A Comparative Study of Outcomes after Transcatheter Closure of Secundum-Type Atrial Septum Defect in Adults Younger than 60 Years and the Older Ones

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Objective: *To compare the results of transcatheter atrial septal defect (ASD) closure between adults younger than 60 years and the older ones in terms of the clinical and echocardiographic outcomes.*
Material and Method: *The cohort study consisted of 333 adult patients who underwent device closure of secundum ASD at Central Chest Institute of Thailand between January 2007 and June 2012. They were divided into two groups, group 1 were patients with age younger than 60 years, and group 2 were patients with age equal or older than 60 years. Clinical and echocardiographic outcomes were collected and analyzed.*
Results: *There were 274 patients in group 1 with mean age of 38.7±12.1 years and 59 patients in group 2 with mean age of 66±4.9 years). One year after ASD closure, functional class improvement ≥1 class was observed in both groups but there was no significant difference between group (64% in group 1 vs. 71.4% in group 2, p = 0.308). A decrease in systolic pulmonary arterial pressure (PAP) and right ventricular systolic pressure (RVSP) were observed in both groups. The absolute changes of RVSP at baseline and one year post procedure were not significantly different between groups (15.8±9.9 mmHg in group 1 vs. 12.3±12.2 mmHg in group 2, p = 0.067). Procedural time and minor complications were comparable.*
Conclusion: *Transcatheter ASD closure can be effectively and safely performed in patients older than 60 years as compared with the younger ones. Symptomatic improvement and reduction of PAP and RVSP were observed at any age. ASD closure should be recommended irrespective of symptoms, even in adults with advanced age.*

Keywords: *Transcatheter closure of secundum atrial septum defect, Over 60 years of age, Elderly*

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Atrial septal defect (ASD) is one of the common congenital heart disease that are diagnosed in adult. Chronic right heart volume overload leads to chronic right heart failure, pulmonary hypertension, and atrial arrhythmias[1,2]. Closure of ASD in children and young adults result in an improvement in symptoms, right heart remodeling, and reduction in pulmonary artery pressures[3-6]. However, the benefits of ASD closure in patients with advanced age are less clear and remained uncertain[7,8].

Transcatheter closure of secundum type atrial septum defect is widely accepted as an alternative to surgical closure. This procedure is less invasive, lower complication rate and shorter length of hospital stay as compared with surgery[9-11]. The aim of the present study was to compare the effects of transcatheter ASD closure on functional status and echocardiographic parameters between patients over and under the age of 60 years.

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Material and Method

Patient recruitment

This cohort study enrolled 333 consecutive patients age over 20 years old who underwent device closure of secundum ASD at Central Chest Institute of Thailand, Nonthaburi between January 2007 and June 2012. The indication for closure included significant left to right shunt defined by calculated Qp/Qs ratio over 1.5 and the presence of right heart dilatation on echocardiogram, irrespective of symptoms. Transesophageal echocardiography (TEE) was routinely performed in all patients prior to scheduled device closure to assess ASD morphology and to exclude additional lesions such as anomalous pulmonary venous connection. Transcatheter ASD closure was not performed in patients who had ASD size >36 mm or inadequate morphology (multiple defects, insufficient rim except anterior rim, interatrial septum aneurysm, and significant additional lesions).

Invasive evaluation was routinely performed prior to the intervention. During study period, transcatheter ASD closure was attempted in 338 patients, but five patients (1.5%) required surgery because of device migration immediately after deployment.

Device closure

Transcatheter closure of ASD was conducted under local anesthesia with fluoroscopic and/or transesophageal echocardiographic guidance, after obtaining written informed consent. The Amplatzer septal occluder (AGA Medical Corporation) was used in all patients and device size was selected by intraprocedural transthoracic or transesophageal echocardiogram. The size of device was chosen based on maximal diameter plus 2 mm. Oral aspirin (162-325 mg/day) was administered one day before the procedure and continued for six months. Clopidogrel was given orally 300 mg loading one day prior to the procedure and then 75 mg once daily for one month.

