Original Research Article

A retrospective study of atrial septal defect

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Abstract

Background: An Atrial Septal defect is an abnormal hole of variable size in the atrial septum, which generally permits left to right shunting of blood at the atrial level. ASD is one of the most common congenital cardiac anomalies, present in 10-15 percent of patients with congenital heart disease.

Aim: To study the clinical profile, diagnostic modalities used, post operative morbidity and mortality of patients operated for atrial septal defect in a major teaching hospital in Telangana.

Materials and Methods: This study was based on a patient population of 50, admitted to undergo surgical correction for atrial septal defect.

Results: The incidence of ASD is more in females. The male to female ratio was 1:2.1 in this study. The majority of the patients were symptomatic (96%). The commonest symptom was dyspnoea on exertion (76%). Most of the patients were in NYHA class II (62%). Consanguineous marriage of parents was present in 28% of patients. Most of the patients were in sinus rhythm (94%). ASD were of fossa ovalis type (96%). In 74% of the patients, the size of ASD was between 2-4 cm in diameter. 78% of the patients were repaired by direct closure of ASD. Most of the patients (96%) were supported by ventilation, out of which 62% (31/50) of patients were ventilated for 1-6 hours. Patients (70%) were discharged by 9^{th} –12^{th} post operative day. Mortality was 2% in this study.

Conclusion: Surgical repair of atrial septal defects is a safe procedure which is associated with excellent results and low morbidity.

Key words

Atrial septal defect, Surgical repair, Congenital cardiac anomalies.

Introduction

An Atrial Septal defect is an abnormal hole of variable size in the atrial septum, which generally permits left to right shunting of blood at the atrial level. ASD is one of the most common congenital cardiac anomalies, present in 10-15 percent of patients with congenital heart

disease. It is the most common congenital cardiac lesion in the adults.

Atrial septal defect (ASD) is the cause of approximately one-third of the cases of congenital heart disease (CHD) diagnosed in adults and almost 10% of all CHDs. Due to the lack of specific symptoms, diagnosis can be missed during childhood [1]. Patients with ASD and left-to-right shunts are at an increased risk of developing pulmonary arterial hypertension. While large atrial septal defects may present in childhood with signs of heart failure, a significant proportion of patients present in the third or fourth decade of life [2]. Progressively limiting, untreated ASD can lead to early death in middle-aged adults. ASD has been surgically repaired for almost 60 years. The distinct feature of ASDs which sets them apart from other CHDs is the slow progress of the clinical course, which does not lead to debilitating symptoms until after the fourth or fifth decade of life [3]. When defects are closed in adults, the majority of those with pre-operative arrhythmias do not revert to sinus rhythm and new atrial flutter/fibrillation develops in 8% of those over 40 years (follow-up 3.8 years). The objectives of surgical closure of an ASD are the reversal of hemodynamic abnormalities and the prevention of complications, including heart failure and irreversible pulmonary vascular obstructive changes, hence leading to improvement of symptoms. Surgical closure of ASD provides good early post-operative and long-term results [4]. So, here we aim to study post operative morbidity and mortality of patients operated for Atrial septal defect.

Materials and methods

The records of the 50 cases of ASD's that were surgically corrected at Gandhi Hospital, Hyderabad from January, 2011 to March, 2015 were reviewed.

All patients with isolated ASD (ostium secundum, ostium primum and sinus venosus with or without PAPVD) were included. Excluded from the study were patients with ASD associated with one or more other congenital heart anomalies (ventricular septal defect, Ebstein's Anomaly, Tetralogy of Fallot, complete atrioventricular septal defect, pulmonary valve stenosis etc). Clinical and echocardiographic data from baseline evaluation, early follow-up and late follow-up were obtained by chart review. Baseline clinical data included gender, symptoms, diagnosis, age at surgery, and the size of the defect. The diagnosis was established by transthoracic cross-sectional echocardiography. Variables assessed pre-operatively included the type and size of the ASD. Other clinical and hemodynamic echocardiographic factors were also assessed. Operative data consisted of the duration of surgery (time of incision to the time of dressing), minimum temperature, surgical technique employed to close the ASD and type of myocardial preservation (crystalloid or blood cardioplegia). The post-operative data included the presence of any residual ASD shunt via a post-op echo (significant >2 mm), the use of inotropic support, length of cardiac intensive care unit (CICU) stay, length of hospital stay, use of ventilation support for >48 hours and any morbidity or mortality.

