. The number "36" refers to 36 questions which concern 8 aspects of general health and quality of life – that is: physical function, role-physical, bodylity pain, general health, vitality, social function, role-emotional and mental health.

Statistical analysis

Continuous data are expressed as mean ± standard deviation and baseline and follow-up was compared by the paired Student's t-test. For the comparison of categorical variables the a chi-squared test (X2 test) was used. The level of statistical significance was two-sided and set at $p<0.05$. Multivariate analyses such as multiple forward stepwise regression and canonical correlation were used to evaluate the parameters affecting improvement of

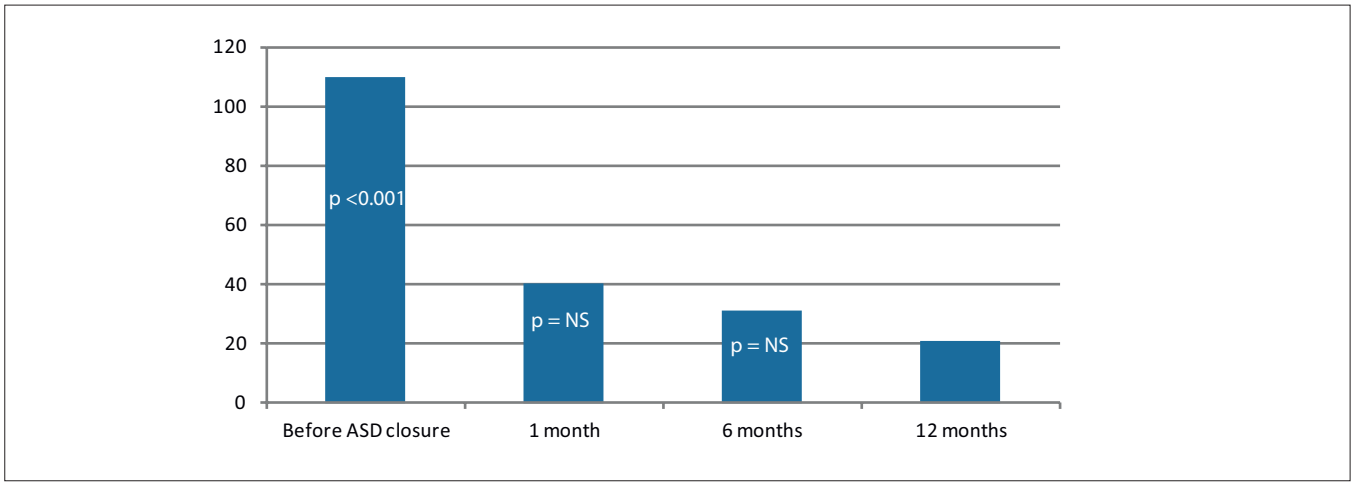

Figure 1. Frequency of the dyspnoe before and after atrial septal defect closure

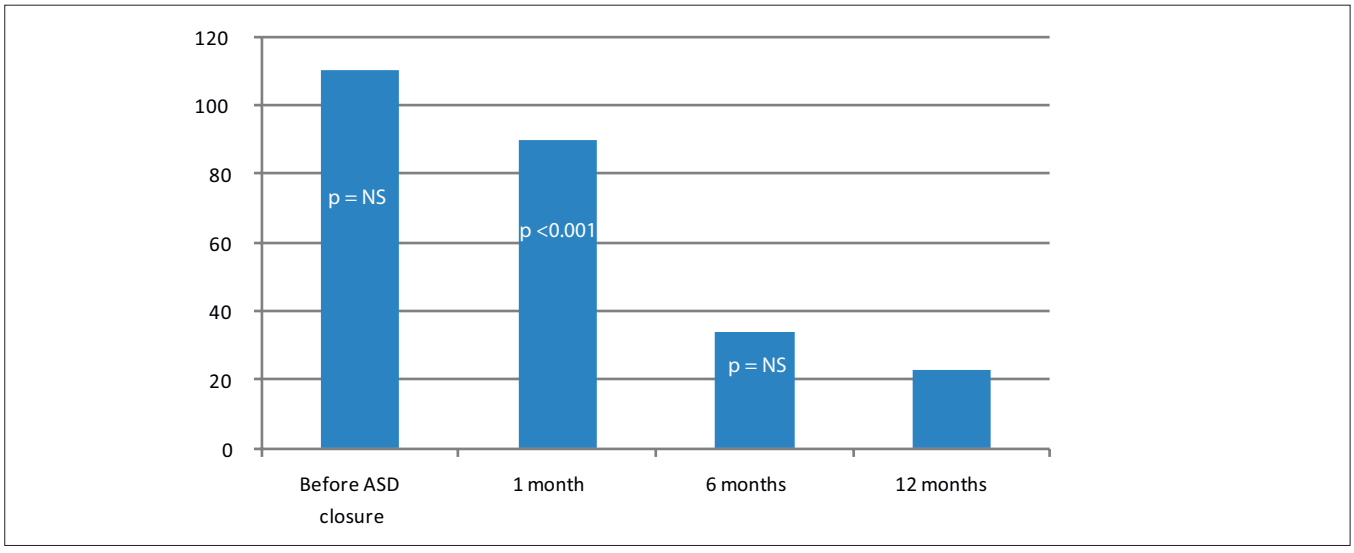

Figure 2. Frequency of the palpitations before and after atrial septal defect closure

quality of life.Statistical analysis was performed with SPSS version 15.0.0 for Windows.

