Outcome of Surgical Closure of Atrial Septal Defect in Sulaimani City

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Abstract- An atrial septal defect (ASD), sometimes called a hole in the heart is a type of congenital heart defect in which there is an abnormal opening in the dividing wall between the upper filling chambers of the heart (the atria). To determine the outcome of surgical closure in patients with atrial septal defects, we designed a retrospective study, including 120 patients present with an atrial septal defect after surgical closure done in the cardiac teaching center in Sulaimani city. The data collected include the patients that admitted which are known cases of ASD and treated by open heart surgery during the last nine years from 1st of January 2008 until the 1st of January 2018. A total of 120 children diagnosed with Atrial Septal Defect (ASD) were included in this study with a mean age of 7.8±4.4 years; 32.5% of them were 1-5 years old, 50.8% of them were in the age group 6-12 years, and 16.7% of them were in the age group 13-19 years. Only three ASD children received medical treatment while all of them were treated surgically with open-heart surgery. The mean age of ASD children at surgery was7.8±4.4 years; 5.8% of them were 1-2 years old, 28.4% of them were 3-5 years old, 49.1% of them were in the age group 6-12 years, and 16.7% of them were in the age group 13-19 years. There was a significant association between primum ASD type and large ASD with posteroinferior deficient rims (*P*=0.04). A significant association was observed between primum ASD type and large IAS (*P*=0.006). Mean ASD diameter was significantly higher among patients with primum ASD type (*P*=0.01). The outcome of surgical closure of the atrial septal defect in children is effective and safe. Ventricular arrhythmia in the form of ectopic was the postoperative complication in one patient. The main echocardiography findings of children with atrial septal defects were large ASD with posteroinferior deficient rims.

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Introduction

ASD is characterized by a defect in the interatrial septum allowing pulmonary venous return from the left atrium to pass directly to the right atrium (1).

ASD types strictly include ostium secundum type (~75% of cases), ostium primum type (15-20%), and sinus venosus type (5-10%), while coronary sinus defects are rarely closely related (2).

ASDs have been estimated at 3.89 per 1000 children and 0.88 per 1000 adults, which may be underestimated due to clinically silent and unidentified cases (3).

The decision to repair any kind of atrial septal defect (ASD) is depended on the clinical and echocardiographic information, including the location and the size of the ASD, the magnitude, and hemodynamic impact of the left-to-right shunt, and the presence and degree of pulmonary arterial hypertension. Generally, elective closure is advised for all ASDs, Considerations and even contraindications to consider no intervention include the small size of the defect and shunt, diagnosis during pregnancy (intervention can be deferred until after), severe pulmonary arterial hypertension, severe left or right ventricular dysfunction (2).

For both children and adults, surgical mortality rates for uncomplicated secundum ASD are approximately 1-3%. Because of the risk associated with ASD, as outlined, including paradoxical embolization, there should be ongoing review and evaluation of the indication and risks for closure, even in patients with small shunts. However, such closure remains controversial because patients with a small defect have a good prognosis generally, and the risk of cardiopulmonary bypass may not be warranted. The widespread use of catheter closure of secundum ASD

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type with lower mortality and without cardiopulmonary bypass has raised the question regarding the need to close even a small defect.

Long-term prevention of death and complications is best achieved when the ASD is closed before age 25 years, and when the systolic pressure in the main pulmonary artery is less than 40 mm Hg. Even in elderly patients with large shunts, surgical closure can be performed at low risk and with good results in reducing symptoms.

Each method of closure, whether surgical or transcatheter, results in excellent hemodynamic outcomes with non-significant differences with regard to survival, functional capacity, embolic neurologic events, or atrial arrhythmias (4). However, neurologic events and atrial arrhythmia remain long-term risks, particularly for patients with preexisting events (5). Furthermore, independent risk factors for unsuccessful transcatheter closure include smaller retro-aortic and inferior rims and the morphologic atrial septal variation of mal-attached septum primum (MASP) (4).

Materials and Methods

Surgical method

Presently, minimally invasive surgery has replaced full thoracotomy in ASD repairs. The different surgical techniques include partial lower sternotomy, right antero-lateral small thoracotomy, and total endoscopic atrial septal repair. All surgical techniques use cardioplegia and cardiopulmonary bypass.

