Surgical Outcomes of Adult Congenital Heart Disease with Left to Right Shunt at Siriraj Hospital

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Background: *Outcomes of surgical treatment of adult congenital heart disease (ACHD) in developing country are scant but are of critical importance for caring of these patients.*
Objective: *We studied characteristic and surgical repair outcomes of simple ACHD at Siriraj Hospital.*
Material and Method: *We studied 297 adults with atrial septal defect (ASD), ventricular septal defect (VSD), or patent ductus arteriosus (PDA) whom underwent surgical repair between January 2006 and September 2014. There were 211 ASD, 80 VSD, and 6 PDA. We focused on perioperative data, follow-up data, and factor(s) associated with adverse events.*
Results: *Of 297 patients, 37.4% were males; mean age was 41.8 years (range, 20-78 years). Pulmonary hypertension and valvular regurgitation (mitral, tricuspid, or aortic) were presented in 74.7% and 35.0% of the patients, respectively. Majority of defects were closed with patching (85.4% for ASD and 82.7% for VSD), while the rest were closed directly. Of the 190 concomitant procedures, most of them were tricuspid repair (28.9%), and mitral repair (17.4%). There were eight hospital deaths (2.7%). At median follow-up of 25 months (range, 1-102 months), the mean functional classification was reduced from 1.9 to 1.1 ($p<0.01$). There were five re-interventions and four late deaths. Overall survival was 96.1% at five years and 76.1% at eight years. Concomitant procedure(s), tricuspid, and mitral regurgitation were associated with worse survival. Concomitant procedure(s), mitral, and aortic regurgitation were associated with re-intervention.*
Conclusion: *Outcomes of surgical repair of simple ACHD were good. Valvular regurgitation and concomitant procedure(s) adversely affected the outcomes.*

Keywords: *Adult congenital heart disease, ASD, VSD, PDA, Surgery, Outcomes*

J Med Assoc Thai 2016; 99 (6): 675-83
Full text. e-Journal: *http://www.jmatonline.com*

The prevalence of congenital heart disease (CHD) is approximately one percent of population. It is one of the most common congenital malformations. The remarkable improvement in survival of patients with CHD has led to a continuously growing number of adults with CHD. One would expect that in the next decade, almost 1 in 150 young adults would have some form of CHD[1,2]. Special knowledge and special health care professionals are required to meet the needs of this special population[3]. More than half of adults with CHD are having moderate or high complexity of their defect. Even in simple defect, pulmonary vascular obstructive disease, valvular insufficiency, and/or supraventricular arrhythmias might develop as the patient grow up[4,5].

Surgery during adulthood may be required in various situations such as patients with prior repair and residual or new complications, patients with conditions not diagnosed or not indicated for surgery during childhood, and patients with prior palliation.

In developing country, significant portion of patients remain un-operated until reaching adulthood. Results of surgical correction in this particular group of patients are not as good as pediatric patients. For instant, closure of atrial septal defect before 25 year-old results in normal life expectancy, while closure beyond 25 years associated with shorter survival and worse quality of life when compared to normal population[6,7].

Knowledge about these groups of patient is critical to undertake proper management. Furthermore, a significant number of adults with CHD presents in our institution. Therefore, we decided to study the clinical characteristics and outcomes of surgical treatment for simple CHD in adult patients at our hospital.

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Material and Method

Patient population

The present study was approved by the Institutional Review Board (Protocol number 707/2557

(EC4), COA number Si761/2014). We retrospectively reviewed patients of the Faculty of Medicine Siriraj Hospital, Bangkok, Thailand whom underwent surgical repair of cardiac defect between January 2006 and September 2014. The inclusion criteria were age greater than 20 years and diagnosed as atrial septal defect (ASD), ventricular septal defect (VSD), or patent ductus arteriosus (PDA). The exclusion criteria were cardiac transplantation and CHD-unrelated primary surgical indication.

Outcomes measurement

We retrieved clinical data from electronic outpatient database, inpatient database, and follow-up records.

Preoperative parameters, operative procedure details, post-operative outcomes, and follow-up visits data were collected.

Statistical analysis

We used SPSS™ software version 20.0 (SPSS Inc., IBM Company, Chicago, Illinois, USA) for the statistical analyses. Continuous data are expressed as the mean ± standard deviation (SD) and categorical data as frequency (percentage) unless otherwise specified. The probability of survival was estimated according to the Kaplan-Meier method. Survival curves were compared by means of log-rank test. The *p*-value of less than 0.05 were considered statistically significant.