Surgical Treatment

Indications / Contraindications

Presence of an uncomplicated ASD with evidence of RV volume overload is an indication for operation i.e. (QP/QS>2:1). Optimal age for operation is 1 – 2 years because of the deleterious effects of longer periods of RV volume overload.

Very young age or very old age is not a contra indication for surgery. Associated Ticuspid or mitral regurgitation which occurs in older patients is not a contraindication for surgery. If significant, such lesions are repaired along with closure of ASD. Grading mitral regurgitation by angiography or echocardiography may be misleading when major runoff occurs from the left to right atrium through the ASD, and the regurgitation becomes more significant when the ASD is closed. For these reasons moderate mitral

regurgitation is usually an indication for mitral valve repair. Mitral regurgitation is under graded in the presence of an ASD.

Pulmonary vascular disease of sufficient severity to raise RPI to 8 – 12 Wood units/m2 at rest that fails to decrease less than 7 Wood units/m^2 with a pulmonary vasodilator is a contraindication to operation. Such conditions are usually present with resting QP/QS of less than 1.5 in patients with elevated pulmonary artery pressure.

Technique of Operation

The repair of ASD is done under cardiopulmonary bypass under General anesthesia.

Skin incisions

- Median sternotomy – commonest incision.
- Alternative incisions
    - Right anterolateral fifth inter costal space incision.
    - Small lower sternotomy approach.
    - Small vertical right parasternal incision.
    - Mini Lateral thoracotomy (Mid axillary line)

Each incision requires modification of the setup for caval cannulation and patient position.

After incision is made and the pericardial stay sutures placed, intrapericardial anatomy is assessed. The characteristically large right atrium and right ventricle of ASD are noted as well as the normal sized Left atrium and Left ventricle. A left superior venacava in the fold of Marshall is sought. The external position and connections of the right and left superior and inferior pulmonary veins are noted. The ASD is palpated through the atrial wall. The function of mitral and tricuspid valves is assessed.

The patient is heparinised and aortic cannula is inserted. Two venous cannulae are used, one inserted through the right atrial appendage and the other through the low right atrial wall.

Cardio Pulmonary Bypass is established with the perfusate temperature at 34°C. The cardioplegic needle is now placed in the ascending aorta, the aorta is clamped and cold cardioplegia solution is injected. The caval tapes are snugged and the right atrium is opened obliquely. A few fine stay sutures are placed on the edges of the atriotomy incision. Blood in the left atrium is suctioned only enough to expose clearly the edges of the ASD, because evacuation of more blood than this from left side of the heart needlessly exposes the patient to risk of air entrapment and subsequent air embolism.

The entire right atrial internal anatomy is examined, particularly identifying the limbus and defining any rim of the ASD. The relationship of the defect to the ostium of the coronary sinus, membranous portion of the atrio ventricular septum and commissural area between the septal and anterior tricuspid leaflets is studied because these features serve as guides to the location of the atrio ventricular node and penetrating portion of the bundle of His. Possible fenestrations in the floor of the fossa Ovalis are sought. These are usually between the fossa ovalis and limbus anteriorly or near the Inferior venacava inferiorly. When present, these fenestrations may be joined to the main defect by excising sufficient tissue to create an edge strong enough to hold sutures well or the fenestrated tissue simply may be imbricated into the suture line.

