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STUDY OF FACTORS AFFECTING OUTCOMES OF REDO CARDIAC SURGERY IN A TERTIARY CARE HOSPITAL: A RETROSPECTIVE OBSERVATIONAL STUDY

Dr. UmaKarthik K [1], Dr. Tella Ramakrishna Dev [2], Dr. Sai Surabhi.P [3], Dr. R V Kumar[5]

[1]Resident, [2,3]Associate Professor, Professor, and HOD: Department of Cardio-Thoracic Surgery: Nizam's Institute of Medical Sciences, Punjagutta, Hyderabad.

***Corresponding author**

Dr. Tella Ramakrishna Dev,
Associate Professor,
Department of Cardio-Thoracic Surgery,
Nizam's Institute of Medical Sciences,
Punjagutta, Hyderabad, Telangana.

ABSTRACT

Introduction-Redo cardiac surgery has several inherent difficulties that increase mortality and morbidity and is associated with technical challenges. There are important patient-related factors that contribute to the risk of operation. Risk also depends on the type of operation and the number of previous surgeries.

Objective-The aim of this study is to observe the factors that affect mortality and morbidity after Redo cardiac surgeries.

Materials and methods-We have retrospectively analysed 50 consecutive patients who underwent Redo cardiac surgery with median sternotomy at our hospital. Data regarding demographic variables, mode of clinical presentation, investigations, perioperative variables were obtained. All data was analysed at the end of the study with appropriate statistical methods.

Results-The average age at presentation in our study was 33.9yrs with female 27[54%] predominance. Of the cases presented for redo cardiac surgery majority belong to redo mitral valve [27] followed by redo aortic surgery [13]. Stuck valve, valve degeneration and failure of valve repair were the most common causes. Exertional dyspnoea, palpitations and chest pain were the most common symptoms. Stuck valve associated with severe left ventricular (LV) dysfunction and grade III and grade IV dyspnoea were associated with high mortality. Congenital cases have had a prolonged post operative stay. Bleeding was the most common post operative complication followed by wound infection and sepsis. Prognostic markers of mortality were severe LV dysfunction, heart failure symptoms at admission, emergency

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presentation, renal failure and associated co-morbidities. Most common cause of death was renal failure [2] followed by sepsis [1] and low cardiac output [1]

Conclusion-Redo cardiac surgery has more female predominance with dyspnoea, palpitation are most common symptoms and signs. Most common complications are bleeding, low cardiac output, sepsis, renal Failure. Prognostic markers of mortality are severe LV dysfunction, heart failure symptoms at admission, emergency presentation, and renal failure and associated co-morbidities.

Keywords: Femoral Bypass, Redo Aortic Surgery, Redo Cardiac Surgery, Redo Mitral Surgery, Redo sternotomy.

INTRODUCTION

The number of patients undergoing re-operations for various heart diseases is increasing and will continue to increase as general population ages. Redo cardiac surgery has several inherent challenges that can increase mortality and morbidity. There are several important patient-related factors that contribute to the risk of operative mortality and morbidity to redo operations [1, 2]. Older age (>70 years), female sex, diabetes mellitus, chronic obstructive pulmonary emphysema, renal failure or elevated baseline serum creatinine (>2 mg/100 dL), history of stroke, and elevated total body weight are considered as contributing factors for increased risk of mortality during redo cardiac surgery [3,4,5].

Additionally complex anatomy in a previously operated patient, repeat valvular surgery for prosthetic valve endocarditis, a low starting left ventricular ejection fraction (~20%), and urgent operation independently contribute to a higher mortality [6]. Risk of operation is related not only to the co-morbid conditions of the patient and the type of operation but also to the number of previous operations.

Over the last 50 years that open heart surgery has been performed, the improvement in re-operative cardiac surgery has been nothing short of spectacular. On May 6, 1953 the first open heart surgery operation with pump oxygenator was performed by Gibbon in Philadelphia [7]. Within the next few years, reoperations became an increasing part of the cardiac surgical practice [7]. Initially, the mortality was extremely high because of bleeding problems associated with Cardio-pulmonary bypass, but with each decade since that time, the operative morbidity and mortality have fallen. The decrease in morbidity and mortality is due to improved surgical techniques, earlier referral of patients, and improved peri-operative factors so that even patients in their eighties may undergo safe cardiac reoperations [3,4].