Results

Between January 2006 and September 2014, 303 adult patients underwent surgical correction of cardiac defect(s) within the study scope. Details were illustrated in Fig. 1. Due to deficient of post-operative visit data, six patients were excluded from the analysis. The remaining 297 patients composed of 211 patients with ASD, 80 VSD, and six PDA. Of these 297 patients, seven patients had multiple (two or three) shunt levels and were assigned to each group according to their defect of maximal shunt burden.

Baseline characteristics (Fig. 2, Table 1)

The mean age of the patient was 41.8±14.6 years (range, 20 to 78 years), 111 of the patients were male (37.4%). The mean age of the patient with ASD was significantly higher than that of the patient with VSD by 9.3 years. Non-cardiac co-morbidities were presented in 83 patients (27.9%) and most of them were hypertension and diabetes. Of these 83 patients, 18 patients had two co-morbidities and one patient had three co-morbidities.

Clinical features (Table 2)

Two hundred thirty six patients (79.5%) were symptomatic at the time of presentation. Symptomatic patients were 8.4 years older than asymptomatic patients (mean age 43.5±14.9 vs. 35.1±11.3, *p*-value <0.01). Majority of symptoms were dyspnea or congestive heart failure (70.0% of 297 patients). The median duration of presentation was 12 months. The mean preoperative New York Heart Association (NYHA) functional classification was 1.9±0.7.

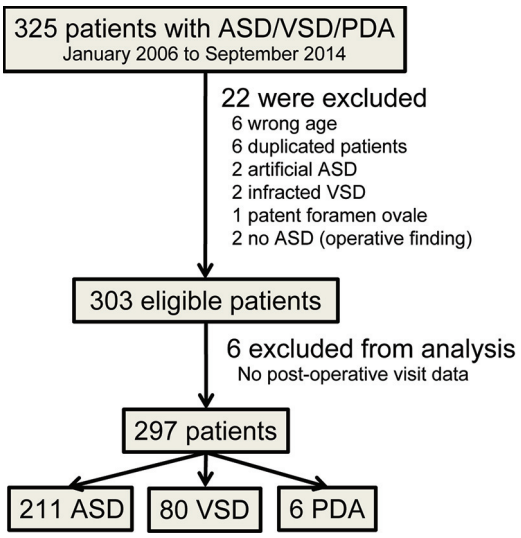

Fig. 1 Study scheme.

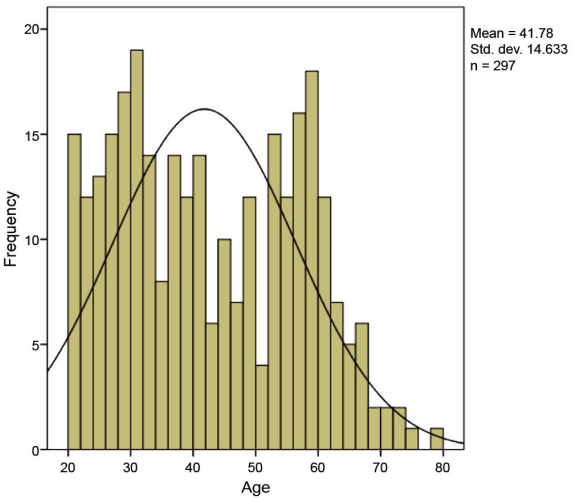

Fig. 2 Age distribution.

Table 1. Baseline characteristics

Variable	Value (n = 297)
Age (years), mean ± SD	41.8±14.6
Age of ASD patient	44.5±14.0*
Age of VSD patient	35.2±14.3
Age of PDA patient	35.8±13.0
Male sex, n (%)	111 (37.4)
Weight (kg), mean ± SD	56.5±12.1
Height (cm), mean ± SD	161.0±8.6
Patient with co-morbidities (% of 297)	83 (27.9)
Hypertension	31
Diabetes mellitus	17
Pulmonary disease	10
Neurogenic disease	9
Alimentary tract disease	7
Neoplastic disease	6
Thyroid disorder	5
Down syndrome	4
Arrhythmia (exclude AF, AFL)	3
Genetic disorder (exclude DS)	2
Chronic kidney disease	2
Other	8

AF = atrial fibrillation; AFL = atrial flutter; ASD = atrial septal defect; DS = Down syndrome; PDA = patent ductus arteriosus; VSD = ventricular septal defect

