DOI: 10.5114/kitp.2014.47338

Surgical correction of atrial septal defect in the elderly

Virginija Rudiene[1], Lina Gumbiene[1,2,3], Alicija Dranenkiene[2], Rimantas Karalius[2,3], Raimondas Sirmenis[3], Virgilijus Tarutis[2,3]

[1]Centre of Cardiology and Angiology, Vilnius University Hospital, Santariskiu Klinikos, Lithuania
[2]Clinic of Cardiovascular Diseases, Faculty of Medicine, Vilnius University, Lithuania
[3]Centre of Cardiac Surgery, Vilnius University Hospital, Santariskiu Klinikos, Lithuania

Kardiochirurgia i Torakochirurgia Polska 2014; 11 (4): 391-396

Abstract

Introduction: Atrial septal defects (ASDs) are one of the most common congenital malformations in adults. Correction of ASDs in advanced age remains controversial, even though beneficial effects in this patient group were found in recent studies. In older patients, less invasive transcatheter closure of ASDs has been recommended.

Aim: The aim of this study was to analyze our advanced age ASD surgical cohort: early and late results.

Material and methods: Retrospective analysis of 32 patients operated on at an age of ≥ 60 years (i.e. age 66.13 ± 4.8, range from 60 to 78) in our center between 2001 and 2011 was carried out. We reviewed our experience of surgical ASD closure in elderly patients over a 10-year period to assess the effects of this type of treatment on early postoperative and long-term survival, early and late complications, preoperative and postoperative clinical status (New York Heart Association [NYHA] functional class), pulmonary hypertension (PH) and atrial arrhythmias. The patients were divided into two groups according to age.

Results: The frequency of comorbidities was lower in younger age group patients (11 [61%] vs. 13 [93%], $p < 0.05$). Atrial fibrillation/flutter was found in 21 (66%) of all patients. Late postoperative mortality was higher in the older patient group (3 [21%] vs. 1 [5.6%]). Despite this, we observed significant improvement of symptoms and functional ability in the older population after surgical ASD closure (group I, $n = 10$ [56%] vs. group II, $n = 12$ [86%]).

Conclusions: Surgical correction of clinically significant ASD is effective even in older patients with comorbidities.

Key words: atrial septal defect, surgical treatment, elderly patients, early and late complications.

Streszczenie

Wstęp: Ubytek przegrody międzyprzedsionkowej (*atrial septal defects* – ASD) jest najczęstszą wrodzoną wadą serca występującą u dorosłych. Choć wykonywanie zabiegów korekcyjnych ASD w podeszłym wieku nadal budzi kontrowersje, ostatnio przeprowadzone badania dowiodły, że tego typu procedury dają pozytywne wyniki. W wypadku starszych pacjentów zaleca się mniej inwazyjne przezskórne zamknięcie ASD.

Cel: Analiza wczesnych i późnych wyników zabiegów chirurgicznej korekcji ASD u pacjentów w zaawansowanym wieku.

Materiał i metody: Retrospektywną analizą objęto 32 chorych operowanych w wieku ≥ 60 lat (średnia wieku: 66,13 ± 4,8 roku, zakres: 60–78 lat) w ośrodku autorów w latach 2001–2011. Przeanalizowano zabiegi chirurgicznego zamknięcia ASD w podeszłym wieku (przeprowadzone przez ostatnie 10 lat), aby ocenić wpływ tego typu procedur na wczesne pooperacyjne i długoterminowe wyzdrowienie, powikłania wczesne i późne, przedoperacyjne i pooperacyjne stany kliniczne [klasyfikacja funkcjonalna wg New York Heart Association (NYHA)], nadciśnienie płucne i arytmie przedsionkowe. Pacjentów podzielono na dwie grupy według wieku.

Wyniki: Choroby współistniejące występowały rzadziej u pacjentów z młodszych grup wiekowych [11 (61%) *vs* 13 (93%), $p < 0,05$]. Migotanie/trzepotanie stwierdzono w 21 przypadkach (66%). Większą późną pooperacyjną śmiertelność zanotowano w starszej grupie wiekowej [3 pacjentów (21%) *vs* 1 pacjent (5,6%)]. Ponadto zaobserwowano znaczne zmniejszenie nasilenia objawów i poprawę sprawności wśród starszych osób po zabiegu chirurgicznej korekcji ASD [grupa I: $n = 10$ (56%) *vs* grupa II: $n = 12$ (86%)].

