Reoperative valve surgery:

A retrospective analysis of last ten years

DISSERTATION SUBMITTED BY **Dr. VINAY.M.RAO** IN PARTIAL FULFILLMENT OF **M.Ch DEGREE (CARDIOTHORACIC SURGERY)** EXAMINATION OF **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY,** CHENNAI TO BE HELD IN **AUGUST 2010**

CERTIFICATE

This is to certify that the thesis entitled **"Reoperative valve surgery: A retrospective analysis of last ten years."** is the bonafide work done by **Dr. Vinay. M.Rao** in partial fulfillment of the rules and regulations for **M.Ch Degree (Cardiothoracic Surgery)** examination of **The Tamilnadu Dr. M.G.R. Medical University**, Chennai to be held in **August 2010**. His work was carried out under the supervision of **Prof. ROY.THANKACHAN** in the department of Cardiothoracic Surgery.

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Dr. Vinay M Rao

Contents:

INTRODUCTION

Extensive advances have been made in cardiac valve surgery since the first artificial valve replacements of the early 1950s. Improved survival after the first operation has meant that more patients ultimately require a redo operation at the same site and the number of patients will continue to increase as the general population ages. This trend reflects many factors, such as the increased life expectancy of the population, the decreased overall mortality associated with valvular surgery, and the increasing use of bioprostheses which have limited durability because of structural dysfunction. Hence re-operations are an integral part of the cardiac surgeon's current daily practice. Among heart valves case load, re-operations on prostheses represent between 2.5% and 17% (3).

Patients requiring heart valve reoperation are diverse in terms of both the initial operation and the reoperation and form a very heterogeneous group presenting with a variety of clinical conditions including, structural dysfunction of prosthetic valve, mechanical valve thrombosis, paravalvular leaks, progression of native valve disease after nonvalve surgery and prosthetic valve endocarditis. Reoperations in this group of patients are technically more demanding than primary operations because of adhesions around the heart with an associated risk of re-entry, the presence of more advanced cardiac pathology, and the existence of more frequent co morbidities such as pulmonary hypertension. Perhaps most important, reoperations often are performed in functionally compromised patients who tolerate complications poorly or who have little reserve.

Division of the sternum is primarily a blind procedure and carries an increased risk of injury for major cardiac structures in the presence of adhesions between the posterior table and the innominate vein, right ventricle, and extracardiac conduits and grafts. The risk of catastrophic hemorrhage on sternal reentry is estimated to be 0.5% to

1% with an associated mortality rate of 21% (21).Resternotomy carries a high risk of cardiac injury and subsequent catastrophic hemorrhage.

More advanced cardiac pathology is associated with increased operative and postoperative morbidity and mortality. Re-operations are identified as risks factors for blood transfusion requirements, major sternal wound infections and mediastinitis(15).

As a consequence of the above mentioned factors, reoperative valve surgery historically has been associated with a considerably higher operative mortality than primary valve surgery. The operative mortality associated with reoperative heart valve surgery exceeds the rates than that for the corresponding primary operation. However, the risk is higher in certain conditions, such as the presence of prosthetic valve endocarditis and the patient being operated on an emergency basis in NYHA functional class IV. It may also be increased in the elderly. Reoperations carry a higher risk in most surgeons' experience.

However, in spite of all these factors, it has been observed that successful replacement of the degenerate cardiac valve usually results in gratifying symptomatic and hemodynamic improvement even in this group of functionally compromised group of patients.

In this modern era, with use of alternative surgical approaches and advanced perioperative care, there has been significant improvement in outcomes. Greater awareness of the most dangerous steps and refinements to surgical technique has contributed to the decreased mortality. Reductions in operative risk and postoperative morbidity after reoperative valve surgery has been achieved through advances in myocardial protection, as well as alternative perfusion strategies such as the proper use of

deep hypothermic cardiac arrest. In addition, use of peripheral cannulation techniques to institute cardiopulmonary bypass has become a relatively standard practice in reoperative cases. Early institution of cardiopulmonary bypass prior to reentry is known to prevent injury to the distended right ventricle during reoperative sternotomy. In addition, this technique reduces myocardial oxygen consumption by decreasing myocardial distension.

