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Original Research Article

"Cardiac Remodeling after Surgical Patch Closure of Adult Congenital Atrial Septal Defects: Perspective of Bangladesh"

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Abstract: ***Introduction:*** Atrial septal defect is one of the congenital heart diseases. An atrial septal defect (ASD) represents a communication between the left and right atrium leading to left to right shunt. It makes up about 10% of all congenital heart diseases after delivery and up to 30—40% of heart defects diagnosed in patients aged over 40 years. ***Objectives:*** To identify the status of cardiac remodeling after surgical patch closure of adult congenital atrial septal defects. ***Methodology*****:** The descriptive and observation study was carried out atDepartment of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh from January 2013 to April 2015. The patients both male and female undergoing surgical closure of atrial septal defect, Department of Cardiac Surgery, BSMMU, Dhaka, Bangladesh. Total sixty (60) patients were studied, thirty (30) in each group. Group A: Thirty (30) patients of surgical closure of ASD at or before age of 25 years. Group B: Thirty (30) patients of surgical closure of ASD at or after age of 25 years. A purposive sampling technique was used for sample selection. The sample size was determined by using the standard formula for comparison between two proportions. To make it more convenient and reduce the error sample size of this study was fixed at 60 (30 in each group). Careful history regarding the complaints of- Exerttional dyspnoea, Palpitation, Fatigability, General weakness, Electrocardiography (ECG), Chest X ray, Echocardiography (Echo), Left atrial diameter (LA), -Left ventricular internal diameter at the end of diaslole (LVIDd), -Left ventricular internal diameter at the end of systole (LVIDs), Interventricular septal thickness (IVST), Posterior wall thickness (PWT), Fractional shortening (FS), Ejection fraction (EF) were measured. ***Results:*** From the result it was found that exertional dyspnoea in 60.0%, palpitation in 70.0%, fatigue in 66.6% and general weakness in 53.33% in group A and in group B exertional dyspnoea in 80.0%, palpitation in 73.33%, fatigability in 63.33% and general weakness in 80.0%. There was no significant difference in presenting complaints distribution in between two groups. From the ECG findings between two study groups it was found that arrhythmia in 13.33%, left axis deviation in 10.0%, right axis deviation 23.330% and in group B arrhythmia in 16.67%, left axis deviation in 13.33%, right axis deviation 36.67%. There were differences between two groups regarding ECG findings. In early age group there was few complains but complains are more in late age

group. From the types of ASD between two study groups it was revealed that septum secundum defect is 66.67%, Septum primum 20 % and sinous venosus defect in 13.33 % in group A. In group B septum secundum defect is 76.67%, Septum primum 13.33 % and sinous venosus defect in 10 %. There was no significant difference in type of ASD in between two groups. ***Conclusion*:** This study concluded that cardiac remodeling occurs after surgical closure of atrial septal defect in all age group and degree of cardiac remodeling was better in early age group (up to 25 years) compared with late age group (>25 years).

Keywords: Atrial Septal Defect (ASD), Septum Secundum, Sinus Venosus, Left Atrial Diameter (LA), Exertional Dyspnea.