The partial lower sternotomy technique involves a vertical skin incision at the lower sternal border followed by a partially inverted J-shaped sternotomy from the xiphoid to the right third intercostal space (ICS). Cardiopulmonary bypass is utilized with aortic cross-clamping. Then the ASD is closed through a standard right atriotomy with direct closure or patch closure (5).

In contrast, the right anterolateral small thoracotomy technique involves a small anterolateral thoracotomy in the right fourth ICS. A 22-French or 25-French venous cannula is introduced into the femoral vein for port access; the femoral artery is also cannulated. The right lung is deflated, and the pericardium is opened 2 cm longitudinally along the phrenic nerve course. The ascending aorta is clamped through an incision in the third ICS. The defect is then repaired with a standard right atriotomy.

The total endoscopic atrial septal repair technique involves three incisions: one at the right anterior axillary line at the sixth ICS, the next one at the right mid-axillary line at the third ICS, and the last one at the parasternal line at the fourth ICS (6).

Death is one complication although its rare, as fare as the mortality rate of an uncorrected ASD is 50% by 40 years of age and increases by 6% per year.

Arrhythmias Chronic volume overload leads to atrial dilation and remodeling, which predisposes to atrial tachyarrhythmias. Atrial arrhythmias are common in patients with uncorrected ASDs, occurring in 10% of patients by age 40.

After closure, atrial tachyarrhythmias decline to 5% to 6%. Patients younger than 40 and without a previous history of atrial arrhythmias have the lowest incidence of atrial arrhythmias after ASD closure. The persistence of a residual shunt and onset of new AV block are associated with a higher incidence of atrial fibrillation, although its rare (7,8).

Conduction abnormalities, including first- and second-degree heart block, other arrythmias may occur after surgical closure (9).

One adult patient died during his hospital stay as a consequence of sepsis (0.4% total mortality rate). Severe early complications (pericardial tamponade, renal failure, sepsis) occurred in three children (2.5%) and ten adults (8.8%), moderately severe complications (pneumonia, pleural effusion requiring thoracocenthesis) in four children (3.4%) and seven adults (6.1%) and mild complications (atelectasis, gastrointestinal, urinary tract infection, pleural effusion) in 86 children (72.9%) and 77 adults (67.5%). Only 25 children (21.2%) and 20 adults (17.5%) experienced an uneventful peri-operative period.

The results show that an isolated secundum atrial septal defect can be surgically closed with a minimal mortality but significant complications can occur. The majority of the early complications for the patients were of minor significance, and severe complications were observed more often in adults than in children (9).

Aim of the study

To determine the outcome of surgical closure in patient with atrial septal defect.

Patient and method

This is retrospective study including 120 patients present with atrial septal defect after surgical closure done in cardiac teaching center in Sulaimani city.

The data collected include the patients that admitted which are known cases of ASD and treated by open heart surgery during the last 9 years from 1st of January 2008

until the 1st of January 2018 , then demographic data collected, age of diagnosis, echo assessment for the defect and its associated anomalies by the same cardiologist in the same institute and follow up patients postoperatively by the dame cardiologist, then the type of surgical repair by Sulaimani cardiac center surgeons team and follow up patients postoperatively for any complications.

Ethical considerations

1. Approval was taken from Sulaimani Pediatrics Teaching Hospital Authority.
2. Approval was taken from patients and/or their parents.
3. Confidentiality was taken into consideration.
4. The researcher informed Physicians about any deteriorated cases

All patients' data entered using computerized statistical software; Statistical Package for Social Sciences (SPSS) version 18 was used.

Descriptive statistics presented as (mean±standard deviation) and frequencies as percentages. Kolmogorov Smirnov's analysis verified the normality of the data set. Multiple contingency tables conducted, and appropriate statistical tests performed, Chi-square used for categorical variables (Fisher's exact test was used when expected variables were less than 5).

One-way ANOVA analysis was used to compare more than two means. In all statistical analyses, the level of significance (*P*) set at ≤0.05, and the result presented as tables and/or graphs.

