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Original Research Article

The impact of surgical closure of atrial septal defect on the pulmonary hypertension: a prospective observational study

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ABSTRACT

Introduction: The most prevalent congenital disease is atrial septal defect. Atrial septal defects that have a left to right shunt result in persistent volume overload in the pulmonary vasculature. So histological changes occur in pulmonary vasculature leads to pulmonary hypertension. Without surgery, both life expectancy and functional ability are reduced. The aim of this study was to observe the impact of surgical closure of atrial septal defect on pulmonary hypertension.
Methods: This observational study was done in the department of cardiac surgery, Bangabandhu Sheikh Mujib Medical University from June 2020 to June 2022. Sample size was 24 Patients were evaluated preoperatively, postoperative day of operation through a clinically, ECG, color doppler echocardiography. The statistical analysis was performed by using SPSS version 26.0 for windows software.
Results: In my study, the mean age of the patients was 33.33±11.3 years, male female ratio was 1:2. The mean pulmonary artery systolic pressure got decreased from 57.54±7.9 mmHg to 53.29±8.30 mmHg on postoperative day. 75% patients improved into New York heart association class 2 on post operative day. Significant improvement was seen in functional capacity of the patients. 29.2% patients had atrial fibrilation preoperatively, after surgery on post-operative day it became 25%.
Conclusions: This study concludes that surgical closure of atrial septal defect leads to a significant reduction in pulmonary hypertension.

Keywords: Pulmonary hypertension, ASD, Surgical closure

INTRODUCTION

Atrial septal defect (ASD), the second most common congenital heart defect, occurs in approximately 1.6 out of every 1000 live births.[1] Among congenital heart defects in children, ASD accounts for 10% to 15%, while in adults, it is responsible for 20% to 40% of such defects.[1,2] It is more prevalent in women, occurring twice as often as in men.[3] Atrial septal defect has been linked to maternal exposure to substances like alcohol, hydantoin, valproic acid, and amphetamines. Infections during pregnancy, such as cytomegalovirus or rubella, as well as conditions like diabetes, advanced maternal age, multiple gestations, and obesity, are also associated with ASD. Furthermore, low-birth-weight and premature infants have a higher prevalence of ASD compared to the general population.[4] Atrial septal defects (ASDs) can be diagnosed in adults as well. In such cases, before the closure of the ASD, more than 60% of patients over 40 years of age are classified as New York Heart Association (NYHA) class III to IV, indicating significant limitations in their daily activities due to heart-related symptoms. However, after the closure of the ASD, more than 80% of patients experience an improvement in their functional status and are classified as NYHA class I to II, indicating a better quality of life with fewer limitations. A study involving 117 patients over 60 years of age who underwent ASD closure demonstrated an immediate and sustained improvement in functional class and a reduction in pulmonary artery pressure.[5,6] Consequently, an improvement in both 5-year and 10-year survival rates was observed.[1,2] These findings suggest that ASD closure can be beneficial regardless of age for the majority of patients. While most ASD patients do not experience symptoms and may remain asymptomatic, atrial fibrillation and congestive heart failure can develop as late complications. Even in children, occasional shortness of breath during strenuous activities may be observed. Additionally, recurrent respiratory infections are common in individuals with large ASDs.[4] Although studies indicate that closure of the ASD can lead to improvements in pulmonary arterial pressure, further evaluation and treatment should be considered for each individual case.[7-10]

Surgical closure of an atrial septal defect (ASD) can not only enhance the patient's functional condition but also result in a decrease in both right ventricular volumes and pressures. Additionally, the closure of ASD may lead to a slight reduction in left ventricular volumes and an improvement in the left ventricular ejection fraction, which measures the heart's pumping efficiency. Pulmonary hypertension, a condition characterized by increased pressure in the pulmonary arteries, is categorized as mild (41-49 mmHg), moderate (50-59 mmHg), or severe (60 mmHg and above) based on the pulmonary artery systolic pressure (PASP) determined through echocardiography. A PASP of 40 mmHg is considered normal.[11-13] The aim of this study was to see the impact on pulmonary hypertension who underwent surgical closure of atrial septal.

Objectives

The objective of this study was to observe the effects of surgical closure of atrial septal defects (ASDs) on pulmonary hypertension.

METHODS

This was an observational study and was conducted in the Bangabandhu Sheikh Mujib Medical University (BSMMU, Dhaka, Bangladesh during the period from June 2020 to June 2022. A total of 24 patients who were male and female, aged 15 years above were included in the study. A standardized semi-structured data collection sheet was used to collect necessary information and face to face interview. Necessary information was collected by reviewing related medical reports. A semi structured questionnaire was developed in English. The questionnaire was developed using the selected variables according to the specific objectives. The questionnaire contained questions related to socio-demographic characteristics, preoperative and post-operative outcomes. A checklist was also developed to record desired variables from admission record, history sheet and related medical records. The preformed structured questionnaire and checklist was pre-tested on 5 patients.

Data were checked immediately after completing interview and review of necessary investigation reports. All relevant data were collected from each respondent by use of an interview schedule, measured parameters, and investigations in a predesigned format. We included patient having secundum variety of atrial septal with pulmonary.