I INTRODUCTION

Atrial septal defect is one of the congenital heart diseases. An atrial septal defect (ASD) represents a communication between the left and right atrium leading to left to right shunt. It makes up about 10% of all congenital heart diseases after delivery and up to 30—40% of heart defects diagnosed in patients aged over 40 years [1]. Surgical management of atrial septal defect became a clinical reality in the 1940s. Indeed the initial experience with extracorporeal circulation was closure of these defects. Despite more than 50 years experience with surgical correction of atrial septal defects there are still unresolved issues. Of concern is the decision to operate on patients in their fifth decade and beyond [2]. Atrial septal defects belong to a group of congenital cardiac anomalies that allow communication between the left and right sides of the heart. These interatrial communications include several distinct defects in the cardiac terminations of the systemic and pulmonary veins (sinus venosus and coronary sinus defects) and in the interatrial septum (atrial septal defects). Patent foramen ovale is a normal communication during fetal life and is commonly encountered after birth. Pathologic remodeling may occur with pressure overload (eg, aortic stenosis, systemic hypertension), volume overload (eg, atrial septal defect, valvular regurgitation), or following cardiac injury (eg. myocardial infarction). In each of these settings, remodeling may reveal transition from an apparently compensatory process to a maladaptive one [4]. Heart failure (HF) is a chronic heart disease that represents one of the leading causes of mortality worldwide. The term HF usually refers to the inability of the heart to maintain the blood flow necessary to satisfy the metabolic requirements of the body [6]. Cardiac remodeling is strictly associated with the progression of HF [7]. It encompasses all the molecular, cellular, and interstitial events that contribute to the clinically relevant changes in the shape, size, and mass of the heart after cardiac injury [7]. Cardiac remodeling may occur following several pathophysiological stimuli leading to a reduction of contractility and/or an increase in wall stress, such as ischemia/reperfusion (I/R), MI, pressure and volume overload, genetic background, hypertension, and neuroendocrine activation [7–9]. It may be either an adaptive or a maladaptive mechanism [7]. In the first case, structural changes of the heart exert a compensatory effect, maintaining normal cardiac function [10, 11]. On the contrary, after sustained stress, cardiac remodeling leads to a progressive and irreversible dysfunction of the heart [12]. From a cellular point of view, major mechanisms that contribute to cardiac remodeling involve both cardiomyocytes and noncardiomyocytes. In fact, during cardiac remodeling, cardiomyocyte loss has been extensively described to occur through necrosis, necroptosis, apoptosis, or autophagy, whereas fibrosis occurs through fibroblast proliferation and extracellular matrix (ECM) reorganization. Furthermore, mitochondrial dysfunction and metabolic abnormalities also contribute to the development and progression of cardiac remodeling by reducing contractility [13]. The extent of cardiac remodeling after surgical correction depends on initial morphological changes attributed to the disease process itself. So the age at which surgical corrections are made have important bearings on the remodeling process itself. Apparently, surgical closure of atrial septal defect in earlier age group should have positive beneficial effect on outcome and whether this positive outcome correlate with cardiac remodeling process needs to be worked out.

II METHODS AND MATERIALS

The descriptive and observation study was carried out at Department of Cardiac Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), and Dhaka, Bangladesh from January 2013 to April 2015. The patients both male and female undergoing surgical closure of atrial septal defect, Department of Cardiac Surgery, BSMMU, Dhaka, Bangladesh.

Inclusion criteria

a) Patient presenting with Surgical Patch Closure of early age group and late age groupt Congenital Atrial Septal Defects, BSMMU, Dhaka, Bangladesh.

Exclusion criteria

a) Exclusion criteria included insulin-dependent diabetes.
b) Current known psychiatric illness, a diagnosis of AIDS.
c) Patients of atrial septal defect with associated cardiac lesion.
d) Systemic disease such as end stage renal disease, hepatic failure, respiratory failure.
e) Atrial septal defect with Eisenmenger's syndrome.

Grouping of the Patients

1. Group A: Thirty (30) patients of surgical closure of ASD at or before age of 25 years.
2. Group B: Thirty (30) patients of surgical closure of ASD at or after age of 25 years.

Data processing and analysis

The data collected from the patients with Surgical Patch Closure of Adult Congenital Atrial Septal Defects attending cardiovascular OPD, BSMMU has been entered into SPSS 16. The data have been checked for their completeness and consistency. Incomplete and inconsistent data have been corrected if it is possible, otherwise removed. The processed data has been presented as in percentage (%). The result has been verified as logical and accurate as per filled up questionnaire.

III RESULTS

Total sample size was 60, out of them 30 were in the group A (<25 years) and the rest of 30 in group B (>25 years). The findings of data analysis are stated below: *Age distribution:* The age distribution of the selected patients between group A and group B are showed in table-1. The mean age of patients in group A is 20.06+3.29 years and in group B 35.71+5.79 years. There was significant difference as the patients were purposively distributed between two groups.

Table-1: Comparison of age between two study groups.

	Group A		**Group B**			
Variable	(n=30)		(n=30)		t value	p value
	Mean±SD	Range	Mean±SD	Range		
Age (years)	20.06+3.29	15-25	35.71+5.79	35-55	-13.55	<0.005[s]

Data were expressed as number and Mean ± SD. Statistical analyses were done by unpaired t-test. s= Significant. n = Number of subjects.