Rheumatic heart disease is still prevalent in developing Nations. It is a disease which predominantly affects the young in countries like India. Surgery is frequently required to provide symptomatic relief [8]. These patients may return for reoperation for many reasons such as recurrent rheumatic activity, prosthetic valve dysfunction (thrombosis, paravalvular leak, and prosthetic valve endocarditis), degeneration of homograft or tissue valves, and failed repair.

Re-operative cardiac surgery is known to be associated with a higher risk holds true for re-operative aortic surgery [3, 4.] Silva et al. reported an in-hospital mortality rate of 12.1% in

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patients undergoing re-operative ascending aortic and aortic root procedures versus 6.8% for similar primary procedures. [5, 9, 10.]

The aim of this study was to observe the factors that affect mortality and morbidity after Redo cardiac surgeries. This includes collection of demographic and clinical profiles of patients presenting for Redo cardiac surgeries, discuss various surgical strategies and to observe outcomes.

MATERIALS AND METHODS

A retrospective observational study was conducted at our hospital - Nizam's Institute of Medical Sciences, Hyderabad, from January 2016 to December 2020, with the approval of institutional ethics committee. We have retrospectively observed 50 patients who underwent Redo cardiac surgery at our hospital- who had fulfilled the inclusion and exclusion criteria. Our inclusion criteria included both elective and emergency redo cardiac surgeries. Exclusion criteria included patients with bleeding diathesis, acute cerebrovascular accident (CVA) and patients who underwent redo cardiac surgery via approaches other than median sternotomy. The information was obtained from Case records and Discharge records and telephonic calls. Demographic data like age, sex, occupation and domicile were obtained. Clinical data like symptom of presentation, type of previous surgery done, existing co-morbidities, clinical signs and diagnosis were obtained. Investigative work up in all patients included Hemogram, Urine examination, Blood cultures, Chest X ray, Electro Cardiogram and Echo Cardiography Other investigations were done as and when required.

In our study every patient was evaluated by 2D Echo [Trans thoracic Echocardiography (TTE) and Trans oesophageal echocardiography (TEE)], plain Computerized tomography (CT) chest for adhesions between the sternum and mediastinal structures. Coronary Angiogram was performed for patient aged more than 35 years [institute protocol] and with ischemic symptoms and with risk factors for coronary artery disease. CT aortogram was performed for elective aortic valve cases in view of altered aortic root anatomy, coronaries and adhesions. In our study every patient was approached through Redo Median Sternotomy using oscillating saw. Right or left sided femoral vessels were also painted and draped. For cases with adhesions to cardiac structures, femoral vessels were exposed before sternotomy and made available to go on emergency bypass. Axillary cannulation and bypass approach was made for cases where aortic valve pathology is present with chance of root replacement in selected cases. Cardio pulmonary bypass was instituted in all patients and definitive procedure was carried out under cardioplegic arrest. Data was also obtained regarding type of redo cardiac surgery, intraoperative findings, postoperative outcomes.

STATISTICAL ANALYSIS

All the data was collected, tabulated and analysed in excel spread sheet. Continuous data were represented as mean, categorical data as frequency and percentage.

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RESULTS

In present study it was observed that majority of patients who underwent redo cardiac surgery belonged to age group of 41-50 years accounting to 14 cases (28%), followed by age group of 31-40 years accounting to 12 cases (24%). Least number of cases were observed in above 60 years age group accounting to 1 case (2%). (Table 1)

Age (Years)	No. of cases	Percentage
0-10 Years	4	8%
11-20 Years	6	12%
21-30 Years	9	18%
31-40 Years	12	24%
41-50 Years	14	28%
51-60 Years	4	8%
Above 60 Years	1	2%

Table 1: Age distribution of cases

In current study, female predominance was observed accounting to 27 cases (54%) and males accounting to 23 cases (46%). (Table 2)

Gender	No. of cases	Percentage
Female	27	54%
Male	23	46%

Table 2: Gender distribution of cases

In present study, commonest presenting symptoms were Dyspnoea, Chest pain and palpitations accounting to more than 50% of cases. Deepening cyanosis was observed in 6 patients (12%). Fever was the presenting symptom in 4 patients (8%). Oliguria was the presenting symptom in 2 patients (4%). (Table 3)