Wnioski: Zabieg chirurgicznej korekcji ASD o znaczeniu klinicznym jest skuteczny nawet u starszych pacjentów, bez względu na współwystępowanie innych chorób.

Słowa kluczowe: ubytek przegrody międzyprzedsionkowej, leczenie chirurgiczne, pacjenci w podeszłym wieku, powikłania wczesne i późne.

Address for correspondence: Virginija Rudiene, Vilnius University Hospital, Santariskiu Klinikos, Santariskiu g. 2, 08433 Vilnius, Lithuania, phone: + 37065554952; e-mail: vr.rudiene@gmail.com

Introduction

Atrial septal defects (ASDs) which allow blood to directly communicate between systemic and pulmonary circulations at the atrial level are one of the most common congenital malformations in the adult population [1, 2]. Atrial septal defects rather often remain undetected until adulthood, accounting for 25-30% of newly diagnosed congenital heart diseases [3]. Correction of ASDs in advanced age remains controversial even though beneficial effects in this patient group were found in recent studies [1, 3, 4]. The benefit of ASD closure in adults, particularly those of advanced age, remains a matter of debate [5-7].

In older patients, less invasive transcatheter closure of ASDs has been recommended [2]. Actually, it could not be applied in all cases due to anatomical reasons or surgery is required for concomitant cardiac pathology.

The aim of this study was to analyze our advanced age ASD surgical cohort: early and late results.

Material and methods

Retrospective analysis of 32 patients operated on at an age of ≥ 60 years old in our centre between 2001 and 2011 was performed.

Atrial septal defects were diagnosed by transthoracic echocardiography and hemodynamics were evaluated during cardiac catheterization.

Types of ASDs are shown in Figure 1. Early postoperative and long-term survival, early and late complications, the effect on preoperative and postoperative clinical status (New York Heart Association [NYHA] functional class), pulmonary hypertension and atrial arrhythmias were assessed. Follow-up information was obtained from visits to the out-patient department and telephone interviews.

Definition of complication

Postoperative events were further classified as early (≤ 30 days) and late (≥ 30 days). The complications were classified as minor and major.

Minor complications: transient ischemic cerebral attacks (TIA), arrhythmia managed with medications, hoarseness of voice.

Major complications: death, bleeding (treated with blood transfusion, rethoracotomy), advanced heart failure (managed with intra-aortic balloon counterpulsation), sepsis, arrhythmia (atrial flutter/fibrillation treated with transesophageal electric pacing or cardioversion-defibrillation and bradyarrhythmia treated with pacemaker), acute postoperative severe pulmonary hypertension.

Statistical analysis

Data were expressed as a frequency or percentage for the nominal variables, as the median for the ordinal variables and as the mean (SD) for continuous variables.

Results

Patients' characteristics and procedural data

There were 26 women (81%) and 6 men (19%). Patient's average age was 66.13 ± 4.8. The oldest patient was 78 years old.

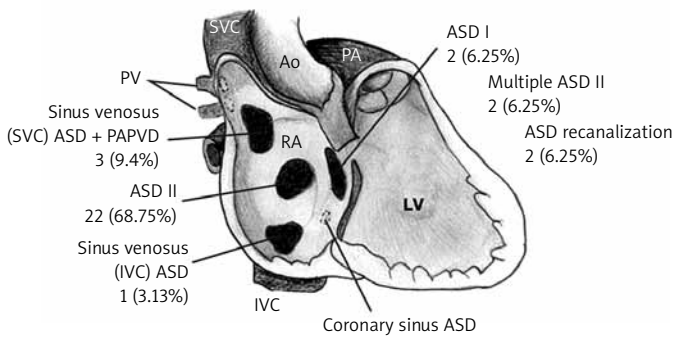
We divided patients into two age groups: group I consisted of 18 patients 60-65 years old; group II consisted of 14 patients over 65 years old (Table I).

Most of our patients – 78% (n = 25) – had comorbidities before surgery as well. Coronary artery disease – 25% (n = 8); 15 (6%) of these patients required coronary artery bypass grafting (CABG). Tricuspid valve insufficiency (moderate – severe) was observed in 26 (81%) cases. More than half of patients had systemic hypertension (n = 22 [69%]), and 3 patients had diabetes mellitus (9.4%).