Usually the ostium secondum ASD is closed directly. The suturing is begun at the inferior angle by placing a half purse string stitch. Care is taken to catch good, substantial anterior and posterior limbic tissue with the first and last bites of this stitch, which must be inferior to any remaining fenestrations. After this half purse-string stitch is tied, the ASD assumes a slit like appearance. The suture line is now carried superiorly. The sutures must not be placed too far from the edge anteriorly to avoid damage to the Atrio ventricular node. Before the last few

stitches are pulled up, a clamp or tissue forceps is placed in the aperture and the anesthesiologist inflates the lungs to expel any air from the left atrium. The suture line is snugged while lung inflation is maintained and an additional bite is taken with the stitch, which is then tied. After the right atrium is sucked dry, once again the lungs are inflated to drive left atrial blood through suture line and thus identify any defects in the suture line. If seen, the leaks are closed with interrupted sutures. The right atrium to then closed. The caval tapes are released, the apex of left ventricle is aspirated for air, strong suction is placed on the aortic needle vent/catheter and the aortic clamp is released.

After good cardiac action has developed, after usual de-airing procedures done, Cardio pulmonary bypass is discontinued with care taken not to over distend the left side of the heart in the process. The left atrial pressure is estimated by palpation of the pulmonary artery. Complete haemostasis obtained and appropriate mediastinal tube drains placed and operative wound closed in layers.

If the ASD is of a confluent type, the defect may be too large to suture directly. Then a patch of pericardium, knitted polyester valour or polytetra fluroethelene (PTFE) is used.

Patch Repair: Cardiac surgeons vary as to the frequency with which they use a patch to close ASD.

Pericardium is the material of choice for the interatrial patches.

- When a regurgitant jet may strike the patch, such as after repair of Atrio ventricular septum defects, prosthetic patch may produce severe hemolysis under these circumstances.
- When pericardium forms part of the wall of an intracardiac conduit, the precise contour of it is primarily determined by pressures on the two sides.
- In other situations, knitted polyester and PTFE patches are suitable alternatives. Patch repair mostly used in the sinus venosus type of ASD closure to direct the partial anomalous pulmonary venous drainage to the left atrium.

Results

Age and Sex

32% (16/50) patients were Males and 68% (34/50) patients were Females (M: F - 1: 2.1). The age distribution ranges from 7 years to 45 years. The median age was 20 years and mean age was 21.56 years. Commonest age group presentation is between 16 – 20 years (**Table – 1**).

Table - 1: Demographic details in the study.

Age Group (in years)	**Cases**	**%**
6to15	16	32%
16to25	18	36%
26to35	11	22%
36to45	5	10%
Sex		
Male	16	32%
Female	34	68%
Symptomatic distribution		
Asymptomatic	2	4%
Symptomatic	48	96%
Symptoms and history		
SOB	38	76%
Palpitation	15	30%
LRTI	43	86%
Consanguenous Marriage	14	28%
Clinical signs		
ESM in PA	50	100%
S2 Split	50	100%
Precardial bulge	38	76%
Parasternal Pulsation	35	70%
Parasternal Heave	7	14%
Sys. Thrill PA	2	4%

History

Out of 50 patients 96% (48/50) patients were symptomatic and 4% (2/50) patients were asymptomatic. Shortness of breath of varying NYHA class was the commonest symptom,

present in 76% (38/50) of patients. History of Lower respiratory tract infection was present in 86% (43/50) of patients. Most of the patients were from NYHA-Class II, i.e. 62% (31/50). History of palpitations was present in 30% (15/50) of patients. History of consanguineous marriage between parents was present in 28% (14/50) of patients.

Physical Examination

In all 50 patients general physical examination was normal. Pedal Oedema was absent in all patients. Pulse rate was between 70-80 in 44% (22/50) of patients, between 81-90 in 20% (10/50) of patients and rest, i.e. 30% (15/50) of patients had Pulse rate between 91-100, and 6% (3/50) of patients were in Atrial fibrillation. JVP was normal in all patients.