Echocardiography

Transthoracic echocardiographic evaluation was performed the day following the procedure, three to six months and one year to evaluate for residual shunt and complications. Comprehensive echocardiographic data was measured by M-mode, two-dimensional, continuous-wave, pulsed-wave, and color Doppler echocardiography. Right ventricular systolic pressure (RVSP) was estimated using the maximum velocity of the tricuspid regurgitant jet. Right atrial pressure was estimated by inferior vena cava (IVC) diameter.

Follow-up

Patients underwent serial physical examination, 12-lead ECG and chest X-ray 1 day, 3-6 months, 12 months and yearly after the intervention to determine the functional status and any complications.

Statistical analysis

The results were reported as percentages for categorical variables and means with standard deviations or median (minimum-maximum) for continuous variables. The differences between two groups were compared using Chi-square or Fisher's exact test for categorical variables and Independent t-test or Mann-Whitney U test for continuous variables. Two-way repeated measures ANOVA was used for testing the mean difference between two groups. All data were analyzed by SPSS software version 15.0. A p-value of less than 0.05 was considered to indicate statistical significance, and all tests were two-sided.

Results

Baseline characteristics

Baseline clinical characteristics and echocardiographic data were shown in Table 1. Three hundred and thirty three patients were enrolled in the study, 274 were younger than 60 years and 59 were older than 60 years. The ASD size and shunt ratio were not significantly different between two groups. However, the older group had more co-morbid diseases with higher prevalence of persistent atrial fibrillation (AF), history of heart failure, and admission from heart failure as compared with the younger group. All patients in the older group were symptomatic, 91.5% in New York Heart Association (NYHA) class II and 8.5% in NYHA class III. Age was slightly correlated with NYHA ($r = 0.30$, $p<0.001$) and baseline RVSP ($r = 0.28$, $p<0.001$). There was no correlation between age and ASD size. Left atrium size, main pulmonary artery (MPA) size, and moderate tricuspid regurgitation (TR) were significantly higher in the older group. Functional class was significantly related to RVSP with NYHA class I (38.5±12.8 mmHg), class II (45.6±13.5 mmHg) and class III (58.8±29.6 mmHg), $p<0.001$.

Intervention results and complications

Cardiac catheterization data were shown in Table 2. The systolic and mean pulmonary arterial pressure (PAP) significantly increased with age. There was no significant difference in shunt ratio and pulmonary vascular resistance. The device size, fluoroscopy time and procedure time did not significantly differ between age groups. After the procedure, systolic pulmonary arterial pressure (PAP) immediately decreased in both age groups but absolute changes did not differ between groups (10.3±13.8 mmHg for older group vs. 8.5±8.8 mmHg for younger group, $p = 0.308$). No major procedural complication occurred. Subcutaneous hematoma was observed in four patients and two patients had femoral AV fistula. No residual shunt was observed.

Follow-up

In the younger group, one patient was lost to follow-up in early period (3 months) and two patients died from non-cardiac event after two years of follow-up. In the older group, two patients with persistent AF died from cerebrovascular events and