Statistical analysis was performed with SPSS version 15.0.0 for Windows.

Results

The devices were successfully implanted in all the subjects, (procedure time mean 29.7±6.5 (14–59) minutes, fluoroscopy time mean 13.2 ±9.3(6–40) minutes). The defect echo diameter was 21.7± 15.8 (18 – 33) mm. The diameter of the implanted devices ranged 20 – 36 mm. The Amplatzer ASD closure device was used in 5 (33%) patients, and Cardia ASD device in 10 (67%) patients.

There were 10 (67%) patients with ischemic heart disease. In four cases we performed percutaneous transluminal coronary angioplasty with stent implantation before ASD closure, six patients were treated pharmacologically.

There were no serious complications involved no deaths, no device embolizations, no fractures of the device. Minor complications were recorded in 10 (20%) patients with minor venous access bleeding without transfusion. All the patients remained well with no complications or new symptoms at their 12 months follow up. No patient has had any heart related hospital admissions. All the patients had complete 12 months follow-up.

Clinical study

Transcatheter closure of secundum atrial septal defect has created improvement of the clinical status of the patients in the early follow-up. It caused reduction of the breathlessness and palpitation as early as a month after the procedure (Figure 1, 2).

Transthoracic echocardiographic examination

As early as 1 month after the procedure, a significant decrease of the right ventricular dimension and the right atrium dimension

Table 2. Echocardiographic parameters before and after atrial septal defect closure

Parameter	Before ASD closure	1 month after ASD closure	6 months after ASD closure	12 months after ASD closure	p before vs. 1 m-th	p before vs. 6 m-ths	p before vs. 12 m-th
RV_{area} (cm^2)	24.5	22.3	19	19	<0,001	<0,001	<0,001
RA_{area} (cm^2)	26	22,6	21	19	<0,001	<0,001	<0,001

ASD – atrial septal defect, RV_{area} – right ventricle area

Table 3. The parameters of the cardiopulmonary exercise test before and after atrial septal defect closure

Parameter	Before ASD closure	6 months after ASD closure	12 months after ASD closure	p before vs. 12 months
Time of exercise (seconds)	345 ±71	435 ±185	455 ±265	<0,001
VO_{2peak} (ml/kg/min)	9.2 ±3,5	11,8 ±8	13.5 ±9,7	<0,001
VCO_2 (l/min)	1,45 ±1,1	1,59 ±0,9	1,67 ±0,9	<0,001
VE/VCO_2	32,1 ±3,1	26,9 ±4,1	26 ±3,7	<0,05
T_{AT} (seconds)	326 ±70,7	399 ±130	395 ±105	<0,001
VO_{2AT} (ml/kg/min)	11,1 ±9,01	13 ±10,8	15 ±12,1	<0,005

VO_{2peak} – peak oxygen consumption, VO2AT- ventilatory anaerobic threshold, VCO_2 – production of carbon dioxide, VE/VCO_2 – ventilatory Equivalent for CO_2, TAT – time to attain anaerobic treasure, VO_{2AT} – oxygen consumption in Anaerobic Threshold

was observed. All the analized dimentions of the right heart decreased in 12 pts (80%) (Table 2).

The mean systolic pulmonary pressure measured in echo examination decreased 12 months after ASD closure as compared to the baseline data: 57.7 ±25.4 vs 42.2 ±15.9 mm Hg (p<0.001).

Cardiopulmonary exercise tests

Significant improvement of exercise capacity was noted at 6 and 12 months after the procedure. The time of exercise within 6 months of ASD closure was longer, as compared to the baseline values and also the oxygen consumption increased (Table 3).

Quality of life

Apart from the objective improvement of the physical activity in cardiopulmonary exercise test, the significant improvement of the quality of life in patients based on SF36 form was also noted. Moreover, an advancement of each aspects of quality of life with the exception of mental health was observed. The mean SF36q scale increased significantly in 14 (93.3%) pts of mean 40.2 ±29,1 (4–55) (Table 4).

The canonical correlation analysis showed that the following parameters had an influence on improvement of the total SF36 scale: improvement in cardiopulmonary test (prolonged time of exercise, improvement of peak oxygen consumption (VO2peak – ml/kg/min), reduction in the right heart (of the right heart size (right atrial and right ventricular areas)); p< 0.05.