The precordial bulge was present in 76% (38/50) of patients. The left parasternal pulsation was present in 70% (35/50) of patients. Left parasternal heave was present in 14% (7/50) of patients.

The first heart sound was normal in all patients. All the patients in our study group had abnormal second heart sound. The second heart sound had wide and fixed split. Pulmonary component was loud in 16% (8/50) of patients. All the patients had ejection systolic murmur at pulmonary area.

62% (31/50) of patients were in NYHA class II at presentation. 24% (12/50) of patients were in NYHA class I. 14% (7/50) of patients were in NYHA class III (**Table – 2**).

Electrocardiogram

ECG findings were consistent with normal sinus rhythm in 94% (47/50) of patients and 6% (3/50) of patients were in atrial fibrillation with heart rate of more than 140 in all 6% (3/50) of patients. The PR interval was normal in all patients. QRS axis deviation was present in 72% (36/50) of patients and 28% (14/50) of patients had normal QRS axis. The rSR in lead V1 was present 34% (17/50) of patients Right Bundle Branch Block pattern was present in 12% (6/50) of patients. Right Atrial Enlargement was present in 90% (45/50) of patients. Right Ventricular Hypertrophy was present in 88% (44/50) of patients.

Table - 2: Investigation details in study.

NYHA class distribution		
NYHA –I	12	24%
NYHA-II	31	62%
NYHA-III	7	14%
NYHA-IV	0	0%
ECG-QRS axis chamber enlargement		
Rt. QRS Axis	36	72%
Nor. QRS	14	28%
RAE	45	90%
RVH	44	88%
RBBB	6	12%
rSR-V1	17	34%
X ray chest		
Pul. Pleth	40	80%
PA dila.	50	100%
Cardiomegaly	42	84%
Aortic Seg.	15	30%
Size of ASD		
1to2cm	26	52%
2.1to4cm	24	48%
PAH	8	16%
Peroperative size of ASD		
1 - 2cm	14	28%
2.1 - 4cm	37	74%
4.1 - 6cm	9	18%

Chest X-ray

Pulmonary plethora was present in 80% (40/50) of patients. The main pulmonary artery segment was enlarged in 100% (50/50) of patients. Cardiomegaly was present in 84% (42/50) of patients. The ascending aorta and arch of aorta segment was inconspicuous in 30% (15/50) of patients.

Echocardiogram

Presence of Atrial Septal Defect was diagnosed in all 50 patients. 96% (48/50) of patients were diagnosed as fossa ovalis ASD and in 4% (2/50) of patients were diagnosed as Sinus Venosus

Type of Atrial Septal Defect. 52% (26/50) of patients were having <2cm of size of Atrial Septal Defect and 48% (24/50) of patients were having >2cm of size of Atrial Septal Defect. In all the patients Right Atrium and Right Ventricle were dilated. Pulmonary Artery dilatation was also present in all patients. One patient had associated mitral stenosis and one patient had mitral regurgitation (Anterior mitral leaflet cleft). 16% (8/50) of patients had mild to moderate pulmonary arterial hypertension. In 2 patients Partial Anomalous Pulmonary Venus Connection was reported.