Presenting symptom	No. of cases	Percentage
Dyspnoea + Chest Pain	26	52%
Dyspnoea + Palpitations	12	24%
Deepening cyanosis	6	12%
Fever	4	8%
Oliguria	2	4%

Table 3: Symptom on Presentation

In present study, it was observed that majority of patients had previous mitral valve replacement surgery (n=20) followed by Aortic valve replacement (AVR) (n=9). (Table 4)

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Type of Previous Surgery	No. of cases	Percentage
Mitral valve replacement	20	40%
Mitral valve repair	5	10%
Closed mitral valvotomy and Open mitral valvotomy	3	6%
AVR	9	18%
Coronary artery bypass grafting	2	4%
Bidirectional Glenn Shunt	6	12%
Aortic Pseudoaneurysm repair	1	2%
Atrial septal defect closure	1	2%
Ruptured sinus of Valsalva aneurysm repair	1	2%
Aortic root replacement	1	2%
Ventricular septal defect	1	2%

Table 4: Type of previous surgery

In this study, major co-morbid conditions observed in the patients were Hypertension and diabetes. (Table 5)

Comorbidities	No. of cases	Percentage
None	9	18%
Diabetes	9	18%
Hypertension	20	40%
Both Diabetes and hypertension	6	12%
Chronic kidney disease	2	4%
Stoppage of anticoagulant	4	8%

Table 5: Co-morbidities

In current study, majority of patients were diagnosed with stuck mitral valve (n=13) followed by stuck aortic valve (n=10). (Table 6)

Diagnosis	No. of cases	Percentage
Stuck mitral valve	13	26%
Severe mitral regurgitation S/P repair	4	8%
Degenerated bioprosthetic valve	4	8%
Stuck aortic valve	10	20%
Severe AR s/p RSOV Repair	1	2%
Prosthetic valve endocarditis	1	2%
s/p CABG	2	4%
Paravalvular leak	1	2%
Congenital	6	12%

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Pseudoaneurysm	1	2%
RVOT obstruction	1	2%
s/p CMV	2	4%
s/p OMV	1	2%
AVR s/p MVR	1	2%
MVR s/p ASD closure	1	2%
Post aortic root replacement	1	2%

Table 6: Diagnosis at presentation

Echocardiographic data is summarised in table 7.

Echo Findings	**No. of cases**
Elevated Mitral valve gradients	25
Elevated Aortic valve gradients	11
Vegetations	1
BDG shunt	6
Restricted mobility of prosthetic valve	20
Paravalvular leak	1
Hypoplastic Right ventricle	3
Degenerated valve	4
Tricuspid regurgitation	6
Severe Mitral regurgitation	7
Severe Aortic regurgitation	4

Table 7: Echo Data

Echocardiographic assessment of left ventricular (LV) Function by documentation of ejection fraction (EF) using modified Simpson's method is summarised in Table 8.

LV Function	**No. of cases**	**Percentage**
Severe LV Dysfunction (EF - ≤ 30%)	10	20%
Moderate LV Dysfunction (EF – 30 to 40%)	12	24%
Good LV Dysfunction (EF – ≥ 60%)	28	56%

Table 8: Echo assessment of LV Function

Majority of patients underwent Redo mitral valve replacement (n=28) followed by Redo aortic valve replacement (n=11). Six patients underwent completion Fontan procedure. (n=6) (Table 9)

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Type of Redo Cardiac surgery done	No. of cases
Redo MVR	19
Redo AVR	11
Redo CABG	2
MVR s/p MV repair	4
MVR s/p Bioprosthetic valve degeneration	4
AVR s/p RSOV repair	1
Aortic pseudoaneurysm repair	1
Completion Fontan	6
Aortic root replacement	1
Relief of Right ventricular outflow tract obstruction	1

Table 9: Type of Redo surgery done

In present study we observed 46 patients have survived the Redo cardiac surgery whereas mortality was observed in four cases. We report a mortality of four cases (8%). Two patients underwent emergency salvage Redo mitral valve replacement for stuck mitral valve. One patient underwent Redo aortic valve replacement for stuck aortic valve. One patient underwent aortic valve replacement for severe aortic regurgitation post sinus of Valsalva repair. All four patients underwent emergency salvage procedures. They presented with cardiogenic shock to the department. Their post operative course was complicated by severe low cardiac output leading to multiorgan dysfunction and sepsis.