Recent studies have excluded reoperation as a risk factor for operative mortality; instead patient characteristics and co morbidities have been identified as determinants of operative mortality. We have sought to (1) identify the factors that determine major adverse postoperative events (major operative morbidity or mortality) after reoperative heart valve replacement, and (2) assess the impact of symptom severity on the outcome of cardiac reoperations.

AIMS AND OBJECTIVES

1. To **retrospectively** evaluate our experience in patients who underwent re-operative valve surgery in our institution between January 2000 and December 2009(a period of **ten years**).

2. **To study their manner of presentation, the reasons leading to reoperation, the type of surgery performed and operative techniques.**

3. **To identify the risk factors for early mortality and morbidity associated with these operations.**

4. **To study the incidence of late morbidity and functional class at last follow-up**.

MATERIAL AND METHODS

STUDY DESIGN AND INCLUSION CRITERIA:

This is a retrospective study of patients who underwent re-operative valve surgery between January 2000 and December 2009 in the Department of cardiothoracic surgery. In this period, a total of 43 underwent a first reoperation for a new valve problem of the native/prosthetic valve. There were 5 operative (30 days) mortalities (11.62%). A retrospective review of the hospital inpatient and outpatient charts of the rest of the 38 patients for their age, sex, presenting symptoms, preoperative NYHA class, preoperative risk factors, echocardiogram reports and operative details including surgical approach, total aortic cross clamp time, total cardio-pulmonary bypass time, post operative need for inotropes and ventilation, number of days of ICU care, post operative complications and post operative follow up was performed.(See appendix for proforma of data collection). Six patients were lost in the follow-up.

Patients who had undergone a previous open heart surgery for varied etiologies were included in the study. Coronary angiogram was done in all patients older than 40 years.

The preoperative characteristics are summarized in **Table No: 1**

The mean age was 42.9 years with a range of 12 years to 69 years. 46.5 % of the patients were below the age of 40 years and 53.5 % in the study group were above 40 years. There were 27 males and 16 females. The average interval to reoperation was 12.3 years with a range of 1 year to 29 years.

The 43 patients formed a heterogeneous group of patients who had undergone previous surgeries for a variety of etiologies and also a variety of surgeries. An overwhelming majority of patients (29 patients, 67 %) had a rheumatic etiology and 9

patients (20.9 %) had a congenital heart disease as the etiology for the first operation. A few among these had developed Rheumatic heart disease or Infective endocarditis subsequently necessitating reoperation. The rest 5 patients (11.62 %) had miscellaneous etiologies like bicuspid aortic valve, degenerative aortic valve disease, Barlow's disease. The break-up of the first operations that these patients had undergone were as follows:

Valvotomy/valve repair: 5
MVR: 12
AVR: 16
DVR: 2
ICR: 9

(Table 1) PREOPERATIVE CLINICAL DATA (n=43)

Sl No:	Variable	No (%)
1	Age < 40 years > 40 years	42.97 ± 14.53(Range 12-69 years) 20(46.5%) 23 (53.5%)
2	Gender Male Female	 27 (62.89%) 16 (37.21%)
3	NYHA class Class I Class II Class III Class IV	 0 17(39.54%) 19 (44.18%) 7(16.27%)
4	Cardiac pathology RHD Congenital heart disease Others	 29(67%) 9 (20.9%) 5 (11.62%)
5	Penicillin prophylaxis	10 (31.25%)
6	Interval to reoperation	12.3 ± 7.08(Range 1-29)
7	Presence of CCF	9 (20.93%)
`	Rhythm Sinus Atrial fibrillation	 19(44.18%) 24(55.81%)
9	LVEF >55% 35-55% < 35%	 19(44.18%) 19(44.18%) 5(11.62%)
10	History of neurological deficit	3(6.97%)
11	Presence of renal impairment	6(13.95%)
12	History of neurological deficit	3(6.97%)
13	First operation Valvotomy/valve repair MVR AVR DVR ICR	 5 12 16 2 9