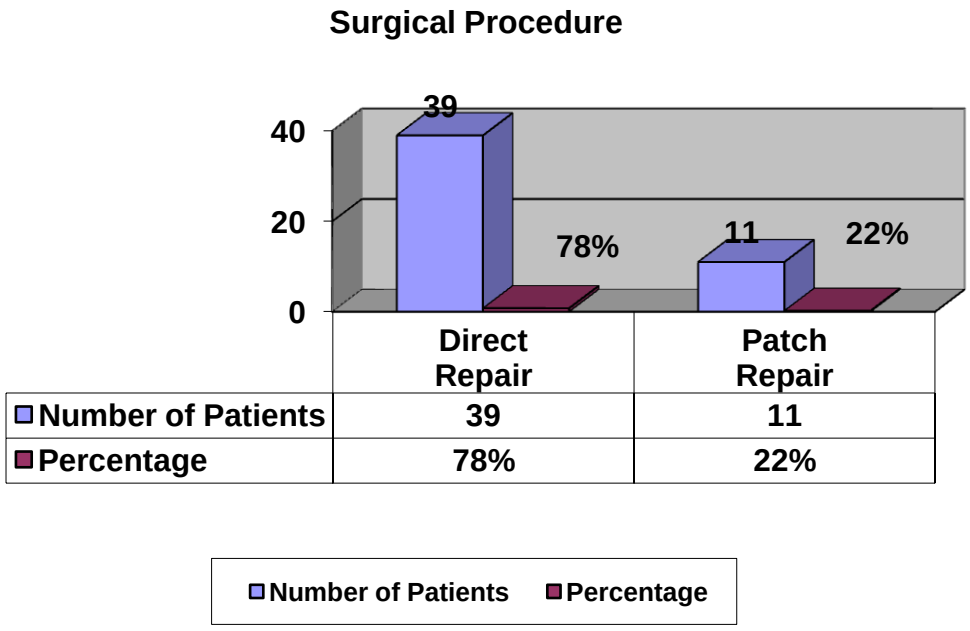
Pathological Anatomy

The Atrial Septal Defect was located mostly in Fossa ovalis area in 96% (48/50) of patients. In 4% (2/50) of patients the defect was located high in the atrial septum above the Fossa Ovalis. In 74% (37/50) of patients the size of ASD was 2-4cm. In 28% (14/50) of patients the size was <2cm and in 18% (9/50) of patients the size was >4cm. One patient had mitral stenosis. One patient had mitral regurgitation due to a cleft in Anterior mitral leaflet. In all patients the Right Atrium, Right Ventricle and Pulmonary Artery were dilated. In two patients anomalous pulmonary veins were present opening into Right Atrium at Right Atrium -Superior Venacava junction.

Surgical Procedures

Direct closure of ASD with 3 'O' polypropylene continuous sutures in two layers was done in 78% (39/50) of patients. Patch closure of ASD (SVC type) with Dacron was done with redirecting the anomalous pulmonary veins to left atrium in 4% (2/50) of patients. Patch closure of ASD was done in 18% (9/50) of patients with ASD size of >4 cm (**Figure – 1**).

Figure - 1: Surgical procedure followed in study.



Post Operative course

Most of the patients were supported by ventilation in the post operative period i.e. 96% (48/50) of patients and two patients were extubated on table. The hours of ventilatory supports were detailed in the table. In 32% (16/50) of patients, Inotropic support was instituted during intraoperative as well as in post operative period. Rest of the patients did not requir Inotropic support (**Table – 3**).

During post operative course, 24% (12/50) of patients had drainage, which was treated by 1 – 3 units of fresh blood transfusion. One patient required re-operation and that patient did not survive the 2nd operation. 26% (13/50) of patients

developed arrhythmias in the form of ventricular ectopics in 8 patients, Supra ventricular tachycardia in 1 patient, atrial fibrilation persisted in 3 patients and ventricular tachycardia/ fibrilation in 1 patient. Low – cardiac output had developed in 14% (7/50) of patients, who required Inotropic support and blood transfusion. Superficial wound infection was observed in 8% (4/50) of patients (**Table – 4**).

Table - 3: Ventilatory and Inotropic support in study.

Hours of Ventilation	**Cases**	**%**
No Vent	2	4%
1 - 6hrs	31	62%
7 - 12hrs	9	18%
13 - 18hrs	5	10%
18 - 24hrs	3	6%
Inotropic support		
Yes	16	32%
No	34	68%

Table - 4: Post operative morbidity and mortality.