Comorbidities diagnosed before surgery are listed in Table II. Unsurprisingly, comparing the two groups, the frequency of comorbidities was lower in the younger group of patients (11 [61%] vs. 13 [93%], $p < 0.05$). Only 1 patient from the older age group had no comorbidities.

Patients' preoperative status

Atrial fibrillation/flutter was observed in 21 (66%) patients. Group I patients had a lower incidence of preoperative atrial fibrillation than group II (10 [56%] vs. 11 [79%], $p < 0.05$). The majority (97%) of the patients were symp-



Ao – aorta, PV – pulmonary veins, PA – pulmonary artery, RA - right atrium, LV – left ventricle, SVC – superior vena cava, IVC – inferior vena cava, PAPVD – partial anomalous pulmonary venous drainage

Fig. 1. Types of atrial septal defects

Tab. I. Clinical features of patients

	At presentation (n = 32)		At last follow-up (n = 28)	
	Group I (60-65 years) n (%)	Group II (> 65 years) n (%)	Group I (60-65 years) n (%)	Group II (> 65 years) n (%)
Number	18	14	17	11
NYHA class – n (%)				
I	0 (0)	0 (0)	3 (18)	1 (9)
II	3 (17)	0 (0)	6 (35)	8 (73)
III	13 (72)	13 (93)	7 (41)	2 (18)
IV	2 (11)	1 (7)	1 (6)	0 (0)
In AF (%)				
Yes	10 (56)	11 (79)	12 (67)	9 (64)
No	8 (44)	3 (21)	6 (33)	5 (36)
	Group I (60-65 years)		Group II (> 65 years)	
Comorbidities – n (%)	11 (61)		13 (93)	
Early complications – n (%)				
Major	2 (11)		7 (50)	
Minor	4 (22)		3 (64)	
Late complications – n (%)				
Major	5 (28)		8 (57)	
Minor	6 (33)		1 (7)	
Hospitalization (days)	22		37	
Mortality – n (%)				
Early	0 (0)		0 (0)	
Late	1 (5.6)		3 (21.4)	

*During hospitalization for surgery
AF – atrial fibrillation, NYHA – New York Heart Association

tomatic. Only 1 patient was symptom-free. Eighty-one percent of patients were in NYHA functional class III. PH was observed in 94% of all patients. Moderate PH was observed in 59%, severe in 3% of all patients before surgery.

Cardiac procedures

Primary correction of ASD (75% secondary ASDs) was performed for 30 patients. Two patients underwent correction of ASD recanalization (36 and 38 years after primary correction). Concomitant procedures during ASD correction were performed in 97% of cases: tricuspid valve repair – 26 (81%), Maze procedure – 5 (16%), mitral valve repair/replacement – 6 (19%), coronary artery bypass grafting in 5 patients (16%). Cardiac procedures performed during follow-up are listed in Table III.

Early complications after surgery

Early major postoperative complications occurred in nearly one third of patients (n = 9 [28%]) (Table IV). Bleeding was observed in 1 patient (3%) and required blood transfusion with rethoracotomy. Sepsis occurred in 2 patients (6, 25%); 1 of them died after more than 2 months of treat-

Tab. II. Comorbidities before atrial septal defect correction

Comorbidity	Patients, n (%)
Coronary artery disease	8 (25)
Needed CABG	5 (15.6)
Mitral valve pathology	8 (25)
Moderate-severe, needed correction	6 (19)
TV insufficiency (moderate-severe)	26 (81)
Atrial fibrillation/flutter	21 (66)
Permanent/persistent	13 (41)
Pulmonary hypertension	29 (91)
Moderate	19 (59)
Severe	1 (3)
Arterial hypertension	22 (69)
Diabetes mellitus	3 (9.4)
Sick sinus node syndrome	1 (3)
Thyroiditis	1 (3)
No-comorbidities	1 (3)

CABG – coronary artery bypass grafting, TV – tricuspid valve

Tab. III. Cardiac procedures during follow-up. Patients, *n* = 8

Patient no.	Age* (years)	Gender	Primary procedure	Time after ASD surgery	Following procedure
1	68	F	ASD II correction + Maze procedure	14 days	PM implantation
2	76	F	ASD II, PAPVD correction + TV repair	15 days	PM implantation
3	72	F	ASD II correction + TV repair	1 month, 9 days	MV + TV repair
4	62	M	ASD I correction + MV and TV repair + CABG (3 CAD)	3 months, 7 months, 9 years	Atrial flutter RFA + PM, MV replacement + Maze, PM replacement
5	69	F	ASD II correction + TV repair + CABG (2 CAD)	1 year, 1 month	PM implantation
6	66	F	ASD II correction + TV repair + CABG (2 CAD)	1 year, 3 months	PM implantation
7	78	F	ASD II correction + MV replacement + TV repair + CABG (1 CAD)	2 years, 1 month	MV paravalvular fistula correction, TV Re
8	67	F	ASD II correction + TV repair	4 years, 7 months	Transcatheter closure of ASD recanalization