Table 1. Baseline characteristics of patients

	All patients (n = 333)	<60 years (n = 274)	≥60 years (n = 59)	*p*-value
Age at time of procedure (year)	43.5±15.3	38.7±12.1	66.0±4.9	
Female, n (%)	272 (81.7%)	226 (82.5%)	46 (78.0%)	0.416
BMI (kg/m^2)	22.4±4.8	22.2±4.9	23.6±4.3	0.049
Fn class (NYHA)				<0.001
NYHA I, n (%)	89 (26.7%)	89 (32.5%)	0	
NYHA II, n (%)	224 (67.3%)	170 (62.0%)	54 (91.5%)	
NYHA III, n (%)	20 (6.0%)	15 (5.5%)	5 (8.5%)	
History of heart failure, n (%)	23 (7.0%)	12 (4.4%)	11 (18.6%)	<0.001*
Diabetes, n (%)	20 (6.0%)	8 (2.9%)	12 (20.3%)	<0.001*
Hypertension, n (%)	58 (17.4%)	27 (9.9%)	31 (52.5%)	<0.001
Respiratory disease, n (%)	10 (3.0%)	2 (0.7%)	8 (13.6%)	<0.001
Ischemic stroke, n (%)	1 (0.3%)	0	1 (1.7%)	0.177*
Persistent AF, n (%)	21 (6.3%)	8 (2.9%)	13 (22.0%)	<0.001*
Paroxysmal AF, n (%)	10 (3.0%)	6 (2.2%)	4 (6.8%)	0.082*
History of admission from CHF, n (%)	18 (5.4%)	10 (3.7%)	8 (13.6%)	0.006*
Echocardiographic data$^+$				
ASD size from TTE (mm)	21.1±6.8	21.1±6.6	20.6±7.5	0.657
ASD size from TEE (mm)	20.9±6.0	21.1±5.7	19.9±7.0	0.194
Shunt ratio Qp/Qs	3.4 (1.05, 75)	3.3 (1.1, 75.0)	3.8 (1.2, 12.0)	0.093$^\#$
MPA size (mm)	28.9±5.8	28.3±5.6	31.4±6.2	<0.001
Left atrium size (mm)	35.7±7.8	34.1±6.9	43.0±7.4	<0.001
LVEF%	65.2±10.9	65.0±10.4	66.0±12.9	0.607
LVEDD (mm)	37.3±5.8	37.0±5.5	38.6±7.1	0.051
LVESD (mm)	24.0±5.2	23.7±4.4	25.1±7.7	0.2
RVOT diameter (mm)	29.9±5.7	29.1±5.2	31.4±6.2	0.029
RVSP (mmHg)	43.8±15.4	42.2±15.6	51.1±12.3	<0.001
Moderate TR, n (%)	73 (22.1%)	53 (19.5%)	20 (33.9%)	0.023*
Severe TR, n (%)	27 (8.2%)	19 (7.0%)	8 (13.6%)	0.113*

BMI = body mass index; NYHA = New York Heart Association; AF = atrial fibrillation; CHF = Congestive heart failure; ASD = atrial septal defect; TTE = transthoracic echocardiogram; TEE = transesophageal echocardiography; MPA = main pulmonary artery; LVEF = left ventricular ejection fraction; LVEDD = left ventricular end-diastolic diameter; LVESD = left ventricular end-systolic diameter; RVOT = right ventricular outflow tract; RVSP = right ventricular systolic pressure; TR = tricuspid regurgitation

* Fisher's exact test, $^\#$ Mann-Whitney U test

$^+$ Data were presented as mean (SD) or median (min, max) as appropriate

one patient died from lung cancer two year after the procedure. One elderly patient died one month after discharge from unknown cause.

Functional status

Functional class improvement ≥1 class was observed in both age groups but there was no significant difference between groups (64.3% in younger group vs. 71.4% in older group, $p = 0.308$). As shown in Fig. 1, one year after the procedure, 95.2% of younger group were asymptomatic. In the older group, 37.5% of patients remained in NHYA class II, whereas 62.5% were asymptomatic. Patients who had history of admission from heart failure prior to ASD closure had a significant reduction in readmission rate from heart failure; one patient in younger group and none in the elder group had to be readmitted due to heart failure in the first year after the procedure.