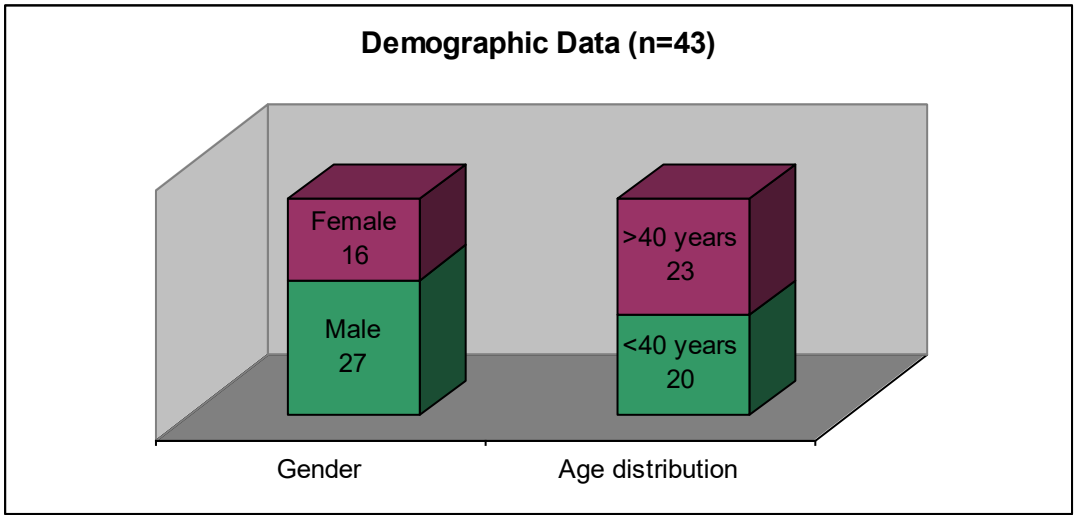

Fig 1: Demographic Data

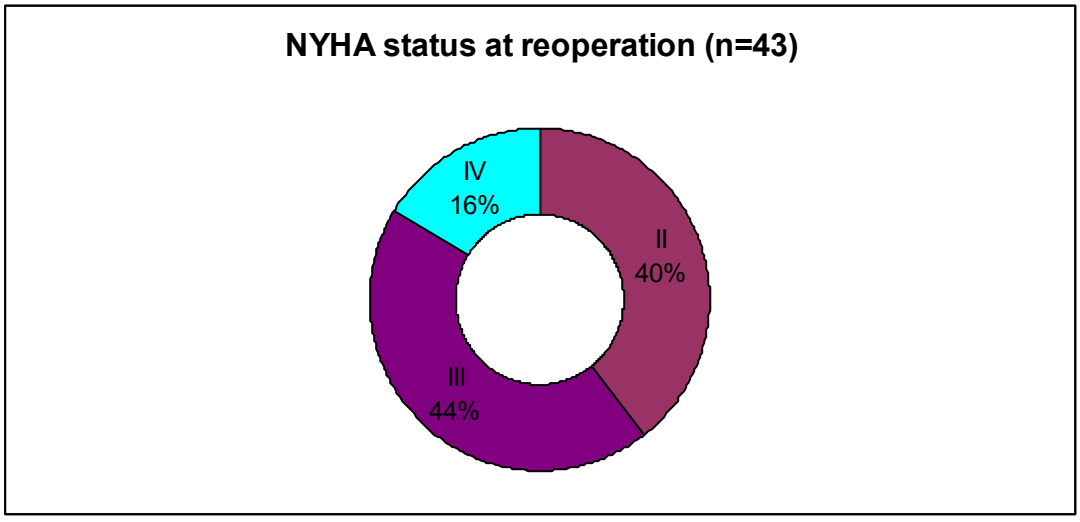

Fig 2: NYHA status of patients at admission

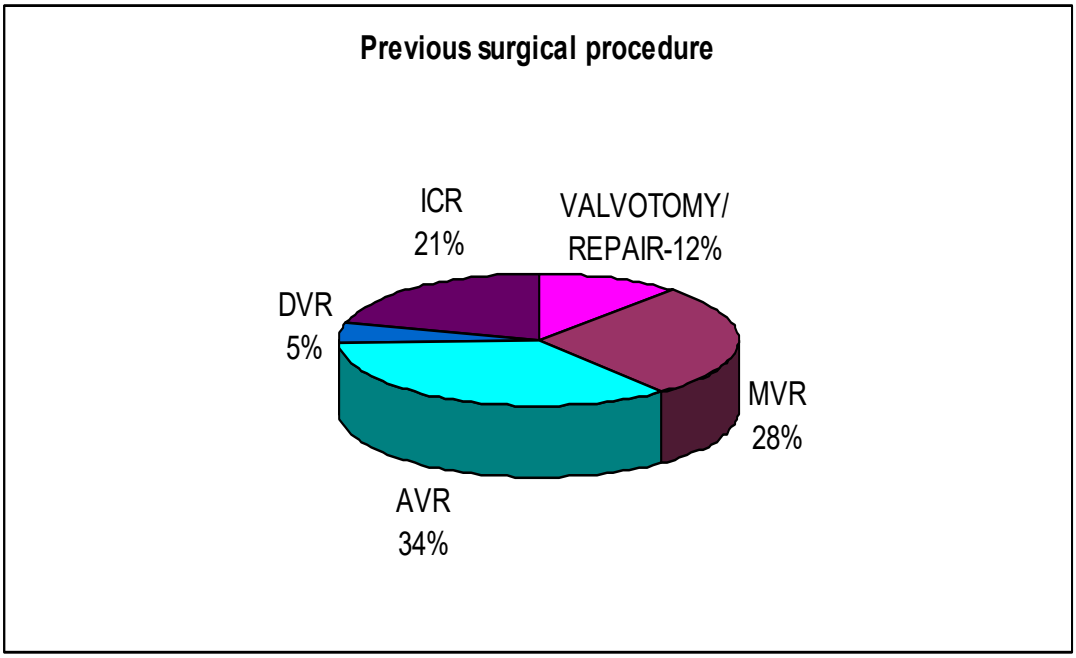

Fig 3: Break-up of first surgical procedure

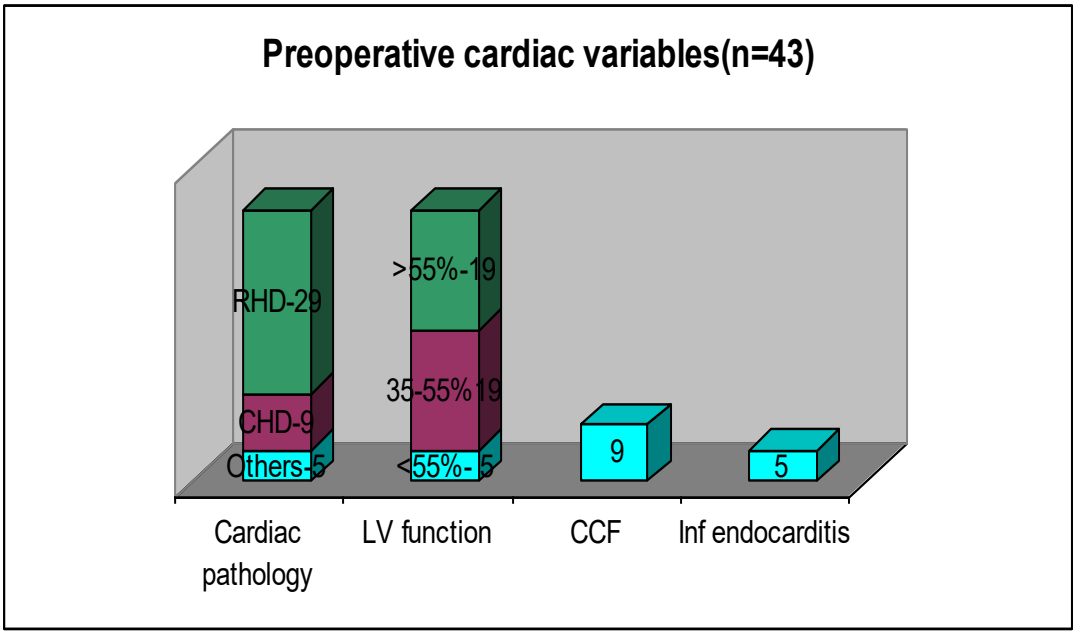

Fig 4: Preoperative cardiac variables

PREOPERATIVE MANAGEMENT:

In the preoperative period, 17 patients (39.54 %) were in NYHA class II, 19 patients (44.18 %) were in NYHA class III and 7 patients (16.27 %) were in NYHA class IV. 9 patients (20.93%) were in congestive cardiac failure. All patients were on optimal medical management with digoxin and frusemide (injectable in patients who were in CCF). 3 (6.9%) patients needed inotropes due to low cardiac output, during the preoperative period, one patient with native valve endocarditis, one with late prosthetic valve endocarditis and the third with non-structural dysfunction. 2 patients required mechanical ventilation in the immediate preoperative period. 6 patients (14%) had renal impairment before surgery. Of the 43 patients, 35 patients (81 %) underwent reoperation on an elective basis and the rest 8 patients (19 %) underwent reoperation on an emergency basis.