Results

A total of 120 children diagnosed with Atrial Septal Defect (ASD) were included in this study with a mean age of 7.8±4.4 years; 32.5% of them were 1-5 years old, 50.8% of them were in the age group 6-12 years, and 16.7% of them were in the age group 13-19 years. Female children with ASD were more than males (Table 1).

Most of the studied children with ASD were living in urban areas (79.2%), and 20.8% of them were living in rural areas. More than half (55.8%) of ASD children were diagnosed with ASD at the age of less than one year, while 44.2% of them were diagnosed at the age of more than one year.

The main presentation of ASD before treatment were dyspnea on exertion (43.5%), failure to thrive (22.6%), chest infection (13.1%), sweating (9.5%), chest pain (9.5%) and palpitation (1.8%).

The main ECG findings of children before surgery are shown in table 1.

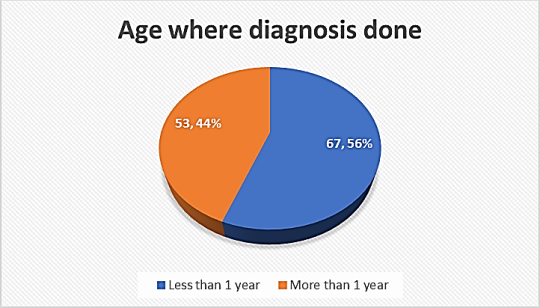

Figure 1. Age at diagnosis

Table 1. ECG findings of children with ASD before surgery

Variable		No.	%
ECG	RAD & RBBB	56	46.6
	Normal axis with RVH	48	40.0
	RAD & RVH	8	6.7
	LAD & RVH or	6	5.0
	RAD & no RVH	2	1.7
	Total	120	100.0

The main echocardiography findings of children with ASD were large ASD with posteroinferior deficient rims (35.8%), large size ASD (31.7%), moderate size ASD (14.2%), large ASD with deficient posterior rim with the large shunt (10.8%), medium-size ASD with deficient rims (5%), etc. The IAS of ASD was small for one child, medium for six children, moderate for 17 children, and large for 96 children. The mean ASD diameter was 19.7±6.5 mm. Types of ASD were classified into sinus venosus (11.7%), secondum (83.3%), and primum (5%). All these findings were shown in table 2.

The common associated finding of children with ASD is shown in table 3.

No shunt seen across ASD was detected by echocardiography for the majority (99.2%) of ASD children postoperatively while one child had small apical effusion with normal chambers. Only four ASD children had associated systemic anomalies like a bilateral congenital anomaly at hand (25%), thalassemia major (25%), congenital anomalies of back and legs (25%) and Down syndrome (25%).

Only three ASD children received medical treatment while all of them were treated surgically with open-heart surgery. The mean age of ASD children at surgery was7.8±4.4 years; 5.8% of them were 1-2 years old, 28.4% of them were 3-5 years old, 49.1% of them were in the age group 6-12 years, and 16.7% of them were in the age group 13-19 years. All these findings were shown

in table 5.

Most children with ASD surgically treated had no postoperative complications, while only one child had ventricular ectopics postoperatively.

No significant difference was observed between ASD children with different ASD types regarding their age (P=0.7). There was a significant association between female gender and ASD secondum type (P=0.008). All these findings were shown in table 6.

Table 2. Echocardiography findings of children with ASD

Variable		No.	%
Echocardiography findings	Large ASD with deficient posteroinferior rims	43	35.8
	Large size ASD	38	31.7
	Moderate size ASD(good rim)	17	14.2
	Large ASD with deficient posterior rim	13	10.8
	Medium size ASD with deficient rims	6	5.0
	Large ASD with deficient inferior rim	2	1.7
	Small size ASD with PAPVR	1	0.8
	Total	120	100.0
IAS	Large	96	80.0
	Moderate	17	14.2
	Medium	6	5.0
	Small (sinus venousus)	1	0.8
	Total	120	100.0
ASD diameter mean±SD (19.7±6.5 mm)			
Type of ASD	ASD secondum	100	83.3
	ASD sinus venosus	14	11.7
	ASD primum	6	5.0
	Total	120	100.0