Echocardiographic results and arrhythmias

As shown in Fig. 2, a decrease in RVSP was observed in both age groups. The absolute changes of RVSP at baseline and one year post ASD closure were not significant difference among groups

Table 2. Cardiac catheterization data+

	All patients (n = 333)	<60 years (n = 274)	≥60 years (n = 59)	*p*-value
Systolic PA pressure (mmHg)	38.7±16.4	36.8±15.5	47.5±17.8	<0.001
Mean PA pressure (mmHg)	24.2±9.6	23.4±9.9	27.7±7.5	0.002
Shunt ratio Qp/Qs	2.6 (0.5, 28.0)	2.6 (0.50, 23.0)	2.6 (1.4, 28.0)	0.493#
Pulmonary vascular resistance (wood unit)	2.23 (0.01, 27.6)	2.2 (0.01, 27.6)	2.5 (0.95, 5.03)	0.080#
Device size (mm)	27.4±5.1	27.4±5.0	27.1±5.6	0.673
Fluoroscopic time, min	11.0±5.3	10.7±5.3	12.2±5.0	0.053
Procedure time, min	46.8±16.8	46.1±16.3	50.2±18.4	0.087

PA = pulmonary artery
* Fisher's exact test, # Mann-Whitney U test
+ Data were presented as mean (SD) or median (min, max) as appropriate

(15.8±9.9 mmHg in older group vs. 12.3±12.2 mmHg in younger group, $p = 0.067$). There were no significant changes in left ventricular dimensions and ejection fraction. Patients with persistent atrial fibrillation were remained in this rhythm at follow-up.

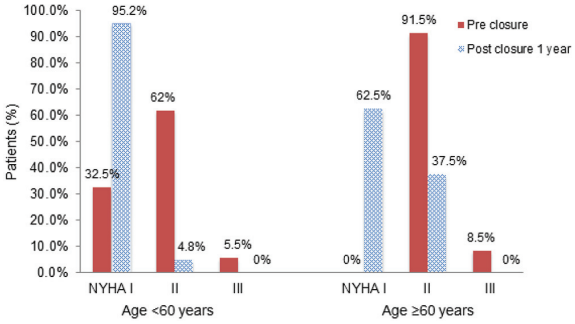

Fig. 1 Functional status before and after ASD closure for patients younger and older than 60 years old.

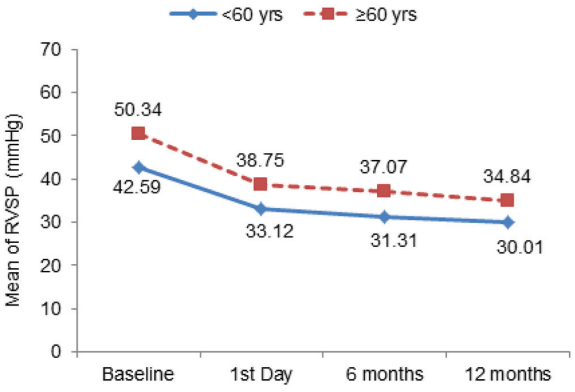

Fig. 2 Right ventricular systolic pressure (RVSP) before, 1 day, 6months and 1 year after atrial septal defect closure for patients over and younger than 60 years.

Discussion

Current guideline recommends all hemodynamically significant ASD patients should undergo ASD closure, regardless of symptoms[12]. Transcatheter ASD closure is much less invasive than surgery and has been reported as safe and effective treatment[13-15]. This procedure can relieve the symptom, improve exercise capacity, and right heart remodeling[5,16]. Elderly patients have a prolonged left to right shunt resulting in chronic right ventricular volume overload and subsequent pulmonary hypertension and atrial arrhythmia. Furthermore, elderly patients have high prevalence of co-morbid conditions such as hypertension, diabetes, ischemic heart disease that concern benefits of ASD closure in these patients. Surgical closure of ASD in the elderly can result in significant mortality and morbidity[17,18]. There were limited studies regarding safety and efficacy of transcatheter ASD closure in patients over 60 years of age. However, previous small studies revealed that this procedure not only can be performed safely, but also results in improvement of functional capacity and regression of RV dimension[19-22].