* Patient with ASD were younger than patient with VSD, *p*-value <0.05

Table 2. Clinical features

Variable	Value (n = 297)	% of 297 patients
Presentation		
Dyspnea or heart failure	208	70.0
Arrhythmia	8	2.7
Syncope	5	1.7
Angina	4	1.3
Endocarditis	4	1.3
Asymptomatic	61	20.5
- Murmur	30	
- Aortic cusp prolapse	16	
- Abnormal chest film or ECG	15	
Other	7	2.4
Duration of presentation (month)		
Mean ± SD	26.9±50.7	
Median	12	
NYHA classification, mean ± SD	1.9±0.7	

ECG = electrocardiography; NYHA = New York Heart Association

Primary diagnosis and associated cardiac conditions (Table 3, 4)

Three hundred eight shunt lesions were presented in 297 patients (215 ASD, 81 VSD, and 12 PDA). Asides from the seven patients with multiple shunt levels as mentioned above, three patients had two types of defect at the atrial level. The patent foramen ovale (PFO) was not considered as primary cardiac defect in the present study.

The average major axis of the ASD was 28.0±9.9 mm. Secondum type was accounted for 81.9% of the ASD. The average size of the VSD was 9.4±6.0 mm. Majority of VSD were outlet type (55.5%) and membranous type (42.0%). The average diameter of the PDA was 6.2±3.6 mm. The average systolic pulmonary artery pressure (SPAP) was around 55-57 mmHg in every group.

Pulmonary hypertension (defined as mean pulmonary artery pressure greater than 26 mmHg or SPAP greater than 40 mmHg) were presented in 74.7% of the patients and valvular insufficiency of more than or equal to moderate degree were documented in 35.0% of the patients; most of them had functional tricuspid regurgitation. Patients with valvular regurgitation were 10.6 years older than that without valvular regurgitation (mean age 48.7±14.4 vs. 38.1±13.4, *p*-value <0.01). The distribution of specific valvular regurgitation according to primary cardiac defect was detailed in Table 4. Fourteen percent of the patient developed supraventricular arrhythmias at the time of presentation. Patients with supra-ventricular arrhythmias were 17.9 years older than that without arrhythmia (mean age 57.1±10.4 vs. 39.2±13.6, *p*-value <0.01).

Table 3. Primary cardiac diagnosis classification and severity

Variable	Value
ASD group (n = 211)	
ASD type	
- Secondum	81.9%
- Sinus venosus	10.2%
- Primum	7.9%
Major axis (mm), mean ± SD	28.0±9.9
SPAP (mmHg), mean ± SD	56.2±20.7
VSD group (n = 80)	
VSD type	
- Outlet	55.5%
- Perimembranous	42.0%
- Inlet	2.5%
Diameter (mm), mean ± SD	9.4±6.0
SPAP (mmHg), mean ± SD	57.5±27.5
PDA group (n = 6)	
PDA diameter (mm), mean ± SD	6.2±3.6
SPAP (mmHg), mean ± SD	55.0±28.5

ASD = atrial septal defect; PDA = patent ductus arteriosus; SPAP = systolic pulmonary artery pressure; VSD = ventricular septal defect

Table 4. Associated cardiac conditions

Variable	Value	% of 297 patients	% of subgroup patients
Pulmonary hypertension	222	74.7	
Valvular insufficiency (moderate or severe)	104	35.0	
ASD patient (n = 211)			
- Tricuspid regurgitation	77		36.5
- Mitral regurgitation	16		7.6
VSD patient (n = 80)			
- Aortic regurgitation	8		10.0
- Tricuspid regurgitation	7		8.8
- Mitral regurgitation	5		6.3
PDA patient (n = 6)			
- Mitral regurgitation	2		33.3
- Aortic regurgitation	1		16.7
Atrial fibrillation or flutter	43	14.0	
Aortic cusp prolapse	19	6.4	
PAPVR	15	5.0	
Coronary atherosclerosis	11	3.7	
Aneurysm of sinus of Valsalva	9	3.0	

ASD = atrial septal defect; PAPVR = partial anomalous of pulmonary venous return; PDA = patent ductus arteriosus; VSD = ventricular septal defect

Surgical technique (Table 5, 6)

All ASD closure and VSD closure were performed under cardiopulmonary bypass (CPB) with cardioplegic arrest. The ASD were closed with patch in 85.4%, directly closed in 12.7% and 1.9% of the ASD were closed with fenestration. The VSD were closed with patch in 82.7% and 17.3% were closed directly. The PDA were ligated or divided in 75% and 25% were closed internally via the pulmonary arterotomy under CPB due to ductal calcification. Of all patients, operations were performed through median sternotomy in 93.9%, thoracotomy in 5.1%, and re-sternotomy in 1.0%.