Table 3. Echocardiographic associated findings among ASD cases

Variable	No	%
Associated echo findings		
Moderate to hugely dilated right-side heart	85	70.8
Right side heart dilation & mitral valve prolapsed with mitral regurgitation	12	10
Dilated right heart side and pulmonary hypertension	7	5.7
Right side heart dilation & partial anomalous pulmonary venous return	8	6.7
Right heart side dilation with another small ASD(multiple ASDs)	4	3.4
Dilated right heart side and patent ductus arteriosus	2	1.7
VSD	2	1.7
Total	120	100.0

Table 4. Post-operative characteristics of children with ASD.

Variable		No.	%
Postoperative Echo findings	No shunt is seen across ASD patch	119	99.2
	Small apical effusion with normal chambers	1	0.8
	Total	120	100.0
Associated anomalies of the body	Negative	116	96.7
	Positive	4	3.3
	Total	120	100.0
Type of associated anomalies	Bilateral congenital anomaly at hand	1	25.0
	Thalassemia major	1	25.0
	Congenital anomalies of back and legs	1	25.0
	Down syndrome	1	25.0
	Total	4	100.0

Table 5. Age of surgical correction

Variable	No.	%
Age at surgery mean±SD (7.8±4.4 years)		
1-2 years	7	5.8
3-5 years	34	28.4
6-12 years	59	49.1
13-19 years	20	16.7
Total	120	100.0

There was a significant association between primum ASD type and large ASD with posteroinferior deficient rims (P=0.04). A significant association was observed between primum ASD type and large IAS (P=0.006). Mean ASD diameter was significantly higher among patients with primum ASD type (P=0.01). All these findings were shown in table 7.

There was a highly significant association between dilated right heart side and ASD secondum (P<0.001). All these findings were shown in table 8.

Table 6. Distribution of children's demographic characteristics according to ASD types.

Variable		Venosus		Secondum		Primum		*P*
		No.	%	No.	%	No.	%	
Age	**1-5 years**	6	42.9	30	30.0	3	50.0	0.7* NS
	6-12 years	6	42.9	53	53.0	2	33.3	
	13-19 years	2	14.3	17	17.0	1	16.7	
	Mean±SD (years)	6.3±4.1		8.1±4.4		6.8±3.5		0.2** NS
Gender	**Male**	10	71.4	31	31.0	1	16.7	0.008* S
	Female	4	28.6	69	69.0	5	83.3	

* Fisher's exact test, ** One way ANOVA, NS=Not significant, S=Significant.

Table 7. Distribution of echocardiography findings according to ASD types.

Variable		Venosus		Secondum		Primum		*P*
		No.	%	No.	%	No.	%	
Echocardiography findings	**Small size ASD**	0	-	1	1.0	0	-	0.04*S
	Medium size ASD with deficient rims	1	7.1	5	5.0	0	-	
	Moderate size ASD	7	50.0	10	10.0	0	-	
	Large size ASD	4	28.6	32	32.0	2	33.3	
	Large ASD & deficient posterior rim	1	7.1	12	12.0	0	-	
	Large ASD & deficient	0	-	2	2.0	0	-	
	Large ASD & posterioinferior deficient rims	1	7.1	38	38.0	4	66.7	
IAS	**Small**	0	-	1	1.0	0	-	0.006*S
	Medium	1	7.1	5	5.0	0	-	
	Moderate	7	50.0	10	10.0	0	-	
	Large	6	42.9	84	84.0	6	100.0	
ASD diameter								
Mean±SD (mm)		14.7±6.1		20.4±6.2		21.5±4		0.01**S

* Fisher's exact test, ** One way ANOVA, S=Significant

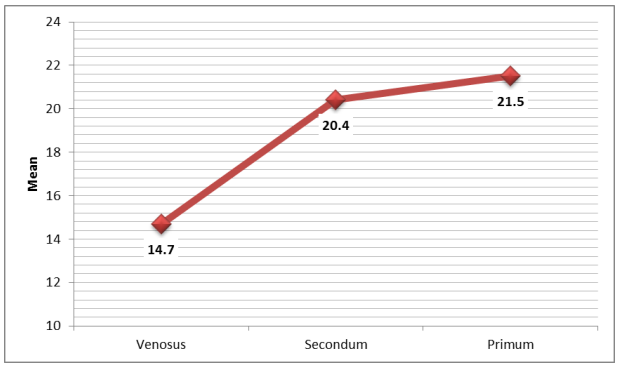

Figure 2. ASD diameter according to ASD types

Table 8. Distribution of associated findings according to ASD types.