The present study showed that transcatheter ASD closure was associated with very low rate of complications and particularly no mortality even though it was performed in patients older than 60 years. High success rate of closure was found in both age groups (97%). Procedural time, fluoroscopy time and complication rate were similar in both age groups. Vijarnsorn et al[23] reported that this procedure was safe and had low rate of complications, regardless of age. The major concern about acute transient pulmonary edema after ASD closure was described in elderly patients[22,24]. However, it did not occur in our patients. Significant improvement of functional class was

observed in all age particularly in the elderly because all patients in the older groups were symptomatic and had higher baseline RVSP. Moreover, elderly patients with history of hospitalization from heart failure did not require additional admission from heart failure during one-year follow-up.

The risk of atrial arrhythmia is closely related to age. Previous studies reported that the new onset of atrial arrhythmias occur more frequently in patients older than 40 years at time of surgery[3]. Furthermore, the likelihood of remaining no arrhythmia after transcatheter ASD closure was highest in patients younger than 40 years without a history of atrial arrhythmia[25]. The present study showed that the incidence of atrial fibrillation after ASD closure was higher in the older group than in the younger group. Atrial fibrillation persisted in all patients who had this rhythm before the procedure.

RVSP and PAP increased continuously with age. A reduction in RVSP and PA pressure has been documented in younger patients after ASD closure[26,27]. Several authors have suggested that these beneficial effect may be blunted or disappear with advancing years[9,26]. Humenberger et al[27] reported regression of PA pressure and RV size with symptomatic improvement in three months after ASD closure even in patients with advanced age. Nevertheless, the present study showed that the RVSP and PA pressure decreased in both groups at one year after the procedure but the absolute changes did not significantly differ between age groups. Future study is required to demonstrate whether long-term follow-up of RVSP can show further reduction.

Conclusion

Transcatheter ASD closure can be effectively and safely performed in patients older than 60 years as compared with the younger ones. The symptomatic improvement as well as reduction of RVSP and pulmonary arterial pressure can be noticed at any age. However, the absolute changes of RVSP did not significantly differ between age groups and not reach the normal level after one year follow-up.

Limitations

First, the improvement of functional class in the present study was based on the patients' subjective, not on other functional measurement such as six-minute walk test or cardiopulmonary exercise test. However, it is a practical and easy way to assess patients during outpatient visit. Second, this study did not monitor patient's rhythm with 24 hour ECG monitoring, so it could underestimate the incidence of arrhythmias.

What is already known on this topic?

The benefits of ASD closure in patients with advanced age are less clear. The previous studies showed that transcatheter ASD closure in patients over 60 years of age not only can be performed safely, but also results in symptomatic improvement, reduction of RVSP and regression of RV dimension.

What this study adds?

This study confirmed the benefit of transcatheter ASD closure in the elderly in terms of functional class improvement, reduction of RVSP and pulmonary arterial pressures. There was no additional heart failure hospitalization during one-year follow-up in elderly patients with history of previous hospitalization. This procedure is safe so it should be recommended even in the elderly patients.

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Potential conflicts of interest

None.

References

1. Lindsey JB, Hillis LD. Clinical update: atrial septal defect in adults. Lancet 2007; 369: 1244-6.
2. Graham TP Jr. Ventricular performance in congenital heart disease. Circulation 1991; 84: 2259-74.
3. 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: 839-46.
4. 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: 2035-42.
5. Veldtman GR, Razack V, Siu S, El Hajj H, Walker F, Webb GD, et al. Right ventricular form and function after percutaneous atrial