Besides addressing the primary defects, 190 concomitant procedures were performed in 131 patients (44.1% of 297 patients). The number of concomitant procedures ranged from one to four procedures. Majority of procedures were valve repairs (96 valves, 50.5%; 55 tricuspid valves, 33 mitral valves, and eight aortic valves) and valve replacements (14 valves, 7.4%; eight mitral valves and six aortic valves).

In-hospital results (Table 7, 8)

The mean ICU stay was 2.0±4.3 days; mean post-operative length of hospital stay was 7.0±6.0 days. There were eight hospital deaths (2.7%) and the main causes of death were multi-organ dysfunction and ventricular failure. Details of mortality cases were described in Table 8. Atrial arrhythmia was the most common complication (8.4%).

Table 5. Surgical technique

Variable	Value	% of patients
Approach (n = 297)		
Sternotomy	279	93.9
Thoracotomy	15	5.1
Re-sternotomy	3	1.0
Use of CPB	294 in 297	99.0
CPB time (minute), mean ± SD	68.0±42.8	
Aortic cross clamp time (minute), mean ± SD	46.0±32.0	
ASD (n = 212)*		
Patch closure	181	85.4
Direct closure	27	12.7
Closure with fenestration	4	1.9
VSD (n = 81)*		
Patch closure	67	82.7
Direct closure	14	17.3
Closure with fenestration	0	0.0
PDA (n = 12)*		
Ligation	7	58.3
Trans-PA ligation	3	25.0
Division	2	16.7

ASD = atrial septal defect; CPB = cardiopulmonary bypass; PA = pulmonary artery; PDA = patent ductus arteriosus; VSD = ventricular septal defect

* The number of defect closure > number of patient in each group due to multiple defects in same patient

Table 6. Concomitant procedures

Procedure	Value	% of 190 procedures
Valve repair	96	50.5
Tricuspid valve	55	
Mitral valve	33	
Aortic valve	8	
Valve replacement	14	7.4
Mitral valve	8	
Aortic valve	6	
PAPVR repair	14	7.4
Coronary artery bypass grafting	11	5.8
ASOV repair	10	5.3
SVC augmentation	10	5.3
Subvalvular PS resection	8	4.2
PFO closure	6	3.2
Maze procedure	5	2.6
Other procedure	16	8.3
Total number of procedures	190	100.0

ASOV = aneurysm of sinus of Valsalva; PAPVR = partial anomalous of pulmonary venous return; PFO = patent foramen ovale; PS = pulmonic stenosis; SVC = superior vena cava

Table 7. In-hospital results

Variable	Value (n = 297)	% of 297 patients
Ventilator day (day), mean ± SD	1.7±4.7	
ICU stay (day), mean ± SD	2.0±4.3	
Post-operative hospital stay (day), mean ± SD	7.0±6.0	
Hospital death	8	2.7
Complications		
Arrhythmia	25	8.4
Infection	10	3.3
Pleural space complication	8	2.7
Pericarditis	6	2.0
Renal failure	3	1.0
Reoperation for mediastinal bleeding	3	1.0
Pulmonary hypertensive crisis	2	0.7
Stroke	2	0.7
Atrio-ventricular block	1	0.3
Other complications	16	5.4

ICU = intensive care unit

Table 8. Causes of in hospital deaths

No.	Age (year), sex	Diagnosis	Procedure	Cause of death	Timing (POD)
1	58, male	Primum ASD, severe MR, severe TR, severe PHT, chronic AF	ASD patching, MV repair with conversion to MVR, TV annuloplasty	PHT, sepsis, bleeding, liver failure, renal failure	3
2	31, female	Perimembranous VSD, ASD post patching, severe TR, severe PHT	Redo-sternotomy, VSD patching, TV annuloplasty	VF cardiac arrest, CPR non-responsive	4
3	27, female	Sinus venosus ASD, moderate TR, PAPVR, PFO	ASD patching with PAPVR repair, closure PFO, TV annuloplasty	Cardiac tamponade	8
4	59, male	Sinus venosus ASD, moderate TR, MR, PAPVR, moderate PHT	ASD patching with fenestration, PAPVR repair, MV annuloplasty, TV annuloplasty	Sepsis, cardiac arrest	52
5	73, male	Secondum ASD, severe TR, severe MR, TVD, chronic AF, moderate PHT	ASD patching, MV repair, TV annuloplasty, CABG x2	Multi-organ failure, sepsis, LV failure	30
6	21, male	Subaortic VSD, IE with severe AR, severe PHT, LV dysfunction	VSD patching, AVR, IABP insertion	LV failure, sepsis, HIE	22
7	52, female	ASD secondum, severe MR, severe TR, moderate PHT	ASD closure, MVR, TV annuloplasty	Multi-organ failure, sepsis	21
8	21, male	Perimembranous VSD, PFO, PDA, severe PHT	ASD patching, PFO closure, PDA ligation	PHT crisis, pneumonia, multi-organ failure	26