*Age during ASD closure
ASD – atrial septal defect, CABG – coronary artery bypass grafting, CAD – coronary artery disease, MV – mitral valve, PAPVD – partial anomalous pulmonary venous drainage, PM – pacemaker, RFA – radiofrequency ablation, TV – tricuspid valve, Re – redo repair

Tab. IV. Early postoperative complications

Patients, *n* = 15 (47%)	
Complication	**Patients, *n* (%)**
Major (patients *n* = 9, 28%)	
Bleeding (blood transfusion, rethoracotomy)	1 (3)
Heart failure	3 (9.4)
Intra-aortic balloon counterpulsation	1 (3)
Sepsis	2 (6.25)
Arrhythmia	3 (12.5)
Atrial flutter/fibrillation (TES, CV)	1 (3)
Bradyarrhythmia (PM)	2 (6.25)
Acute postoperative pulmonary hypertension	1 (3)
Other	3 (6.25)
Death	0 (0)
Minor (patients *n* = 6, 19%)**	
Transient ischemic cerebral attack	3 (9.4)
Arrhythmia (treated with medications)	3 (9.4)
Hoarseness of voice	1 (3)

*Three patients had 2 or 3 major complications.
**One patient had major and minor complications.
TES – transesophageal electric pacing, CV – cardioversion-defibrillation, PM – pacemaker

ment. Heart failure treated with intra-aortic balloon counterpulsation was observed in 1 patient. Two patients with heart failure were treated with medications. Early arrhythmias were recorded in 3 patients (9.4%): atrial flutter/fibrillation in 1 patient, and the other two had bradyarrhythmias that required permanent pacemaker implantation. Early minor complications were observed in 6 patients (19%) (Table IV).

Patients' postoperative status

The incidence of atrial fibrillation was higher in the younger age group after surgical closure (12 [67%] vs. 9 [64%]). New atrial fibrillation developed in 4 of our patients (Fig. 2). Improvement of clinical status was observed in 59% of all patients (Fig. 3). Both groups had improvement of NYHA class (group I, *n* = 10 [56%] vs. group II, *n* = 12 [86%]). Hence, group II had a higher number of patients with NYHA class improvement. Pulmonary hypertension decreased in 50% of all patients. The effect of ASD closure on pulmonary hypertension is shown in Figure 4.

Late complications after surgery

Four patients died during follow-up (after 0.3-4.9 years). The postoperative mortality rate was 12.5% in our study. Cerebral infarction and heart failure were the cause of death in 2 cases in our study (1 patient died after 1.3 years of follow-up, the second after 2.8 years). Sepsis after non-cardiac surgery occurred in the other 2. The mortality rate was higher in older age group patients (*n* = 3 [21.4%] vs. *n* = 1 [5.6%], $p < 0.05$).

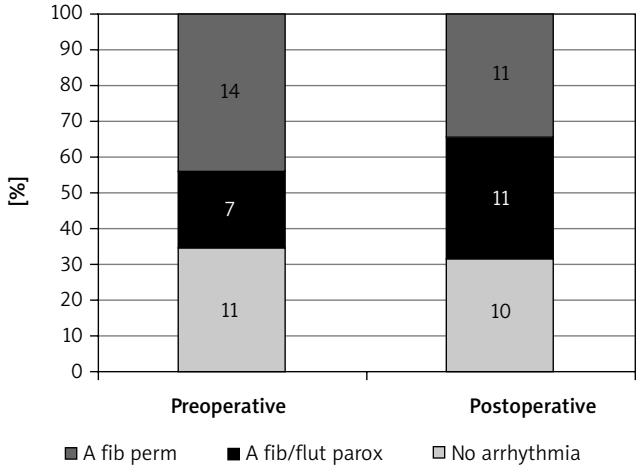
The major early and late complication rates were higher in group II patients (early major complications *n* = 7 [50%] vs. *n* = 2 [11.1%]; late major complications *n* = 8 [57%] vs. *n* = 5 [28%]).