The multiple forward stepwise regression analysis revealed that of all parameters [parameters of echocardiography study and cardiopulmonary exercise test] improvement of VO_{2peak} ($F(6.21)=9.1635$; $p < 0.001$, standard error 2.1810) had the strongest influence on improvement of the total SF36 scale.

Discussion

Isolated ASD constitutes the second most common (after bicuspid aortic valve) congenital heart lesion in adults [1,2].

Surgical closure of atrial septal defect has been practiced for about 45 years [3,4]. Since the first attempt in 1976, transcatheter closure of *secundum* ASD has evolved over the past three decades [5-8,10]. Surgical repair of ASDs in patients > 60 years of age may results in significant mortality and morbidity. Harjula et al. [16] reported an operative mortality rate of 6% and a postoperative morbidity rate of 24% in the form of major complications. In another study, the hospital stay after surgical repair of ASDs in patients >60 years of age ranged from 8–20 days (average 11 days) [17]. On the other hand, transcatheter closure of ASD has a low morbidity rate and shorter hospital stays compared to surgically treated patients. However, there have been no reports comparing results, closure rates, morbidity rates and complications of transcatheter and surgical closure of ASDs at the same institution among patients > 60 years of age.

The benefits of the transcatheter treatment of the congenital heart diseases are obvious. First of all, we can avoid complications of the open heart surgery, what is absolutely crucial in the group of elderly patients. Another benefit is avoidance of a surgical scar and would healing process and shorter hospitalization time [8,9].

Moreover, the closure of the atrial septal defect in the elderly patients is controversial. Some authors undermine the necessity of

Table 4. Results of the SF 36 questionnaire before and after atrial septal defect closure

Parameter	Before ASD closure	12 months after	P value
SF36 total scale	21.8±21	51.4±31	P<0.001
PF-Physical Function	9.2±1.1	12.2±4.2	P<0.01
RP- Role Physical	6.8±2.7	12.1±1.1	P<0.01
BP-Bodily Pain	9.0±4.0	12.2±4.0	P<0.01
GH-General Health	5.2±4.5	9.9±4.0	P<0.001
V-Vitality	1.2±3.3	5.2±3.3	P<0.01
SF- social functioning	11.2±3.7	13.2±2.1	P<0.01
RE – Role Emotional	12.1±7.3	18.1±8.9	P<0.01
MH – Mental Health	3.2±4.3	4.7±4.1	P<0.01

defect correction in patients who survive more than 60 years with atrial defect [11–13].

Although, based on some analysis, it would appear that ASDs should be closed when they are identified, irrespective of the patient's age [11–15]. However, little data are available about the outcome of this procedure in the elderly population (>60 years of age). So if ASD is diagnosed after the age of 60 is always a question whether the symptoms are connected with the ASD shunt or associated diseases and whether transcatheter closure is justified. What's more, symptoms in elderly patients with ASD are quite common and can be masked because of the numerous associated diseases.

Transcatheter closure of atrial septal defects (ASDs) is a safe and effective treatment [11].

Our study results demonstrate that device closure of ASDs in the elderly is safe with minimal complications and there is no difference in comparison to results in younger patients group, which is consistent with the reports in literature [19–24].

The aim of our study was to evaluate the outcome of transcatheter closure of ASD in the elderly patients. All those patients had: the coexisting impairment of physical status or enlargement of right heart cavity or pulmonary hypertension.

One of the most difficult problems for treatment of ASD in elderly patients is comorbid disease. More than one third of patients have systemic hypertension and other systemic diseases such as diabetes mellitus, multiarterial arteriosclerosis or chronic pulmonary obstructive disease. Cardiac comorbidities such as ventricular dysfunction, atrial arrhythmia and ischemic heart disease (IHD) are known to make the transcatheter closure more questionable [16,17]. In our study 10 patients had IHD. In four cases we performed percutaneous transluminal coronary angioplasty with stent implantation before ASD closure, six patients were treated pharmacologically.

Closure of the atrial septal defect has created significant improvement of the clinical status of the patients in the early follow-up. It caused subjective reduction of the breathlessness as well as the palpitation. There were no patients who had not improved somehow, the improvement was also confirmed in the group of patients with pulmonary arterial hypertension. The mean systolic pulmonary pressure measured in echo examination decreased after ASD closure as compared to the baseline data.

Some reports have documented that substantial reverse remodeling of the heart after closure improves the symptoms and functional status [16–23]. We found a great reduction in right heart dimension after device closure. Nearly all patients showed the improvement in functional and exertional capacity measuring in cardiopulmonary exercise test and significant haemodynamic improvement. The quality of life measure in SF 36 questionnaire improved as well as exercise capacity. This improvement was observed in nearly all patients irrespective of coexisting associated diseases.

Thus we convinced that it is really worth to close ASD in the elderly symptomatic patients or with enlargement of right heart cavity or pulmonary hypertension.

Of course, each case should be analyzed and qualified individually.

In conclusion

Transcatheter closure of ASD in the elderly patients results in significant clinical, functional and quality of life improvement.

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