AR = aortic regurgitation; AF = atrial fibrillation; AR = aortic regurgitation; ASD = atrial septal defect; AV = aortic valve; CPR = cardiopulmonary resuscitation; HIE = hypoxic-ischemic encephalopathy; IABP = intra-aortic balloon pump; LV = left ventricular; MR = mitral regurgitation; MV = mitral valve; PAPVR = partial anomalous pulmonary venous return; PDA = patent ductus arteriosus; PFO = patent foramen ovale; PHT = pulmonary hypertension; POD = post-operative day; TR = tricuspid regurgitation; TV = tricuspid valve; VF = ventricular fibrillation; VSD = ventricular septal defect

Post-operative visit data

The mean and median follow-up time was 33.4 and 25 months respectively (range, 1 to 102 months). The mean post-operative NYHA functional classification at last visit was 1.1±0.5. Average reduction in NYHA functional classification was 0.74 class (p-value <0.01).

One-hundred and fifteen patients (38.7%) were in NYHA class 1 without any cardiovascular medication. In this special subgroup, compared with the rest of cohort, patients was younger (mean age 35.4±12.3 year vs. 45.9±14.5 year, p-value <0.01), had fewer co-morbidities (16.5% vs. 35.1%, p-value = 0.07), had less preoperative arrhythmia (1.7% vs. 22.5%, p-value <0.01), had better preoperative functional classification (average NYHA class 1.6±0.6 vs. 2.1±0.7, p-value <0.01), had lower pulmonary