Hospitalization time was longer in older patients (i.e. 37 [CI = 13.43] vs. 22 [CI = 2.7] days).

The longest follow-up period was 10 years.

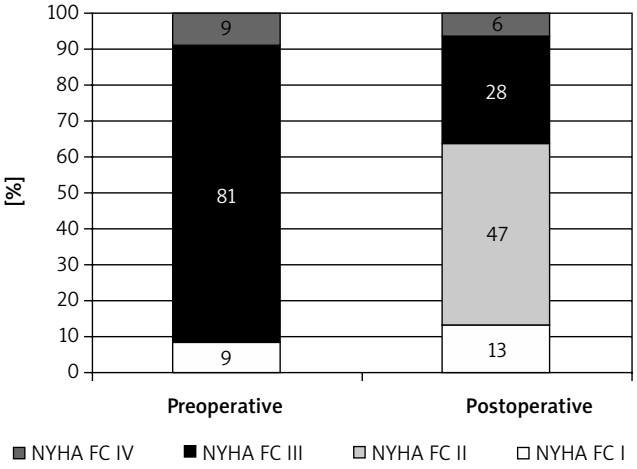
Discussion

The beneficial effects of ASD closure, which include improvement in symptoms, positive right and left heart



Changes in atrial arrhythmia: atrial fibrillation (A fib) and atrial flutter (A flut) permanent (perm) and paroxysmal (parox) during postoperative follow-up

Fig. 2. Effect on atrial arrhythmia



New York Heart Association functional class (NYHA FC) improvement after ASD closure. Postoperative NYHA FC – at the last visit of follow-up

Fig. 3. Effect on clinical status

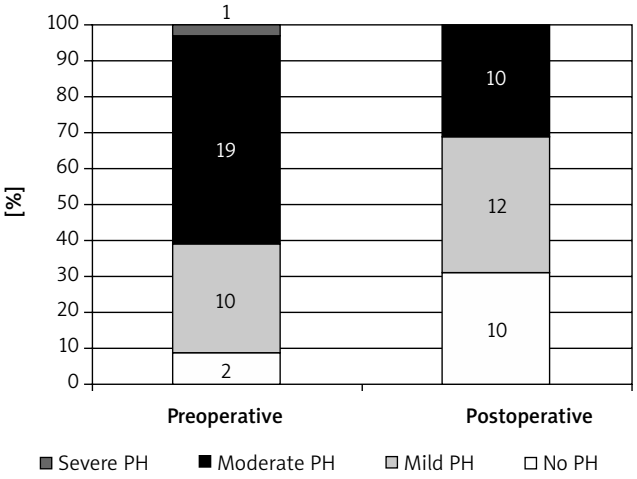
remodeling, increase in exercise capacity, reduction in tendency of development of atrial arrhythmias, and decrease in pulmonary arterial pressures, are the principal aims of ASD closure in older patients [3, 8-10]. The benefits of ASD repair have been influenced by the type of ASD, the size of the defect, pulmonary hypertension grade and the age of the patient. One of the most important problems in elderly patients is that they have a lot of additional diseases and the risk of interventions increases with age. Mortality is higher in the elderly and in patients with comorbidities [2], but there remains the question whether it is worthwhile treating these patients. However, high quality of the surgery team and professional postoperative care may permit these high-risk patients to be considered for a more aggressive strategy – surgical treatment.

In our study in late follow-up 4 (12.5%) patients died. One death was related to ASD surgical correction (postoperative sepsis), and the other 3 were unrelated to the procedure. Very similar results (12.5% mortality) were reported by Nasrallah *et al*. [11].

In another study on multivariate analysis, surgical closure was associated with a significant reduction in 10-year mortality after adjusting for baseline characteristics (5% vs. 16% with medical therapy), with adjusted relative risk of 0.31 in the Konstantinides study [12].

Our study has shown that older age group patients' late postoperative mortality was higher (3 [21%] vs. 1 [5.6%]), but despite this we observed significant improvement in symptoms and functional ability in the older population after surgical ASD closure (group I, n = 10 [56%] vs. group II, n = 12 [86%]). In patients of advanced age with ASDs not suitable for device closure, individual surgical risk due to comorbidities must be carefully weighed against the potential benefits of ASD closure [2].