Variable		Venosus		Secondum		Primum		*P*
		No.	%	No.	%	No.	%	
Associated findings	No	1	7.1	1	1.0	1	16.7	<0.001*S
	Right side heart dilation & partial anomalus pulmonary venous	5	35.7	1	1.0	0	-	
	Dilated right side heart	4	28.6	74	74.0	3	50.0	
	Mild to moderate tricuspid regurgitation and pulmonary regurgitation	0	-	4	4.0	0	-	
	Dilated right heart side and patent ductus arteriosus	0	-	2	2.0	0	-	
	Right side heart dilation & mitral valve prolapsed with mitral regurgitation	4	28.6	3	3.0	2	33.3	
	VSD and dilated right heart side	0	-	1	1.0	0	-	
	Right side heart dilation with left to right shunt	0	-	4	4.0	0	-	
	Dilated right heart side and pulmonary hypertension	0	-	7	7.0	0	-	
	Right heart side dilation with another small ASD	0	-	3	3.0	0	-	

* Fisher's exact test, S=Significant

Discussion

Children with atrial septal defects (ASD) constituted about 10% of all children with congenital heart diseases. The surgical closure of ASD represented the standard treatment with good outcomes, some complications (9). Because of limited resources in some developing countries, non-surgical closure of ASD became the

treatment of choice with great advances in the outcome (10). The atrial septal defect is the frequent congenital heart disease in Sulaimani (27.5%) (11).

The present study showed that the surgical closure of ASD was associated with a lower rate of postoperative complications in the form of ventricular ectopics (0.8%). This finding is consistent with the results of Kim *et al.,* (12) study in South Korea, which reported that surgical closure of ASD is safe with no reported or minor postoperative complications. Bialkowski *et al*., (13) study in Poland compared the outcome of surgical and non-surgical closure of ASD among children and revealed that both of techniques had minor postoperative complications (surgical 0.04% and non-surgical 0.02%), but the surgical closure of ASD enable the surgeon to close the ASD regardless of its size and location. The common reported postoperative complications of surgical ASD closure were wound infection, pericardial effusions, and surgery recurrence in addition to a long hospital stay (14). Previous Canadian study included 100 children surgically operated with ASD closure had no mortality, and with the postoperative post-pericardiotomy syndrome (3%) and pericardial effusions (26%) (15). In another American review study on 176 consecutive patients (47 adult and 129 children) surgically operated with ASD closure, there was no mortality (16). The common recorded perioperative complications were atrial fibrillation (adults 10% and children 1.2%) and post-pericardiotomy syndrome ((adults 2% and children 4.7%) (17). Dodge-Khatami *et al*., (18) study in the UK stated that ectopic tachycardia is a common postoperative complication for the repair of congenital heart diseases. Khairy *et al.,* (19) found an incidence of 1.5% of arrhythmias following surgical closure of ASD among children. Wu *et al.,* (20) study in China on 508 patients with non-surgical closure of ASD showed no reported postoperative complications while Celiker *et al.,* (21) study in Turkey on 85 patients with ASD treated with non-surgical trans-catheter reported two patients with postoperative ventricular ectopic beats.

The most frequent preoperative complications of ASD among children in our study were dyspnea on exertion (43.5%), failure to thrive (22.6%) and chest infection (13.1%). This is similar to the results of Fawzi *et al*., (22) study in Iraq, which stated that dyspnea and chest infection were the common preoperative complications for ASD children. Inconsistently, Geva *et al.,* (23) study in the USA showed that children with ASD were free of symptoms and preoperative complications, but these complications were increased with the increase of age like exercise intolerance, tachycardia, and ventricular dysfunction. Andrews *et al.,* (24) study in the UK showed that although ASD is asymptomatic, failure to thrive was reported, especially among infants.