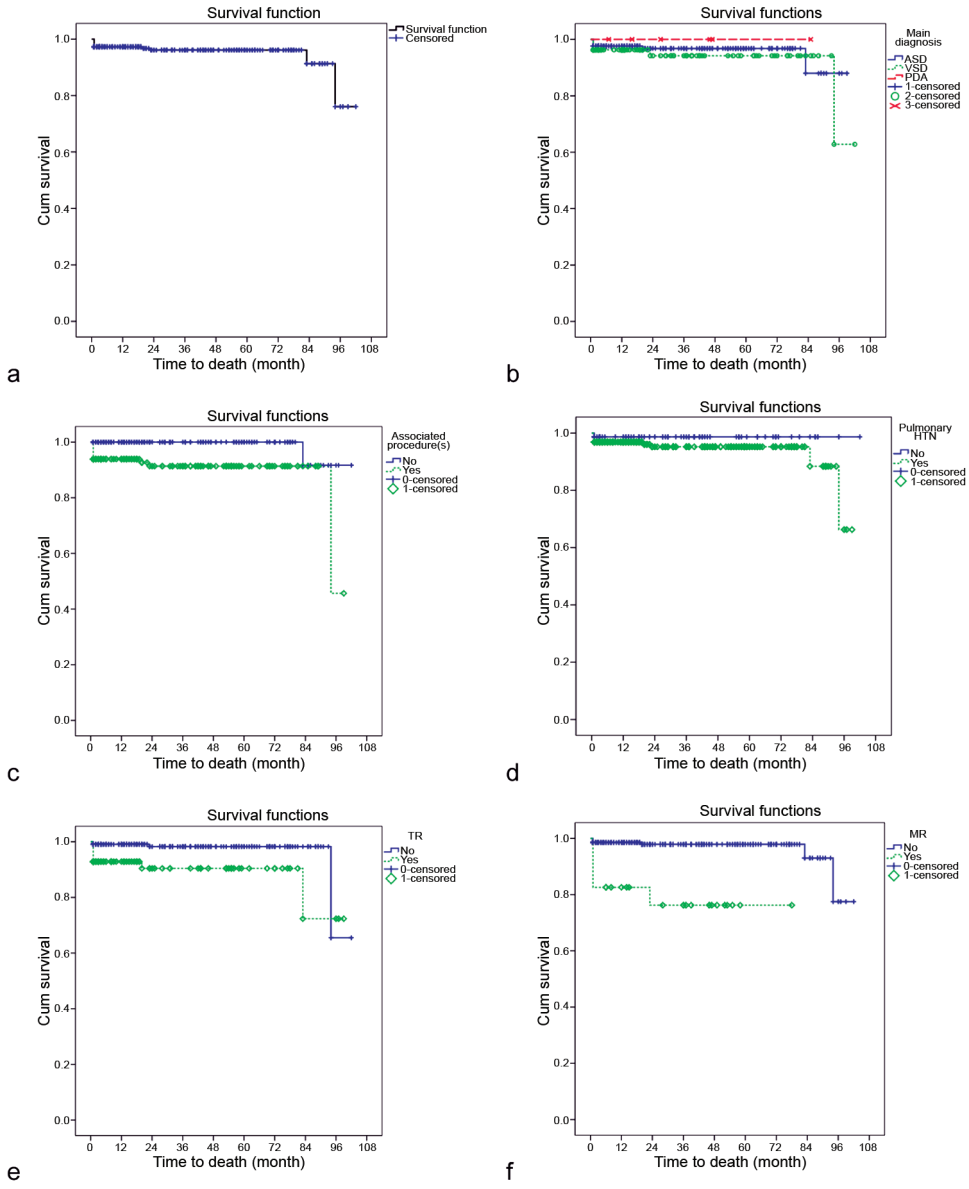

Fig. 3 Overall survival. (a) The overall survival was 96.1% at 5 years and 76.1% at 8 years. (b) Survival among patients with ASD, VSD, and PDA were not different (p = NS). (c) The patient who underwent correction of the heart defect with associated procedure(s) had significantly worse survival (p<0.01). (d) The present of pulmonary HTN did not significantly affect survival (p = NS). (e, f) Significant tricuspid and mitral insufficiency significantly associated with worse survival (p<0.01 and p<0.01).

artery pressure (mean SPAP 48.4±20.1 mmHg vs. 61.3±22.8 mmHg, *p*-value <0.01), had fewer valvular regurgitation (20.0% vs. 44.5%, *p*-value <0.01), and underwent operation with less concomitant procedures (average 0.4±0.7 procedure vs. 0.8±0.9 procedure, *p*-value <0.01).

Five patients required re-interventions at median time of 44 months and four of them were redo-valve replacements. There were four late deaths at median time of 53 months and three of them were cardiac causes.

The post-operative pulmonary artery pressure was measured in 31.3% of the patients. Of these patients, significant reduction in SPAP was observed (mean preoperative SPAP 63.2±22.2 mmHg, mean post-operative SPAP 40.7±16.9 mmHg, mean different 22.1±22.0 mmHg, *p*-value <0.01).

Survival (Fig. 3)

The overall survival was 96.1% at five years and 76.1% at eight years. The survival among patient with ASD, VSD, and PDA were not significantly different. The patient who underwent correction of the heart defect(s) with concomitant procedure(s) had significantly worse survival (91.4% vs. 100% at five years, *p*-value <0.01). The diversion of the survival curves mainly occurred at the early post-operative period. There was a trend toward worse long-term survival in the patients with pulmonary hypertension, but the difference did not reach significant level within this follow-up period. Significant tricuspid and mitral insufficiency also associated with worse survival (*p*-value <0.01 and *p*-value <0.01).

Freedom from re-intervention (Fig. 4)

At eight years, the freedom from re-intervention was 95.3%. The patient with concomitant operation(s) had more re-intervention (89.5% freedom vs. 100% freedom at eight years, *p*-value = 0.011). Significant mitral and aortic insufficiency associated with re-intervention (*p*-value <0.01 and *p*-value <0.01).