A 5-group classification of indication for reoperation was used, based on an original 4-group classification by Lytle and associates (10):

1. Failed repair/new native valve disease: All patients who had a failed previous valve repair and patients who at reoperation required repair or replacement of a valve different from that operated on during the initial procedure.

2. Prosthetic valve dysfunction: Valve dysfunction resulting from tissue ingrowths, mechanical dysfunction and calcification, and leaflet tears for bioprostheses. This group excludes patients with active prosthetic valve endocarditis and thrombosed mechanical valves.

3. Periprosthetic leak: Periprosthetic leak and a normally functioning prosthesis. Patients with active endocarditis were excluded.

4. Valve thrombosis: Thrombosis of the mechanical valve to the extent that the thrombosis interfered with valve opening characteristics. This group does not include patients who had embolic phenomena only.

5. Prosthetic valve endocarditis: Patients with organisms or inflammation documented on the valve specimen, or patients who underwent operation while receiving prolonged antibiotic treatment for clinical endocarditis. Patients with a history of endocarditis who underwent surgery for valve dysfunction that was remote from prolonged antibiotic treatment and whose valves showed neither organisms nor active inflammation were considered to have "healed endocarditis" and were placed in other groups.

PERIOPERATIVE MANAGEMENT

Antibiotic protocol followed in all patients included**-**

Inj. Cefuroxime 25 mg/ kg per dose (2^{nd} generation cephalosporin) up to a maximum of 750 mg/kg/ dose and Inj. Gentamicin 1mg/kg/dose (aminoglycoside).These were given with premedication and at induction. It was followed with three daily doses of Inj. Cefuroxime 25 mg/ kg per dose (up to a maximum of 750 mg/kg/ dose) for 2 days and changed to oral form of the same for another 3 days. Inj. Gentamicin 3 mg/ kg once daily was continued for 5 days.