Surgical Outcome observed		No. of cases
Survived		46
Death	Sepsis and bleeding	1
	Renal failure	2
	Low cardiac output syndrome	1

Table 10: Surgical outcome - Mortality

In our study, 31 patients had uneventful post operative course. Bleeding was the commonest complication observed followed by patients needing prolonged ventilation and wound infection. (Table 11)

Post – Op Complication	No. of cases
Bleeding – Need for surgical reexploration	8
Sepsis	4
Prolonged ventilation	6
Tracheostomy	2
Wound infection	5

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Low cardiac output syndrome	4
Right femoral artery injury repair	2
Fever	4
Renal failure needing Dialysis	4

Table 11: Post – Operative course

In present study, it was observed that 31 patients were discharged with a week.

Duration of Hospital stay – Discharge	**No. of cases**
0-7 days	31
7-14 days	12
14-21 days	5
Above 21 days	2

Table 12: Duration of Hospital stay

DISCUSSION

Redo cardiac surgery has several inherent challenges which can increase mortality and morbidity to the patient with several technical aspects of redo cardiac surgical procedures [1]. There are several important patient-related factors that contribute to the risk of operative mortality and morbidity to redo operations. The presentation and severity of the complaints and clinical features significantly contribute to the overall mortality and morbidity in Redo cardiac surgery patients. Associated comorbidities play an important role in predicting perioperative outcomes [2,3] Additionally complex anatomy in a previously operated patient, repeat valvular surgery for prosthetic valve endocarditis, a low left ventricular ejection fraction (~20%), emergency and urgent operation independently contribute to a higher mortality [2].

In our study of 50 patients, a cohort of n= 27 patients belong to Redo mitral valve cases of various underlying pathologies. Of the n=27 cohort who underwent redo mitral valve replacement, 5 patients belong to male sex and 22 patients from female sex with female predominance. A.Vohra et al[11] from Wessex cardiothoracic sciences south Hampton, UK[11] in their study of Outcome after redo mitral valve replacement in adult patients, they reported total 49 redo mitral cases with 24 male patients and 25 female patients. In our cohort of n = 27, 16 patients presented with Stuck Mitral valve. Stuck valve was the commonest presentation of Redo mitral in our study. In our study, out of 27 cases who underwent Redo mitral valve replacement, 3 were emergencies, 10 were urgent surgeries and 14 were elective surgeries. In Vohra et al study [11], they reported 20 electives, 20 urgent surgeries and 9 emergencies. In Redo mitral valve replacement group (n=27), all the 27 patients presented with exertional dyspnoea, out of which grade III and IV dyspnoea in 13 patients and grade II dyspnoea in 11 patients. Palpitations were present in 20 patients. Chest pain in 10 patients and fever history was present in 3 patients. In our cohort of Redo mitral valve replacement

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(n= 27), 4 patients had previous MVR with bio prosthetic valves presented for Redo MVR with one male and 3 female patients, meantime 5.6 years. They presented as 2patients with severe mitral regurgitation and 2patients with elevated mitral valve gradients. In Vohra et al study n= 49[11], 8 cases presented with history of bioprosthetic degenerated mitral valve. In our cohort of Redo mitral n= 27 cases, 1 case presented with severe paravalvular leak with prosthetic valve dehiscence, 1 case presented as prosthetic valve endocarditis. In our cohort of Redo mitral valve replacement (n = 27), previous surgical approach was median sternotomy in 25 cases and thoracotomy in 2 cases. During redo surgery median Redo sternotomy was used in all 27 cases. In our Redo mitral cohort of n=27 cases, 2D Echo findings were with increased mitral gradients in all 27 cases. Severe LV dysfunction in 5 cases and moderate LV dysfunction in 5 cases and good LV function in 17 cases. 2D echo finding of restricted mobility was present in 19 patients. In our Redo mitral cohort of n= 27 MVR was done with mechanical valve of SJM [Saint Jude Mechanical and rotatable Valve] ranging between [25 to 29] size. Cardio-pulmonary bypass (CPB) access was taken using direct ascending aortic cannulation in 12 cases. Right femoral access in 14 cases and left femoral access in one case. In n=27 mitral cohort cases, replacement combined with tricuspid valve repair was done in 5 cases. Replacement along with Left atrium clot extraction in 3 cases.