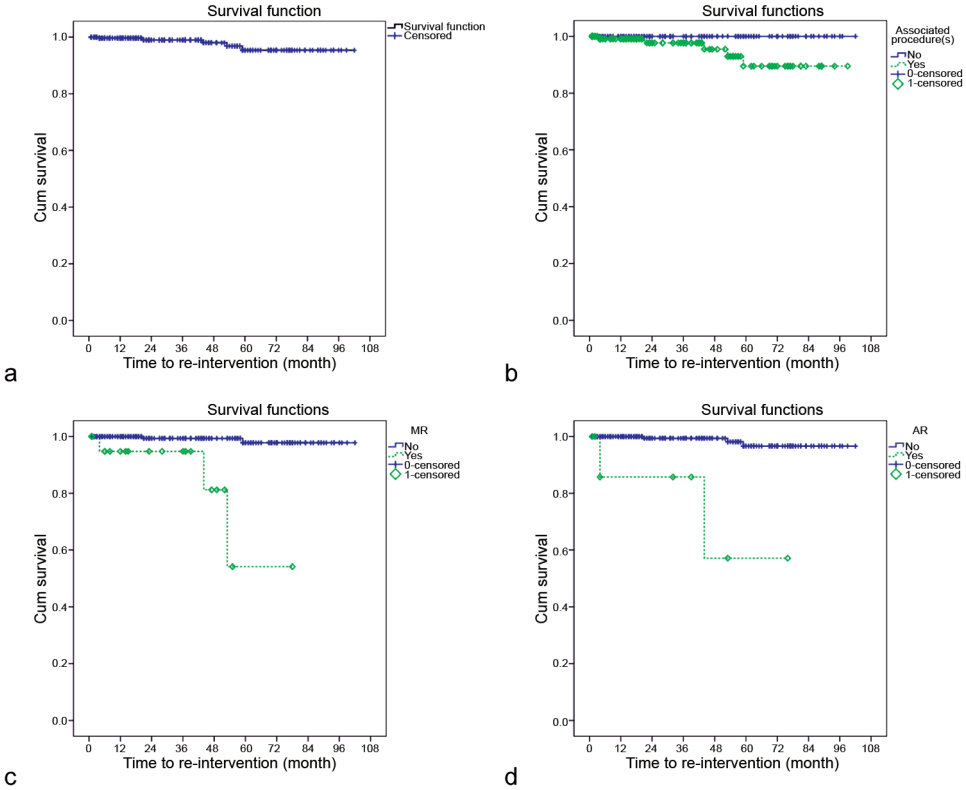

Fig. 4 Freedom from re-intervention. (a) The re-intervention free survival was 95.3% at 8 years. (b) The patient with concomitant procedure(s) had more re-intervention (89.5% freedom vs. 100% freedom at 8 years, $p = 0.011$). (c, d) Significant mitral and tricuspid insufficiency significantly associated with re-intervention ($p<0.01$ and $p<0.01$).

Discussion

Compare with data from western society, the present study demonstrated minor different nature of the adult patient with simple CHD. Majority of the patients were newly diagnosed or prior diagnosed CHD but did not undergo corrective surgery. Five patients had undergone corrective procedures before the operations in the present study (four open repairs with two residual shunts and two different defects and one transcatheter repair with residual shunt). Of those who were late diagnosed CHD, presentation and associated lesion(s) were not different from the western data. However, outlet type of VSD and associated aneurysm of sinus of Valsalva were more prevalent in the present series[8,9]. This is different from previously reported from our institution[10].

Regardless of defect location, excellent surgical outcomes could be expected following the repair of isolated left to right shunt without any hemodynamic consequence. Concomitant procedure(s) added significant perioperative risk and chance of late re-intervention. The present of pulmonary hypertension before the correction might predict suboptimal long-term survival.

In the present series, there was a trend in decreasing number of adult with congenital heart disease treated surgically as the time passed despite quite steady overall number of cardiac surgery performed in our hospital at the same period (average of 45.3, 34.0, and 21.2 cases per year in the first, second, and last tertile, respectively). This trend was observed in patients with and without concomitant procedure(s). This phenomenon might be resulted from two reasons. First, advance in pediatric transcatheter intervention for simple lesion. Second, improvement in Thai public health service accessibility.

Conclusion

The results of surgical repair of simple congenital heart disease in adults were good. Predictors of death and re-intervention were the present of significant valvular regurgitation and concomitant procedure.

Study limitations

Besides retrospective nature, some limitations exist in the present study. First, relatively short follow-up period, this was because the physicians usually discharge patients from our clinic if he/she was doing well without significant residual cardiac lesion. Second, objective parameters of result were incomplete, for instant, post-operative echocardiography was present in only 35.7% of the patients.

What is already known on this topic?

It has already been known from previous study on adult CHD that among simple shunt lesions, ASD are the most prevalent congenital defects. Closure of simple defects remains standard of care in majority of patients.

What this study adds?

Regarding outcomes of surgical closure of simple shunt lesion in adult, the present study showed negative impact of the concomitant cardiac procedure(s) that came along with hemodynamic sequelae from the late presentation of Thai population.

Potential conflicts of interest

None.