Our study results suggest that surgical closure of ASDs provides good improvement in symptoms, with 19 (59%) improving from NYHA class III-IV to class I-II. The majority of survivors showed improvement of NYHA functional class. The Ghosh *et al*. study [13] showed very similar results (54%). Symptomatic relief and better than predicted survival compared to medical therapy have also been described in patients who undergo surgery at 60 years of age or older [14].



Late postoperative improvement of pulmonary hypertension (PH)

Fig. 4. Effect on pulmonary hypertension

Atrial tachyarrhythmias – atrial fibrillation and atrial flutter – occur in approximately 20% of adult patients with ASD and are often the presenting symptom [9, 12, 15, 16]. The incidence of atrial fibrillation/flutter in our study was quite high (in 21 [66%] of all patients). In the Sutton *et al.* study of ASD patients aged ≥ 60 years, arrhythmia prevalence was slightly lower – 52% [14]. This could be explained by the fact that patients with surgical treatable comorbidities were directed for surgical treatment, while for other patients transcatheter closure was recommended.

This rhythm disorder was decreased after closure of the defect but it was also more observable in the elderly group

(group II): before closure atrial fibrillation in group II – 11 (79%), after closure – 9 (64%). Older age itself is a risk factor for AF. The reasons why the older patients had a greater reduction in arrhythmias are not clear and require more long-term investigations. The treatment results for severe patients are more observable. As we mentioned, new onset of these arrhythmias after surgery in our study occurred in 12.5% (n = 4) of patients. Very similar results were noted in the review of 115 patients with sinus venosus defects cited above: atrial fibrillation occurred in 14% and was most common with older age of repair [17]. Furthermore, high risk arrhythmia patients undergoing late ASD closure should be considered for a concomitant arrhythmia-targeting intervention [1]. This procedure could reduce the long-term incidence of AF in selected patients [16, 18, 19]. Despite this, Kobayashi *et al.* demonstrated that a surgical right atrial Maze procedure alone is usually ineffective in restoring and maintaining sinus rhythm after ASD closure [20]. Shim *et al*. [21] reported that the Maze procedure is safe and effective in patients who have ASD and AF for restoring sinus rhythm. In this study, freedom from AF recurrence at 3 months and 5 years after surgery was 97.4 ± 2.6 and 68.2 ± 12.4, respectively [21].

In our study, the Maze procedure was performed in 16% of all patients at the time of ASD closure, but in some cases with AF only rate control was applied. Murphy *et al*. remarked that patients who have an ASD correction after age 40 years were at increased risk of postoperative cardiovascular complications [22]. In our study, nearly a third of patients had early major postoperative complications, but all of them except one survived. As expected, we observed that the complication rate increases with age.

Although less invasive transcatheter closure is the first choice method to close ASD, but it could not be applied in all cases, e.g. due to anatomical reasons or surgery required for concomitant cardiac pathology.

Therefore, correction of ASDs in advanced age remains controversial and is often considered nonbeneficial in older patients, but in this study we demonstrated that ASD surgical closure is technically conceivable with a high success rate and also can be performed in the older population, if less invasive transcatheter closure is not feasible. It is necessary to assess the pre-operative state carefully and to evaluate the risk-benefit ratio, because underlying disease can increase operative risk.

Limitations of the study

It was a nonrandomized, single-center cohort study, on a relatively small group of patients undergoing surgical ASD closure. More detailed investigations on larger cohorts of patients may provide additional valuable information.

Conclusions

Surgical correction of clinically significant ASD is effective even in older patients with comorbidities. Despite this, operational risk in this age group of patients is extremely high. Close postoperative follow-up, early detection and treatment of atrial arrhythmias are highly advised.

Disclosure

Authors report report no conflict of interest.