INTRAOPERATIVE MANAGEMENT

Anesthetic management

Patients were kept nil per mouth for a minimum of six hours for solids and 2 hrs for clear fluids prior to surgery. Fentanyl and Sevoflurane were used during induction and non- depolarizing muscle relaxant (Vecuronium/Atracurium) was used for neuromuscular

blockade. Anaesthesia was maintained with O2, air, and inhalation anaesthetics. Fentanyl (5-10 microgram/kg) and Morphine (0.5mg/kg) were given before going on pump in order to maintain sedation and analgesia.

Cardiopulmonary bypass (CPB)

Polystan, Affinity, Capiox oxygenators were used in our patients. The prime volume in the oxygenator was 1200ml (700ML-Ringer lactate solution and 500ml-Haesteril).Standard femoral arterial and venous cannulae (Chase RMU FEM 11016A (Edwards Lifesciences) for femoral artery and Medtronic DLP cannulae (Medtronic Inc, Minneapolis, MN for femoral vein) were used for all patients based on body weight. Pump flow was maintained between 125-150ml/kg/mt, and blood gases were adjusted according to the pH stat strategy. During initiation of CPB mannitol (0.5 g/kg) and sodium bicarbonate (1ml/kg) were given. After initiation of CPB, moderate hypothermia (28-32 deg C) was induced and aorta was cross clamped. Heart was arrested by giving cold blood cardioplegia (St. Thomas I cardioplegia solution with procaine) through the aortic root/ostia as situation demanded. Ice slush was used for myocardial protection after cardiac arrest. The left side venting in aortic valve replacement s were accomplished by a left atrial vent inserted through the RSPV. The same dose of mannitol and sodium bicarbonate were given during rewarming. When rectal temperatures reached 36deg C, the patients were weaned off bypass.

SURGICAL TECHNIQUE

All patients were operated on in the surgical unit, by the same senior surgeon. Our unit protocol is institution of femoro-femoral bypass followed by sternal re-entry for all re-operative surgery. Through a right femoral incision, the right femoral artery and vein

was exposed, taped and prepared for cannulation. Simultaneously the skin incision on the chest was made on the previous sternotomy incision and excising the scar tissue as well. The sternal wires were untwisted and removed. The incision line on the sternum was marked by electrocautery. Heparin was administrated at a dosage of 3.0 mg/kg. The activated clotting time was kept more than 480 seconds. First, the venous cannula was inserted. We use Medtronic DLP cannulae (Medtronic Inc, Minneapolis, MN) routinely. First, we advanced guidewire through the femoral vein into the right atrium. Then transverse venotomy was performed, and the cannula and its obturator were slipped over the guidewire without any difficulty into the right atrium and superior vena cava. The guidewire and cannula obturator were removed, and the venous cannula was connected to the venous line of the pump. The prepared femoral artery was carefully palpated to recognize any atherosclerotic changes. The softest part of the femoral artery was chosen, and the guidewire was advanced into the femoral artery through a needle. When the guidewire was advanced into the arterial system without difficulty, then arterial clamps were placed and transverse arteriotomy was performed. We use Chase RMU FEM 11016A (Edwards Lifesciences) for arterial cannulation. Both the arterial cannula and its obturator were advanced into the femoral artery. Cardiopulmonary bypass was established without difficulty in all cases. Optimal flow could be maintained in all patients. Body temperature was reduced, and optimal flow was pumped according to the lowered body temperature. We generally did not cool patients to less than 32°C during the sternal re-entry to avoid development of heart fibrillation, which might cause heart distension and compel safer heart dissection.

Sternal re-entry:

An oscillating saw was used in all patients for sternal re-entry. After the resternotomy was completed, first the left part of the sternum was slightly elevated by the second assistant and then the adhesions beneath the sternum could be dissected by electrocautery. The left pleurotomy was routinely performed if it had not been done previously. Immediately after the completion of the dissection of the left part of the sternum, the right part was dissected similarly. We preferred sharp dissection to free the cardio-pericardial adhesions. When the planned procedure was a MVR, the whole heart was freed. The aorta was dissected to facilitate placement of both the aortic cross-clamp and the antegrade cardioplegia cannula. Venting of the left ventricle where necessary was accomplished by a cannula placed in the right superior pulmonary vein or through the PA. In cases of MVR or DVR, a separate cannulation of the SVC was done using a Pacifico cannula and connected to the venous line.