septal defect device closure. J Am Coll Cardiol 2001; 37: 2108-13.
6. Kort HW, Balzer DT, Johnson MC. Resolution of right heart enlargement after closure of secundum atrial septal defect with transcatheter technique. J Am Coll Cardiol 2001; 38: 1528-32.
7. Ward C. Secundum atrial septal defect: routine surgical treatment is not of proven benefit. Br Heart J 1994; 71: 219-23.
8. Webb G. Do patients over 40 years of age benefit from closure of an atrial septal defect? Heart 2001; 85: 249-50.
9. Du ZD, Hijazi ZM, Kleinman CS, Silverman NH, Larntz K. Comparison between transcatheter and surgical closure of secundum atrial septal defect in children and adults: results of a multicenter nonrandomized trial. J Am Coll Cardiol 2002; 39: 1836-44.
10. Thomson JD, Aburawi EH, Watterson KG, Van Doorn C, Gibbs JL. Surgical and transcatheter (Amplatzer) closure of atrial septal defects: a prospective comparison of results and cost. Heart 2002; 87: 466-9.
11. Butera G, Carminati M, Chessa M, Youssef R, Drago M, Giamberti A, et al. Percutaneous versus surgical closure of secundum atrial septal defect: comparison of early results and complications. Am Heart J 2006; 151: 228-34.
12. Warnes CA, Williams RG, Bashore TM, Child JS, Connolly HM, Dearani JA, et al. ACC/AHA 2008 guidelines for the management of adults with congenital heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines on the Management of Adults With Congenital Heart Disease). J Am Coll Cardiol 2008; 52: e143-e263.
13. Moore J, Hegde S, El Said H, Beekman R III, Benson L, Bergersen L, et al. Transcatheter device closure of atrial septal defects: a safety review. JACC Cardiovasc Interv 2013; 6: 433-42.
14. Kotowycz MA, Therrien J, Ionescu-Ittu R, Owens CG, Pilote L, Martucci G, et al. Long-term outcomes after surgical versus transcatheter closure of atrial septal defects in adults. JACC Cardiovasc Interv 2013; 6: 497-503.
15. Majunke N, Bialkowski J, Wilson N, Szkutnik M, Kusa J, Baranowski A, et al. Closure of atrial septal defect with the Amplatzer septal occluder in adults. Am J Cardiol 2009; 103: 550-4.
16. Brochu MC, Baril JF, Dore A, Juneau M, De Guise P, Mercier LA. Improvement in exercise capacity in asymptomatic and mildly symptomatic adults after atrial septal defect percutaneous closure. Circulation 2002; 106: 1821-6.
17. Harjula A, Kupari M, Kyosola K, Ventila M, Hartel G, Maamies T, et al. Early and late results of surgery for atrial septal defect in patients aged over 60 years. J Cardiovasc Surg (Torino) 1988; 29: 134-9.
18. 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: 485-7.
19. Swan L, Varma C, Yip J, Warr M, Webb G, Benson L, et al. Transcatheter device closure of atrial septal defects in the elderly: technical considerations and short-term outcomes. Int J Cardiol 2006; 107: 207-10.
20. Woo SB, Jang SI, Kim SH, Kim SJ, Lee SY, Baek JS, et al. Transcatheter closure of secundum atrial septal defect in patients over 60 years old. Korean Circ J 2013; 43: 110-4.
21. Nakagawa K, Akagi T, Taniguchi M, Kijima Y, Goto K, Kusano KF, et al. Transcatheter closure of atrial septal defect in a geriatric population. Catheter Cardiovasc Interv 2012; 80: 84-90.
22. Jategaonkar S, Scholtz W, Schmidt H, Horstkotte D. Percutaneous closure of atrial septal defects: echocardiographic and functional results in patients older than 60 years. Circ Cardiovasc Interv 2009; 2: 85-9.
23. Vijarnsorn C, Durongpisitkul K, Chanthong P, Chungsomprasong P, Soongswang J, Loahaprasitiporn D, et al. Transcatheter closure of atrial septal defects in children, middle-aged adults, and older adults: failure rates, early complications; and balloon sizing effects. Cardiol Res Pract 2012; 2012: 584236.
24. Ewert P, Berger F, Nagdyman N, Kretschmar O, Dittrich S, Abdul-Khaliq H, et al. Masked left ventricular restriction in elderly patients with atrial septal defects: a contraindication for closure? Catheter Cardiovasc Interv 2001; 52: 177-80.
25. Silversides CK, Haberer K, Siu SC, Webb GD, Benson LN, McLaughlin PR, et al. Predictors of atrial arrhythmias after device closure of secundum type atrial septal defects in adults. Am J Cardiol 2008; 101: 683-7.
26. Yong G, Khairy P, De Guise P, Dore A, Marcotte F, Mercier LA, et al. Pulmonary arterial hypertension in patients with transcatheter closure