In our study of 50 cases, 13 patients underwent Redo aortic valve surgery as a separate cohort(n=13). Of the 13-redo aortic valve cohort, 9(69.23%) were men and 4(30.76%) were women with male predominance which is in comparison with Sergey Leontyev et al from university of Leipzig Germany whose study has 119(61%) male patients out of n=155 cases [12] and 36 female patients. In our study of the redo aortic cohort of n=13 cases, 10 cases were of Stuck aortic valve which was the commonest presentation, one case was severe aortic regurgitation (AR) occurring after sinus of valsalva repair, 1 case was of chronic rheumatic heart disease (CRHD) severe aortic regurgitation post mitral valve replacement and one case of severe AR Takayasu arteritis post aortic root replacement. In Leontyev et al [12] study, they reported 6 stuck aortic valve cases, 64 cases of prosthetic valve endocarditis, 37 cases of bio prosthetic valve degeneration, 28cases of paravalvular leak and 15 ascending aorta aneurysms. In our study of the redo aortic cohort of n= 13 Cases, 4 were emergencies, 5 were urgent surgeries and 4 were elective surgeries. Most common symptom was exertional dyspnoea grade III followed by chest pain. The other presenting symptoms in this group were palpitations and oedema. Fever history was present in 4 patients. In Leontyev et al [12] study, they reported previous 86 Aortic valve replacement cases and 69 previous aortic root replacement cases. In our redo aortic cohort of n=13 cases, Restricted leaflet mobility was present in 10 cases. In Leontyev et al study [12] they reported 100 cases with good LV function, 38 cases with Moderate LV Dysfunction and 17 cases with severe LV Dysfunction. In our redo aortic cohort of n=13 cases, 2D Echo showing Good LV function in 7 [53.84%] cases, moderate LV dysfunction in 4 [30.76%] cases and severe LV dysfunction in 2 [15.38%] cases. Previous surgical approach for all the cases in redo aortic cohort was median sternotomy approach. In our redo aortic cohort of n=13 cases, present treatment approach for all the 13 cases were by redo median sternotomy. Out of 13 cases in this cohort AVR was done in 11 cases with SJM (St. JUDE MEDICAL) Mechanical rotatable valve of size varying

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[17 to 21mm size] and aortic root replacement in 1 case. Thrombus over the mechanical aortic valve was extracted in one case. In our redo aortic cohort of n=13 cases, CBP access was most commonly done with Right Femoral artery access in 9(69.23%) cases, direct ascending aorta access in 3(23.07%) cases and Right Axillary access in1 (7.69%) cases.
Mean pump time in redo aortic cases was 195 min and mean clamp time was79.5 min. In Leontyev et al study their mean pump time is 223 min and mean clamp time 86 min [12].
In our Redo cohort of n= 13 cases, most common postoperative complication was low cardiac output syndrome in 3cases, bleeding of more than 600ml with reexploration was done for 1 case, one patient developed postoperative sepsis with positive blood cultures, postoperative wound infection in one case, two patients developed postoperative complete heart block needing permanent pacemaker implantation, two patients had postoperative renal failure with Haemodialysis support. In Leontyev et al [12] n=155 most common complications were arrhythmias in 63 patients, low cardiac output syndrome in 14 patients, Re- exploration for bleeding in 15 cases, Stroke in 9 cases, Renal failure in 11 cases. In our Redo aortic cohort of n= 13 cases mean postoperative stay was 5.9 days. 7 patients were discharged in 1st week, 4 patients were discharged in 2nd week. In our Redo aortic cohort of n=11cases, mortality was reported in 2 cases (15.38%) which was consistent with mortality associated with redo aortic valve surgery of 2.3 % to 17.6% in literature [15, 16]. In our reported cases of mortality, one case was redoAVR in previously operated case of RSOV repair who presented for urgent surgery with severe AR with associated co morbidities. Cause of death was low cardiac output syndrome. The second reported case of mortality was RedoAVR case that has previous DVR history presented with stuck aortic valve with associated renal failure and jaundice which presented as emergency. Cause of death was renal failure. In Leontyev et al study [12], the reported hospital mortality was 5.8%.