Post operative morbidity		
Bleeding	12	24%
Arrythmias	13	26%
Low Cardiac Output	2	4%
Skin wound Infection	4	8%
post operative stay and mortality		
< 8	4	8%
9 - 12d	35	70%
13- 16	6	12%
17 – 21	1	2%
Mortality	1	2%

Post Operative Hospital Stay

Post Operative Hospital stay was 9 – 12 days in 70% (35/50) of patients. Minimum Hospital stay of 8 days was noted in 8% (4/50) of patients. Maximum Hospital stay of 21 days was noted in 1 patient.

Mortality

There was one death in this series. One was due to bleeding and suspected cardiac tamponade. Patient was reexplored but patient did not survive the 2nd operation. One patient expired due to ventricular tachycardia and fibrillation. One patient had MR with prolonged low cardiac output state and did not recover. One patient did not recover from anesthesia probably due to cerebral air embolism.

Discussion

Atrial Septal Defect is one of the most common congenital cardiac anomalies, present in 10 – 15% of patients with congenital heart disease. It is the most common congenital cardiac lesion in the adults. Ostium asecundum type of Atrial Septal Defects occur more frequently in females with reported Male to female ratio of 1:2. In this study the male to female ratio is 1:2.1.

Majority 96% (48/50) of our patients were symptomatic and only 4% (2/50) were asymptomatic, compared to Dhaliwal R.S., et al. [5] (Group-1) series i.e. 9% were asymptomatic and 91% were symptomatic. Shortness of breath on exertion was the most common complaint in 76% (38/50) of patients. 30% (15/50) of patients had history of palpitation. 86% (43/50) of patients gave history of repeated lower respiratory tract infections. In 28% (14/50) of patients, there was history of consanguineous marriage between parents, comparable to Dhaliwal R.S., et al. (Group-2) study i.e. 83% of patients had shortness of breath on exertion and 65% of patients had palpitation [5].

On physical examination the classical auscultatory findings of atrial septal defect were present in all cases. An ejection systolic murmur was present in all cases in pulmonary area and fixed and wide splitting of the second heart sound was present in all cases. This is comparable to the study of Muta, et al. [6] from Japan, in which 94% of patients presented with ejection systolic murmur and in 90% of patients, wide and fixed second heart sound was present.

In 76% (38/50) of patients precordial bulge was present. Parasternal pulsations were present in 70% (35/50) of patients. Parasternal heave was present in 14% (7/50) of patients. In two patients systolic thrill was present pulmonary area. One patient had mild pulmonary stenosis. In one patient apical pan systolic murmur was present which was conducted to axilla.

On examination ECG of all the 50 patients, 94% (47/50) of patients were in sinus rhythm and only 3 patients were in atrial fibrillation. It is comparable to study of Dhaliwal R.S., et al. [5] (Group-1) in which 100% of patients were in sinus rhythm. Only 3 patients were in atrial fibrillation in this study, because, most of the patients were below the age of 40 years. In 72% (36/50) of patients, the QRS axis was towards Right Axis and in 28% (14/50) of patients the axis was normal. This is comparable to study by Muta, et al. [6] in which 55% patients had right axis deviation and also comparable to the study by Zufelt K. Rosenberg, et al. [7] in which 87% of patients had right axis deviation of QRS. In 12% of patients right bundle branch block was present, but in Muta, et al. [6] reported incomplete right bundle branch block in 79% of cases. The rSR pattern in V1 was present in 34% of patients, but in study by Zufelt, et al., the isolated rSR pattern in V1 was present 87% of patients [7].

On examination of chest X-ray reports, in all the patients pulmonary artery dilatation was present. In 84% (42/50) of patients cardiomegaly was present. Pulmonary plethora was present in 80% (40/50) of patients. Inconspicuous aortic shadow was present in 30% (15/50) of patients. In Muller, et al. [8] study, majority of patients were presented with right ventricular enlargement, right atrial enlargement and increased pulmonary blood flow.