of secundum atrial septal defects: a longitudinal study. Circ Cardiovasc Interv 2009; 2: 455-62.
27. Humenberger M, Rosenhek R, Gabriel H, Rader F, Heger M, Klaar U, et al. Benefit of atrial septal defect closure in adults: impact of age. Eur Heart J 2011; 32: 553-60.

การศึกษาเปรียบเทียบผลการปิดผนังหัวใจห้องบนรั่วแต่กำเนิดชนิด secundum ผ่านทางสายสวนหัวใจ ในผู้ป่วยที่อายุมากกว่าและน้อยกว่า 60 ปี

สมรรัตน์ จำปาเทศ, เกรียงไกร เฮงรัศมี

วัตถุประสงค์: *ศึกษาเปรียบเทียบผลการรักษาในแง่อาการและผลการตรวจคลื่นเสียงสะท้อนหัวใจหลังจากการปิดรูรั่วที่ผนังกั้นห้องหัวใจห้องบนโดยใช้วิธีสวนหัวใจ ระหว่างผู้ป่วยอายุมากกว่าและน้อยกว่า 60 ปี*

วัสดุและวิธีการ: *ศึกษาข้อมูลในผู้ป่วยอายุ 20 ปีขึ้นไป จำนวน 333 ราย ที่ได้รับการรักษาปิดรูรั่วที่ผนังกั้นห้องหัวใจห้องบนโดยใช้วิธีสวนหัวใจที่สถาบันโรคทรวงอก ในช่วง เดือนมกราคม พ.ศ. 2550 ถึง มิถุนายน พ.ศ. 2555 แบ่งผู้ป่วยเป็น 2 กลุ่มอายุ ได้แก่ อายุน้อยกว่า 60 ปี จำนวน 274 ราย (อายุเฉลี่ย 38.7±12.1 ปี) และอายุ 60 ปีขึ้นไป จำนวน 59 ราย (อายุเฉลี่ย 66±4.9 ปี)*

ผลการศึกษา: *หลังการรักษา 1 ปี พบว่าอาการเหนื่อยลดลงอย่างชัดเจนในผู้ป่วยทั้งสองกลุ่มอายุ โดยไม่พบความแตกต่างระหว่างกลุ่มอย่างมีนัยสำคัญ (64% ในคนอายุน้อย และ 71.4% ในคนสูงอายุ, p = 0.308) พบการลดลงของความดันหลอดเลือดปอดและความดันหัวใจห้องขวาล่างทั้งสองกลุ่ม โดยระดับการลดลงของความดันหัวใจห้องขวาล่างหลังการรักษาที่ 1 ปี ไม่แตกต่างระหว่างกลุ่มอย่างมีนัยสำคัญ (12.3±12.2 mmHg ในคนอายุน้อย และ 15.8±9.9 mmHg ในคนสูงอายุ, p = 0.067) รวมถึงไม่พบความแตกต่างในแง่ระยะเวลาและผลแทรกซ้อนจากการรักษาในทุกกลุ่มอายุ*

สรุป: *การปิดรูรั่วที่ผนังกั้นห้องหัวใจห้องบนโดยใช้วิธีสวนหัวใจมีความปลอดภัยสูง และทำให้อาการผู้ป่วยดีขึ้น รวมถึงมีผลลดความดันหลอดเลือดปอดและความดันหัวใจห้องขวาล่างในผู้ป่วยทุกกลุ่มอายุ ดังนั้นการรักษาวิธีนี้จึงควรแนะนำในผู้ป่วยทุกราย แม้ในคนสูงอายุก็ตาม*