In our study 6 cases belonged to congenital category where a previous shunt was performed in the form of Bidirectional Glenn shunt. In this cohort of 6 cases, there were 3 male and 3 female patients of age distribution ranging from 5 years to 14 years. Diagnoses of the 6 cases were tricuspid atresia in 4cases, patent ductus arteriosus (PDA) with severe pulmonary stenosis (PS) in one case and double outlet right ventricle with severe PS in the other case. They were operated with bidirectional Glenn (BDG) shunt in all 6 cases and in one case concomitant PDA was closed through median sternotomy. The present indications for surgery in all cases were increase in the frequency of symptoms in form of deepening cyanosis in all 6 patients and exertional dyspnoea and effort intolerance. They were all evaluated by 2 D Echo, CT chest for adhesions and blood investigations. 2D Echo findings were a patent BDG shunt in all 6 cases, Good LV function in 5 cases and severe LV dysfunction in one case. All 6 cases were offered Completion Fontan surgery through median sternotomy. CPB access for 5 cases was through Right Femoral Bypass and for one case was through direct ascending aortic access. Sternal closure was delayed in all them in view of bleeding. In our study, Bleeding was tackled by packing the mediastinum and elective delayed primary closure after correcting coagulation defects overnight. This was also useful to deal with right ventricular dysfunction and cardiac oedema. This minimizes reexplorations, transfusion of blood and blood products and no increase in mediastinal infections was noted. Median length of post

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operative intubation time in our study is 24 to 48 hrs (8hrs in Bezuska et al 30 yr experience of Fontan surgery study [13]) where in one case led to tracheostomy with prolonged intubation for 7 days, median ICU stay was 72-90hrsin our study (90 to 120 hrs in Bezuska et al[13] study) and median time for chest drains in our study was 7 days (18 days in Bezuska et al[13] study).Complications in form of bleeding was present in 1 case, prolonged intubation leading to tracheostomy was present in 1 case which was decanulated after 28 days. In our study of congenital cohort of 6 cases, there was no reported early and late post operative mortality. Bezuska et al [13] study reported 16% overall early and late post operative mortality rate. In our study of congenital cohort of 6 cases, 5 patients were discharged in 2nd week and one patient in 4th week of post operative period. Mean hospital stay in our congenital cohort was 14.5 days postoperatively.

In our entire study of 50 cases there were 4 cases which were not part of redo mitral, redo aortic and congenital cohorts. One case of Redo pseudo aneurysm of aorta was present for which redo pseudo aneurysmal repair was done by median sternotomy and left femoro femoral bypass access was used. One case of coronary artery bypass grafting (CABG) presented with CRHD Severe MR with graft occlusion was present for which MVR along with Redo CABG was done who was discharged on 6th post operative day. In Salmon et al study [14] of reoperative coronary surgery comparative analysis of 6591 patients, they reported 371 cases of redo CABG along with CRHD, MVR cases with 5% mortality. One case of aneurysm of left ventricle was present after CABG for which Aneurysm Repair was done with ascending aortic CPB access. In Salmon et al series [14] they reported 75 cases of aneurysm of left ventricle for redo CABG with peri operative mortality of 30%. One case presented with right ventricular outflow tract (RVOT) obstruction after ventricular septal defect repair, for which RVOT muscle bundle resection was done with Left femoral bypass access that was discharged on 7th post operative day.

Out of the 50 cases, 4 cases were associated with mortality of which 2 cases were emergency stuck mitral valves with co morbidities and severe LV dysfunction, the cause of death was sepsis and low cardiac output syndrome and renal failure.1 case of AVR with previous history of RSOV repair presented with severe AR severe LV dysfunction reported death with urgent surgery and cause of death in low cardiac syndrome.One case of stuck aortic valve with previous history of DVR presented for emergency with co morbidities of right heart failure due to low cardiac output syndrome.

LIMITATIONS OF THE STUDY

This is a retrospective single centre with small sample size n=50. This study doesn't provide information on functional outcomes and quality of life.

CONCLUSION

Redo cardiac surgery is becoming a more frequent procedure than what was previously due to the advances in investigations and technique. The most common indications still remain redo procedures for valve pathologies. Peripheral institution of the cardiopulmonary bypass makes

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the mid line approach via sternotomy safe. Emergency procedures, compounded renal failure and pre operative severe left ventricular dysfunction with class III/IV dyspnoea were reliable predictors of mortality and morbidity.

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