Echocardiography revealed that it was the most useful diagnostic investigation for atrial septal defects. In this study it was accurate in diagnosing all the cases of ASD. 96% (48/50) of patients were of Ostium Secondum type and 4% (2/50) of patients were of SVC type. In 52% (26/50) of patients the size of ASD reported as <2cm. In 48% (24/50) of patients the size of ASD was 2.1 to 4 cm. In all patients right atrium, right ventricle, pulmonary artery dilatation was present. One patient with associated mitral stenosis and one patient had anterior mitral leaflet cleft with mitral regurgitation. In 16% (8/50) of patients mild to moderate pulmonary arterial pressure was recorded i.e. 30-50mmHg. But Dhaliwal RS, et al. [5] (Group –1) study reported in 9% of patients. It is also comparable to a study by Cherian, et al. [9] in which pulmonary artery hypertension was present in 13% of patients under age of 10 years in south India. In UAB surgical series 14% of patients had pulmonary hypertension. In GLH series 13% of patients had pulmonary hypertension.

The pathological anatomy of ASD had received very little attention in the literature until open repair of ASD's became feasible. In this study, the ASD was located in Fossa ovalis area in 96% (48/50) of patients and in 4% (2/50) of patients, the defect was present high in the atrial septum above the Fossa ovalis with partial anomalous pulmonary veins opening into right atrium at the junction of Superior Venacava and Right Atrium. In all patients Right Atrium, Right Ventricle and pulmonary artery were dialated. In one case mitral stenosis was present. In one mitral regurgitation was present due to at cleft in anterior mitral leaflet.

In our institute, two different techniques for closure of ASD's were used.

- Direct closure with 3 'o' polypropelene, by approximating the edges of ASD in two layers by continuous suturing. Direct closure was done in 78% (39/50) of patients.
- Patch closure: Using Dacron patch, the ASD was closed with 3 'o' polypropelene continuous suture. Patch closure was done in 22% (11/50) of patients (i.e. 2 SVC type ASD + 9 OS ASD with >4cm size). Dhaliwal RS, et

al. reported direct closure in 63% of patients and patch closure in 37% of patients in his Group-1 study. A study from Mayo clinic reported 17% of patch repair. In GLH series, 30% of patch repair was reported. In UAB series only 3% of patch repair was reported. In one patient with mitral stenosis, mitral valve replacement with direct closure of ASD was done. In one patient with mitral regurgitation due to cleft anterior mitral leaflet, the repair of mitral leaflet cleft was done with ASD closure.

During post operative period, most of the patients (96%) were supported by ventilation. Only two patients were extubated on table. 62% of patients were ventilated between 1-6 hours. 18% of patients were on ventilation for 7-12 hours. 10% of patients were on ventilatory support for 13-18 hours. 6% of patients needed ventilation for prolonged periods of 18-24 hours, due to low cardiac output state. Inotropic support was required in 32% of patients.

In post operative period, 24% of patients hjad drainage that needed 1-3 units of fresh blood transfusion. In one case, bleeding with cardiac tamponade was suspected and he was re-explored but patient did not survive the second operation. In 26% of patients arrythmias were noted, mostly in the form of ventricular ectopics in 8 patients, supraventricular tachycardia in one patient who was treated medically. In one patient ventricular tachycardia with fibrillation was present. He did not respond to cardio version. In 14% of patients low cardiac output was present, treated medically with Inotropic supports. In one patient with ASD with Mitral regurgitation sustained low cardiac output state continued and did not respond to medical management and he expired. In 8% of patients superficial skin wound infection was present, treated successfully with antiseptic dressings and appropriate antibiotics. One patient did not recover from anaesthesia and the cause could not be determined. In this study 8% of patients died.

70% of the patients were discharged between 9^{th} -12^{th} post operative day. 8% of patients were discharged on 8^{th} post operative day. 12% of patients discharged between 13^{th} – 16^{th} post operative day. One patient was discharged on 21^{st} post operative day. He had prolonged low cardiac output state and skin wound infection.

Conclusion

Surgical repair of ASDs is a safe procedure which is associated with excellent results and low morbidity in younger as well as adult age groups.

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