Comparison of presenting complaints between two study groups: The presenting complaints between two study groups are shown in table-2. The figure shows exertional dyspnoea in 60.0%, palpitation in 70.0%, fatigue in 66.6% and general weakness in 53.33% in group A and in group B exertional dyspnoea in 80.0%, palpitation in 73.33%, fatigability in 63.33% and general weakness in 80.0%. There was no significant difference in presenting complaints distribution in between two groups.

Table-2: Comparison of presenting complaints between two study groups.

Variable	**Group A**		**Group B**		**p value**
	(n=30)		(n=30)		
	Number	%	Number	%	
Exertional dyspnoea Yes No	18 12	60.0 40.0	24 6	80 20	0.143[ns]
Palpitation Yes No	21 9	70.0 30	22 8	73.33 26.67	0.276[ns]
Fatigability Yes No	20 10	66.67 33.33	19 11	63.33 36.67	0.832 ns
General weakness Yes No	16 14	53.33 46.67	24 6	80 20	0.095 [ns]

Data were expressed as number and percentage. Statistical analysis were done by chi-square-test ns = Not significant, n = Number of subjects.

Comparison of ECG findings between two study groups: The ECG findings between two study groups are shown in table-3. The figure shows arrhythmia in 13.33%, left axis deviation in 10.0%, right axis deviation 23.330% and in group B arrhythmia in 16.67%, left axis deviation in 13.33%, right axis deviation 36.67%. There were differences between two groups regarding ECG findings. In early age group there was few complains but complains are more in late age group.

Table-3: Comparison of ECG findings between two study groups.

Variable	Group A (n=30)		Group B (n=30)		P value
	Number	%	Number	%	
Arrhythmia	4	13.33	5	16.67	0.338ns
Left axis deviation	3	10	4	13.33	
Right axis deviation	7	23.33	11	36.67	
Normal	16	53.34	10	33.33	
Total	3 0	100	3 0	100	

Data were expressed as number and percentage. Statistical analysis were done by chi-square-test ns = Not significant, n = Number of subjects.

Comparison of type of ASD between two study groups: The types of ASD between two study groups are shown in table-4. The figure shows septum secundum defect is 66.67%, Septum primum 20 % and sinous venosus defect in 13.33 % in group A. In group B septum secundum defect is 76.67%, Septum primum 13.33 % and sinous venosus defect in 10 %. There was no significant difference in type of ASD in between two groups.

Table-4: Comparison of type of ASD findings between two study groups.

Variable	Group A		Group B		P value
	(n=30)		(n=30)		
	Number	%	Number	%	
Septum secundum	20	66.67	23	76.67	0.75 ns
Septum primum	6	20	4	13.33	
Sinous venosus	4	13.33	3	10	
Total	30	100	30	100	

Data were expressed as number and percentage. Statistical analysis were done by chi-square-test ns = Not significant, n = Number of subjects.

Comparison of echocardiographic findings at preoperative, after 1 month and 4 months of operation in group A and in group B: In group A: Table-5 shows mean diameter of LA at preoperative period was 27.18+4.00 mm, after 1st month of follow up 34.49+3.28 mm and after 4th month 25.20+3.98 mm. IVST at preoperative period was 9.51+1.17 mm, after 1" month of follow up 11.40+0.77 mm and after 4th month 7.54+1.38 mm. PWT at preoperative period was 10.11+1.59 mm, after 1st month of follow up 11.57+1.50 mm and after 4th month 8.23+1.77 mm. LVIDd at preoperative period was 43.34+3.18 mm, after 1st month of follow up 47.89+3.25 mm and after 4th month 38.14+3.65 mm. LVIDs at preoperative period was 30.46+2.29 mm, after 1st month of follow up 36.40+3.64 mm and after 4th month 26.29+2.88 mm. EF at preoperative period was 64.97+2.58 percent, after 1st month of follow up 55.37+10.91 percent and after 4th month 69.37+3.87 percent. FS at preoperative period was 29.49+1.93 percent, after 1st month of follow up 23.89+5.92 percent and after 4th month 32.91+2.78 percent. The comparison between preoperative findings versus findings at 1 month showed significant dilatation of the heart as evident by increase in LA, IVST, PWT, LVIDd, LVIDs and decrease in EF, FS. The preoperative findings versus findings at 4 months showed statistically significant improvement due to cardiac remodeling after surgical correction of atrial septal defect.