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ผลการผ่าตัดรักษาโรคหัวใจแต่กำเนิดชนิดมีเลือดไปปอดมากในผู้ใหญ่ ในโรงพยาบาลศิริราช

ธีรพงศ์ โตเจริญโชค, ถาวร ทรัพย์ทวีสิน, สมชาย ศรียศชาติ, ปุณณฤกษ์ ทองเจริญ, เกรียงไกร ตันติวงศ์โกสีย์

ภูมิหลัง: *ผลการรักษาโรคหัวใจแต่กำเนิดในผู้ใหญ่ในประเทศกำลังพัฒนามีความสำคัญต่อการรักษาผู้ป่วย แต่มีรายงานไว้อย่างจำกัด*
วัตถุประสงค์: *เพื่อที่จะทราบลักษณะทางคลินิก และผลการผ่าตัดรักษาโรคหัวใจแต่กำเนิดชนิดไม่ซับซ้อนในผู้ป่วยผู้ใหญ่ของโรงพยาบาลศิริราช*
วัสดุและวิธีการ: *ผู้นิพนธ์ศึกษาทบทวนข้อมูลของผู้ใหญ่ที่มีโรคผนังกั้นห้องหัวใจห้องบนรั่ว 211 ราย ผนังกั้นห้องหัวใจห้องล่างรั่ว 80 ราย หรือ มีเส้นเลือดระหว่างเส้นเลือดใหญ่เกิน 6 ราย ซึ่งได้รับการผ่าตัดระหว่าง เดือนมกราคม พ.ศ. 2548 ถึง กันยายน พ.ศ. 2557 โดยเน้นข้อมูลในช่วงการผ่าตัด ผลการติดตามหลังผ่าตัด และวิเคราะห์หาปัจจัยที่ทำนายเหตุการณ์ไม่พึงประสงค์*
ผลการศึกษา: *ผู้ป่วยที่เข้าเกณฑ์และมีผลการติดตามหลังผ่าตัด 297 ราย เป็นชายร้อยละ 37.4 อายุเฉลี่ย 41.8 ปี (พิสัย 20-78 ปี) ร้อยละ 74.7 มีความดันปอดสูง และร้อยละ 35.0 มีลิ้นหัวใจรั่วร่วมด้วย ร้อยละ 79.5 มีอาการจากโรคหัวใจ รูรั่วของผนังหัวใจรับการแก้ไขโดยใช้แผ่นปิดเป็นส่วนใหญ่ (ร้อยละ 85.4 ของผนังห้องบนรั่ว และร้อยละ 82.7 ของผนังห้องล่างรั่ว) ส่วนน้อยแก้ไขโดยไม่ใช้แผ่นปิด มีหัตถการร่วม 190 หัตถการ ในผู้ป่วย 131 ราย (ร้อยละ 44.1) ส่วนใหญ่เป็นการซ่อมลิ้นหัวใจ (ลิ้นไตรคัสปิด ร้อยละ 28.9 และลิ้นไมตรัลร้อยละ 17.4) ผู้ป่วย 8 ราย เสียชีวิตหลังผ่าตัด (ร้อยละ 2.7) ที่มัธยฐานเวลาติดตามอาการ 25 เดือน (พิสัย 1-102 เดือน) ผู้ป่วยเหนื่อยลดลง ค่าเฉลี่ยของนิวยอร์กฟังชั่นลดลง 0.74 คะแนน (จาก 1.9 เป็น 1.1, $p<0.01$) มีผู้ป่วยได้รับการทำหัตถการซ้ำ 5 ราย และมีผู้ป่วยเสียชีวิตภายหลัง 4 ราย อัตรารอดชีวิตโดยรวมที่ 5 ปี ร้อยละ 96.1 และที่ 8 ปี ร้อยละ 76.1 การมีหัตถการร่วม ลิ้นไตรคัสปิดรั่ว และลิ้นไมตรัลรั่ว สัมพันธ์กับการรอดชีวิตที่ลดลง การมีหัตถการร่วม ลิ้นไมตรัลรั่ว และลิ้นเอออติกรั่ว ทำนายการมีหัตถการซ้ำในภายหลัง*
สรุป: *การผ่าตัดรักษาโรคหัวใจแต่กำเนิดชนิดไม่ซับซ้อนในผู้ป่วยผู้ใหญ่ให้ผลน่าพอใจ การมีหัตถการร่วมและการมีลิ้นหัวใจรั่วส่งผลเสียต่อผลการรักษา*