References

1. Webb G, Gatzoulis MA. Atrial septal defects in the adult recent progress and overview. Circulation 2006; 114: 1645-1653.
2. Baumgartner H, Bonhoeffer P, De Groot NMS, Haan F, Deanfield JE, Galie N, Gatzoulis MA, Gohlke-Baerwolf C, Kaemmerer H, Kilner P, Meijboom F, Mulder BJM, Oechslin E, Oliver JM, Serraf A, Szatmari A, Thaulow W, Vouhe PR, Walma E. ESC guidelines for the management of grown-up congenital heart diseases. Eur Heart J 2010; 31: 2915-2957.
3. Humenberger M, Rosenhek R, Gabriel H, Rader F, Heger M, Klaar U, Binder T, Probst P, Heinze G, Maurer G, Baumgartner H. Benefit of atrial septal defect closure in adults: impact of age. Eur Heart J 2011; 32: 553-560.
4. Martucci G, Landzberg M. Closing atrial septal defects in adults older than 60 years. Circ Cardiovasc Intervent 2009; 2: 83-84.
5. Webb G. Do patients over 40 years of age benefit from closure of an atrial septal defect? Heart 2001; 85: 249-250.
6. Gatzoulis MA, Redington AN, Somerville J, Shore DF. Should atrial septal defects in adults be closed? Ann Thorac Surg 1996; 61: 657-659.
7. Ward C. Secundum atrial septal defect: routine surgical treatment is not of proven benefit. Br Heart J 1994; 71: 219-223.
8. Silversides CK, Haberer K, Siu SC, Webb GD, Benson LN, McLaughlin PR, Harris L. Predictors of atrial arrhythmias after device closure of secundum type atrial septal defects in adults. Am J Cardiol 2008; 101: 683-687.
9. Attie F, Rosas M, Granados N, Zabal C, Buendia A, Calderon J. Surgical treatment for secundum atrial septal defects in patients > 40 years old. A randomized clinical trial. J Am Coll Cardiol 2001; 38: 2035-2042.
10. Kim NK, Park SJ, Choi JY. Transcatheter closure of atrial septal defect: does age matter? Korean Circ J 2011; 41: 633-638.
11. Nasrallah AT, Hall RJ, Garcia E, Leashman RD, Cooley DA. Surgical repair of atrial septal defect in patients over 60 years of age. Long-term results. Circulation 1976; 53: 329-331.
12. Konstantinides S, Geibel A, Olschewski M, Görnandt L, Roskamm H, Spillner G, Just H, Kasper W. A comparison of surgical and medical therapy for atrial septal defect in adults. N Engl J Med 1995; 333: 469-473.
13. Ghosh S, Chatterjee S, Black E, Firmin RK. Surgical closure of atrial septal defects in adults: effect of age at operation on outcome. Heart 2002; 88: 485-487.
14. Sutton MG, Tajik AJ, McGoon DC. Atrial septal defect in patients ages 60 years or older: operative results and long-term postoperative follow-up. Circulation 1981; 64: 402-409.
15. Gatzoulis MA, Freeman MA, Siu SC, Webb GD, Harris L. Atrial arrhythmia after surgical closure of atrial septal defects in adults. N Engl J Med 1999; 340: 839-846.
16. Berger F, Vogel M, Kramer A, Alexi-Meskishvili V, Weng Y, Lange PE, Hetzer R. Incidence of atrial flutter/fibrillation in adults with atrial septal defect before and after surgery. Ann Thorac Surg 1999; 68: 75-78.
17. Attenhofer Jost CH, Connolly HM, Danielson GK, Bailey KR, Schaff HV, Shen WK, Warnes CA, Seward JB, Puga FJ, Tajik AJ. Sinus venosus atrial septal defect: long-term postoperative outcome for 115 patients. Circulation 2005; 112: 1953-1958.
18. Sandoval N, Velasco VM, Orjuela H, Caicedo V, Santos H, Rosas F, Carrea JR, Melgarejo I, Morillo CA. Concomitant mitral valve or atrial septal defect surgery and the modified Cox-maze procedure. Am J Cardiol 1996; 77: 591-596.
19. Bonchek LI, Burlingame MW, Worley SJ, Vazales BE, Lundy EF. Cox/Maze procedure for atrial septal defect with atrial fibrillation: management strategies. Ann Thorac Surg 1993; 55: 607-610.
20. Kobayashi J, Yamamoto F, Nakano K, Sasako Y, Kitamura S, Kosakai Y. Maze procedure for atrial fibrillation associated with atrial septal defect. Circulation 1998; 98 (suppl): II-399-II-402.
21. Shim H, Yang JH, Park PW, Jeong DS, Jun TG. Efficacy of the Maze procedure for atrial fibrillation associated with atrial septal defect. Korean J Thorac Cardiovasc Surg 2013; 46: 98-103.
22. Murphy JG, Gresh BJ, Phil D, McGoon MD, Mair DD, Porter J, Ilstrup DM, McGoon DC, Puga FJ, Kirklin JW, Danielson GK. Long-term outcome after surgical repair of isolated atrial septal defect: follow-up at 27 to 32 years. N Eng J Med 1990; 323: 1645-1650.