Table-5: Comparison of Echocardiographic findings at preoperative, after 1 month and 4 months of operation in group A and Group B.

Variables	Groups	Preoperative	At 1 month	At 4 months	Statisticals Analysis P value	
	n=30				Preoperative vs at 1 month	Preoperative vs at 4 months
LA	Group A	27.18+4.00	34.49+3.28	25.20+3.98	<0.0012	<0.0011
Diameter (mm)	Group B	31.43+2.59	32.40+2.72	30.20+4.14	<0.0013`	0.063°
IVST (mm)	Group A	9.51+1.17	11.40+0.77	7.54+1.38	<0.0011 s	<0.0011 S
	Group B	9.83+1.42	10.89+1.37	8.54+1.74	<0.0011`	0.088'
PWT (mm)	Group A	10.11+1.59	11.57+1.50	8.23+1.77	<0.0011 S	<0.0011
	Group B	10.06+1.30	12.26+1.40	8.9711.25	<0.00115	0.766"s
LVIDd	Group A	43.34+3.18	47.89+3.25	39.14+3.65	<0.001 S	<0.0011
(mm)	Group B	48.2912.54	49.46+2.67	47.86+2.83	<0.001s	0.0632"s
LVIDs	Group A	30.46+2.29	36.40+3.64	26.29+2.88	<0.0011 S	<0.0011 S
(mm)	Group B	35.2012.21	36.3712.21	34.74+2.83	<0.001ls	0.081 "s
EF (%)	Group A	64.97+2.58	55.37+10.91	69.37+3.87	<0.0011 S	<0.0011
	Group B	66.00+3.13	65.1413.97	66.3117.12	0.012s	0.758°
FS (%)	Group A	29.49+1.93	23.89+5.92	32.91+2.78	<0.0011 S	<0.0011 S
	Group B	31.3712.12	31.03+2.64	31.1714.84	<0.0011s	0.2768"s

Data were presented as mean +SD; Data were analyzed using unpaired t test s = significant

In group B: The mean diameter of LA at preoperative period was 31.43+2.59 mm, after $_1$st month of follow up 32.40+2.72 mm and after 4th months 30.20+4.14 mm. IVST at preoperative period was 9.83+1.42 mm, after 1St month of follow up 10.89+1.37 mm and after 4th months 8.54+1.74 mm. PWT at preoperative period was 10.06+1.30 mm, after 1st month of follow up 11.26+1.40 mm and after 4th months 8.97+1.25 mm. LVIDd at preoperative period was 48.29+2.54 mm, after 1St month of follow up 49.46+2.67 mm and after 4th months 47.86+2.83 mm. LVIDs at preoperative period was 35.20+2.21 mm, after 1St month of follow up 36.37+2.21 mm and after 4th months 34.74+2.83 mm. EF at preoperative period was 66.00+3.13 percent, after 1St month of follow up 65.14+3.97 percent and after 4th months 66.31+7.12 percent. FS at preoperative period was 31.37+2.12 percent, after 1St month of follow up 31.03+2.64 percent after 4th months 31.17+4.84 percent. The comparison between preoperative findings versus findings at 1 month showed significant dilatation of the heart as evident by increase in LA, IVST, PWT, LVIDd, LVIDs and decrease in EF, FS. Comparison between preoperative findings versus findings at 4 months reveals that remodeling occur at 4 months but was not significant statistically.

IV DISCUSSION

Surgical closure of ASD has been considered the standard treatment for ASD for more than 45 years [17]. Although the perioperative mortality in most cardiac surgical centers approaches zero, residual shunting after surgical closure is not rare, and its incidence varies from 2% to 7.9% in the long-term follow-up data [18,19]. The surgical treatment of ASDs in the modern era of cardiac surgery has many faces. The traditional sternotomy approach remains the easiest technique with the shortest ischemic and CPB times. Modern minimally invasive approaches improve cosmesis, shorten hospital stay, hasten return to full function, and can now be performed without increased risk in terms of mortality and morbidity. Respiratory function in patients with ASD has been relatively rarely assessed. Both normal and decreased values of basic parameters of resting spirometry have been reported [14-16]. In group A: Table-5 shows mean diameter of LA at preoperative period was 27.18+4.00 mm, after 1st month of follow up 34.49+3.28 mm and after 4th month 25.20+3.98 mm. IVST at preoperative period was 9.51+1.17 mm, after 1" month of follow up 11.40+0.77 mm and after 4th month 7.54+1.38 mm. PWT at preoperative period was 10.11+1.59 mm, after 1st month of follow up 11.57+1.50 mm and after 4th month 8.23+1.77 mm. LVIDd at preoperative period was 43.34+3.18 mm, after 1st month of follow up 47.89+3.25 mm and after 4th month 38.14+3.65 mm. LVIDs at preoperative period was 30.46+2.29 mm, after 1st month of follow up 36.40+3.64 mm and after 4th month 26.29+2.88 mm. EF at preoperative period was 64.97+2.58 percent, after 1st month of follow up 55.37+10.91 percent and after 4th month 69.37+3.87 percent. FS at preoperative period was 29.49+1.93 percent, after 1st month of follow up 23.89+5.92 percent and after 4th month 32.91+2.78 percent. The comparison