All patients who admitted into the cardiac surgery department for surgical closure of ASD with pulmonary hypertension without exclusion criteria were taken for the study population. Patients who were fulfilled the inclusion criteria and willing to enroll in the study were included in the study after receiving the proper consent. Patients with significant comorbidities that may confound the assessment of pulmonary hypertension or surgical outcomes, including severe chronic obstructive pulmonary disease (COPD), severe pulmonary fibrosis, severe liver disease, or malignancy with poor prognosis were excluded from our study. Patients unwilling or unable to participate in follow-up assessments, including echocardiography, exercise tolerance tests, and clinical evaluations weren't included. All patients were operated through a median sternotomy approach. After completion of the surgery, all patients were transferred to intensive care unit (ICU). In ICU patients were monitored for heart rate and rhythm with continuous ECG monitoring. ECG monitoring was continued throughout the period of ICU. All patients were receiving a standard general anesthesia

protocol for surgery through a standard median sternotomy approach.

Statistical analysis

All data were recorded systematically in preformed data collection form and quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Statistical analysis was carried out by using Statistical analysis was done by using SPSS (Statistical Package for Social Science) Version 26 for windows 10. P value <0.05 was considered as statistically significant. Ethical clearance was obtained from Institutional Review Board (IRB) of BSMMU to undertake the current study.

RESULTS

The (Figure 1) shows that majority (45.8%) of our patients were aged 15-30 years old, followed by 41.7% & 12.5% were aged between 31-45 & 46-60 years old respectively. We found the Mean±SD of age was 33.33±11.

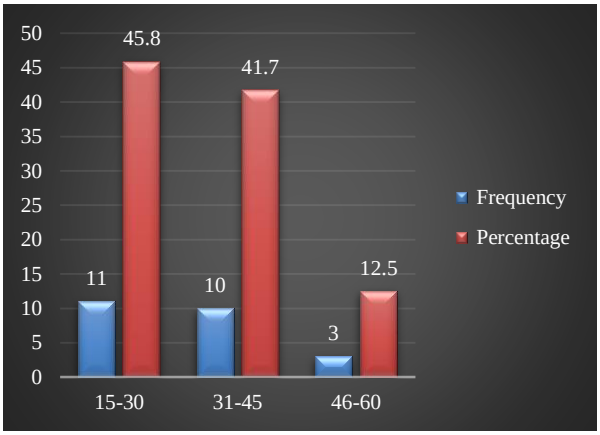

Figure 1: Age distribution of the patients.

The (Figure 2) shows the gender distribution of the patients where most of the patients (66.7%) were male and (33.3%) were female.

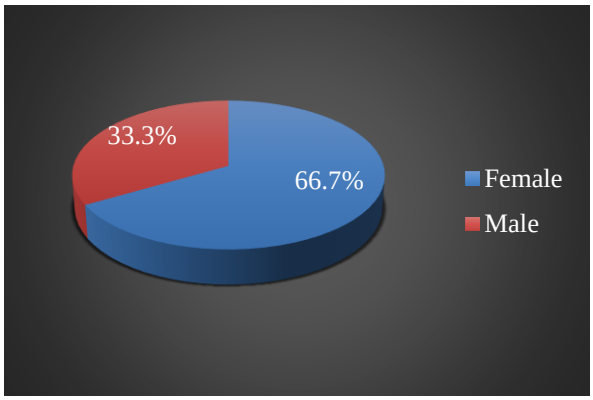

Figure 2: Distribution of our patients by gender.

The (Table 1) the patients of PASP shows that 20.8% patients had systemic hypertension. The mean pulmonary artery systolic pressure of hypertensive patients was 57.8 mmHg and normotensive patient's was 57 mmHg. There was no significant difference in PASP between them.

The (Table 2) postoperative outcomes showed that the mean duration of mechanical ventilation is 5.29±0.9 hours. This measure indicates the average amount of time patients required mechanical ventilation support following their surgery. The mean duration of ICU stay is 4.5±0.5 days. This measure represents the average length of time patients spent in the intensive care unit (ICU) after their surgery and the duration of hospital stays is 8.25±0.79 days. This measure represents the average length of time patients remained in the hospital overall after their surgery.

Table 1: Distribution of the patients according to pulmonary artery systolic pressure.

PASP	N (%)	Mean	P value
Hypertensive	5 (20.8)	57.5	0.268
Normotensive	19 (79.2)	57.98	

Table 2: Postoperative variables of the patients.

Post-operative outcomes	Mean±SD
Duration of mechanical ventilation (hours)	5.29±0.9
Duration of ICU stay (days)	4.5±0.5
Hospital stays (days)	8.25±0.79

Table 3 clinical features shows that the preoperative period 8.3% patients were in NYHA functional class IV, 50% patients were in class III, 33.3% patients were in class II, 8.3% patient were in class I. On post operative day, improvement in functional capacity had been observed, 75% patients were improved into NYHA class II, 12.5% in NYHA class I, least 12.5% remained in class III which was statistically significant. After 6 weeks 66.6% patients were improved into class I remaining 33.3% patients remained in class II. As for 29.2% patient had atrial fibrillation preoperatively and on postoperative day it turned into 25%.