The mean age of children surgically operated in this study was 7.8 years. This mean age at surgery is higher than that of 13.4 months reported by Parvathy *et al*., (25) study in India, which concluded that earlier age of surgical ASD closure is very important for development and lowering the morbidity rates. However, the performance of surgical closure of ASD is dependable on the availability of surgical facilities and anesthesia requirements. Females with ASD in the current study were more than males. This finding is close to the results of Behjati-Ardakani *et al.,* (26) study in Iran, which found that 60.4% of ASD patients were females. Despite that, our finding is inconsistent with the results of a previous study in Sulaimani, which reported an equal pattern of gender regarding ASD (11).

Less than one third (20.8%) of ASD children in this study were living in rural areas. This finding is consistent with the results of Langlois *et al.,* (27) study in the USA, which documented that ASD was more prevalent in urban crowded areas with high pollution to chemicals. The common age at diagnosis for ASD patients in our study was less than one year. This finding is close to the results of Kamal *et al.,* (11) study in Sulaimani, which found that the mean age of children at diagnosis of congenital heart diseases was 2.7 years.

The main ECG changes of children with ASD in the present study preoperatively were right axis deviation & right bundle branch block (46.6%) and normal axis with RVH (40%). This finding coincides with the results of Somura *et al*., (28) study in Japan, which reported that RBBB and volume overload among ASD children were related to the right axis deviation in ECG. They concluded that the use of ECG with echocardiography is helpful for the diagnosis of ASD among children. The main echocardiography findings of children with ASD in our study were large ASD with posteroinferior deficient rims (35.8%), large size ASD (31.7%) and moderate size ASD (14.2%). These echocardiography findings are close to findings of Abdullah *et al*., (29) study in Iraq, which revealed that children half of the children with ASD had posteroinferior deficient rims, and 30% of them had large ASD with intact rims. The current study showed a significant association between primum ASD type with each of large ASD with posteroinferior deficient rims, large ASD diameter, and large IAS. This finding is in agreement with the results of the Song study in South Korea (30), which stated that on echocardiography, the primum ASD is characterized by large ASD with

deficient rims and large IAS. The mean ASD diameter was 19.7 mm. This diameter is considered high, as El-Said *et al*., (31) study in the USA stated that ASD diameter more than 10 mm is high and predicting difficult closure while diameter less than 10 mm is easily closed. Types of ASD in this study were sinus venosus (11.7%), secondum (83.3%), and primum (5%). This finding is in agreement with reports of Rao *et al.*, (32) study in the USA, which revealed that the most common type of ASD among children was the secondum. Our study showed a significant association between female gender and ASD secondum type (P=0.008), which was consistent with the results of a study in the USA (33).

The dilated right-side heart is the most common associated finding of ASD among children. The American Society of Echocardiography stated that the right heart and right pulmonary arterial dilation are the main associated findings (34). Postoperatively, only one child in our study had small apical effusion with normal chambers by echocardiography. This finding is similar to the results of Funjan study in Iraq (35). Our study showed a highly significant association between dilated right heart side and ASD secondum (P<0.001). This finding is consistent with results of Bialkowski *et al.*, (13) study in Poland. The associated other anomalies in the current study with atrial septal defects were bilateral congenital anomaly at hand, thalassemia major, congenital anomalies of back and legs, and Down syndrome. These findings are similar to the results of Al-Ani study (36) in Iraq, which stated that congenital heart diseases were associated with many other anomalies related to consanguinity.

The outcome of surgical closer of atrial septal defect in children is effective and safe.

Ventricular ectopic is the postoperative complication of one child surgically operated with open heart surgery of atrial septal defdect.

The common preoperative presentation of children with atrial septal defect were dyspnea on exertion, failure to thrive and chest infection.

The main ECG changes of children with atrial septal defdect were right axis deviation & right bundle branch block and normal axis with RVH.

The main indication for surgery in children with atrial septal defect were large ASD with posterioinferior deficient rims, large size ASD and moderate size ASD with anomalous venous return or ASD primum cases.

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