between preoperative findings versus findings at 1 month showed significant dilatation of the heart as evident by increase in LA, IVST, PWT, LVIDd, LVIDs and decrease in EF, FS.The preoperative findings versus findings at 4 months showed statistically significant improvement due to cardiac remodeling after surgical correction of atrial septal defect. In group B: The mean diameter of LA at preoperative period was 31.43+2.59 mm, after 1st month of follow up 32.40+2.72 mm and after 4th months 30.20+4.14 mm. IVST at preoperative period was 9.83+1.42 mm, after 1St month of follow up 10.89+1.37 mm and after 4th months 8.54+1.74 mm. PWT at preoperative period was 10.06+1.30 mm, after 1st month of follow up 11.26+1.40 mm and after 4th months 8.97+1.25 mm. LVIDd at preoperative period was 48.29+2.54 mm, after 1St month of follow up 49.46+2.67 mm and after 4th months 47.86+2.83 mm. LVIDs at preoperative period was 35.20+2.21 mm, after 1St month of follow up 36.37+2.21 mm and after 4th months 34.74+2.83 mm. EF at preoperative period was 66.00+3.13 percent, after 1St month of follow up 65.14+3.97 percent and after 4th months 66.31+7.12 percent. FS at preoperative period was 31.37+2.12 percent, after 1St month of follow up 31.03+2.64 percent after 4th months 31.17+4.84 percent. The comparison between preoperative findings versus findings at 1 month showed significant dilatation of the heart as evident by increase in LA, IVST, PWT, LVIDd, LVIDs and decrease in EF, FS. Comparison between preoperative findings versus findings at 4 months reveals that remodeling occur at 4 months but performances are better in early age group than old age group. Sizeable ASDs with right heart dilation are associated with important age-related morbidity and mortality. Advanced diagnostic modalities, earlier closure, and the advent of catheter intervention (for secundum ASDs) are all likely to improve long-term prospects for these patients. Current evidence would suggest that all types of ASDs with right heart dilation should be considered for timely closure once the diagnosis is established, irrespective of age. An atrial septal defect (ASD) is a common congenital heart disease. Its true incidence remains undetermined as it is often clinically silent. Surgical closure of atrial septal defects is still the treatment of choice in children and young adults. The aim of this study is to find out whether cardiac remodeling is better in paediatric group in comparison to adult group and its impact on outcome after surgical closure of atrial septal defect. Cardiac arrhythmias and conduction abnormalities were the most common complications encountered. Although most of these were transient, one patient required pacemaker implantation. Another problem of device closure is the chance of device embolization, which occurred in 1.1% of the patients in this study. But this still compares favorably with previous studies using either the ASO or other devices [20, 21]. Sixty (60) patients were enrolled into this study purposively and were divided into two groups according to the age, who underwent surgical closure of ASD. Group A (n=30), includes patient up to age 25 years, group B (n=30) patient age more than 25 years. Echocardiographic variables such as left atrial diameter, posterior wall thickness, interventricular septal thickness, left ventricular internal diameter at the end of diastole, left ventricular internal diameter at the end of systole, ejection fraction, fractional shortening were taken preoperatively, at 1st month and 4th month of postoperative period.

V CONCLUSION

This study concluded that cardiac remodeling occurs after surgical closure of atrial septal defect in all age group and degree of cardiac remodeling was better in early age group (up to 25 years) compared with late age group (>25 years).

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