On preoperative period 50% patients had severe, 25% patients had moderate, 25% patients had mild pulmonary hypertension. On 7th post operative day 41.7% patients labeled as moderate pulmonary hypertension, 29.2% as severe pulmonary hypertension, 29.2% as mild pulmonary hypertension. The mean preoperative PASP was 57.54±7.9 mmHg but in post operative day it decreased in 53.29 ±8.30 mmHg. Post operatively PASP was decreased but not statistically significant.

DISCUSSION

The surgical closure of the atrial septal defect with pulmonary hypertension have been done successfully.

The obtained result from my study showed the mean age of the patient was 33.33±11.3 years. Suarez et al done a study on 2002 in spain over twenty-nine atrial septal defect patients, their mean age was 56±14 years.[14] Balint and his colleague done a study on 2007 in torento general hospital over fifty-four patients and their mean age was 59±15 years.[13] In this study, 75% patients were female and 25% were male.

Table 3: Patients outcomes at follow up.

Features		Preoperative N (%)	Postoperative N (%)	P value
NYHA class	I	2 (8.3)	3 (12.5)	0.001
	II	8 (33.3)	18 (75)	
	III	12 (50)	3 (12.5)	
	IV	2 (8.3)	0	
Atrial fibrillation	Yes	7 (29.2)	6 (25)	1.00
	No	17 (70.8)	18 (75)	
PASP	Normal	0	0	0.07
	41-49	6 (25)	7 (29.2)	
	50-59	6 (25)	10 (41.7)	
	60 and above	12 (50)	7 (29.2)	

Male female ratio was 2:1, that is similar to normally reported ASD patients. O H Balint and his colleagues showed 76% female and 24% male in their study.[12] Jose Suarez and his colleagues showed 83% female in their study.[14] A study done by Sachweh and his associates, that describe seventy-five patients with pulmonary hypertension underwent preoperative pulmonary biopsy. Women were more likely to have severe histological changes in the lungs.[15] This observation may explain the increased female to male ratio.

In post operative periods, the mean duration of mechanical ventilation was 5.29±0.9, duration of ICU stay was 4.5±0.5 days, mean hospital stay was 8.25±0.79 days. Post operative periods of all the patients were uneventful. There was no mortality. In the study 25% patients had systemic hypertension. The mean pulmonary artery systolic pressure of hypertensive patients was 57.8 mmHg and normotensive patient's was 57 mmHg. There was no significant difference in PASP between them. In the study of Balint and his associates showed 26% had systemic hypertension and there were no mean difference between hypertensive and normotensive patient's pulmonary hypertension.[13]

In this study, on preoperative period 8.3% patients were in NYHA functional class IV, 50% patients were in class III, 33.3% patients were in class II, 8.3% patient were in class I. On post-operative day, improvement in functional capacity had been observed, 75% patients were improved into NYHA class II, 12.5% in NYHA class I, least 12.5% remained in class III which was statistically significant. In my study 29.2% patient had atrial fibrillation preoperatively.

On post-operative day it turned into 25%. There was significant improvement seen among the patient after surgical closure. Earlier observations have suggested that chronic volume overload with pulmonary hypertension and right ventricular dysfunction may be the factors associated with arrhythmogenesis.[16]

Two previous studies have reported higher systolic pulmonary artery pressures in patients with atrial arrhythmia undergoing ASD surgery that resolved after surgical closure.[17] This improvement may in part be due to decreases in the volume load to the right ventricle and subsequent improvement in left ventricular diastolic and systolic function.[14] De Lezo and his associates showed that after

ASD closure the prevalence of atrial fibrillation reduced from 41% to 24% and this was related to the decrease in PASP.[10] On preoperative period 50% patients had severe, 25% had moderate, 25% had mild pulmonary hypertension. On post-operative day 41.7% patients had moderate pulmonary hypertension, 29.2% remained severe pulmonary hypertension. In the study of Jose Suarez and his colleague described that mean PASP just after atrial septal defect closure reduced from 64±23 mmHg to 54±21 mmHg ($p<0.001$).[14]

Limitations

Limitations were; current study was a single centre study. Pulmonary right heart catheterization was not done. We could only study a few adverse effects within a short study period. The sampling was not a randomized. The Sample size was limited.

CONCLUSION

This study concludes that surgical closure of atrial septal defect leads to a significant reduction in pulmonary hypertension. The findings demonstrate that restoring normal cardiac anatomy and hemodynamics through surgical intervention effectively mitigates elevated pulmonary pressures associated with ASD. Consequently,

surgical closure should be considered a primary therapeutic strategy in the comprehensive management of individuals with ASD and associated pulmonary hypertension.

Recommendations

Surgical closure of ASD is essential to improve the prognosis and quality of life for affected individuals. It helps alleviate pulmonary hypertension, reduce ventricular pressures, and enhance functional status. Timely intervention through surgery is crucial in managing ASD and preventing long-term complications, ultimately improving the overall health outcomes for patients.

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