The CPB was instituted using membrane oxygenators, and moderate systemic hypothermia was employed routinely. Myocardial protection was achieved using cold blood potassium rich cardioplegia through the root cannula or direct coronary ostial cannulae using modified St. Thomas' solution, and repeated every 20-25 min. An improved protection of the ventricles was provided by the use of topical hypothermia with ice slush. In the majority of patients, a Medtronic valve was placed in the aortic position while the preferred valve in the mitral position was a St Jude Medical valve. Interrupted horizontal mattress sutures with Teflon pledgets were utilized for both mitral and aortic valve implants.

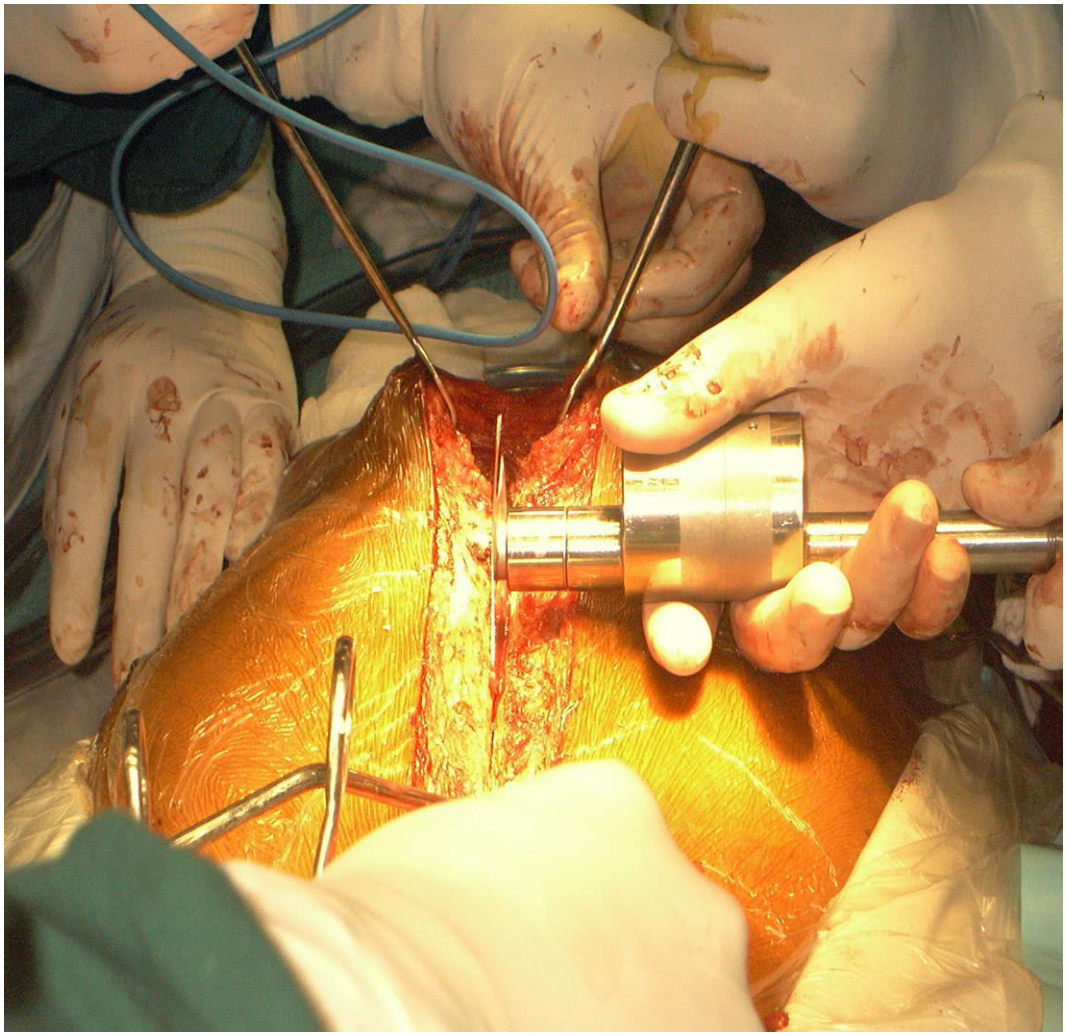

Fig 5: Use of an oscillating saw for sternal re-entry

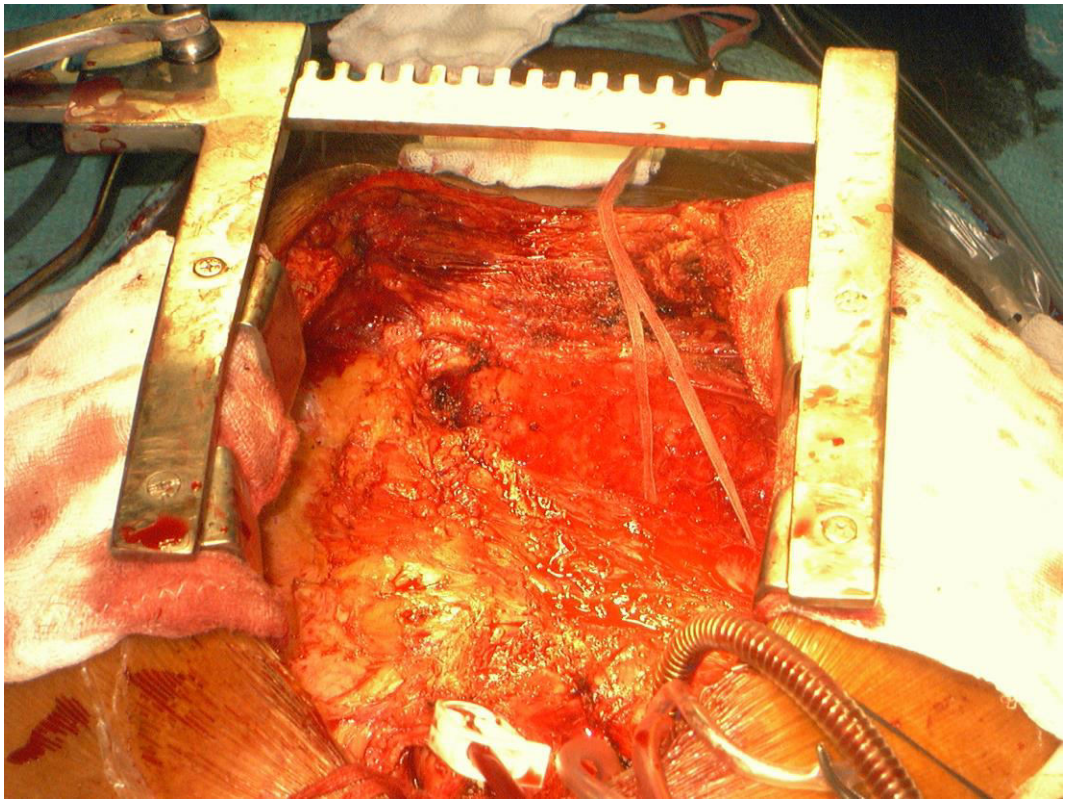

Fig 6: Extensive cardio pericardial adhesions

Aortic valve replacement:

The aorta was cross clamped, oblique aortotomy made, and antegrade cardioplegia was infused using ostial cannulae. Aortotomy extended. The aortic valve was completely excised. The prosthetic/native aortic valve was then excised. The valve was sized and the desired prosthetic valve was placed using interrupted horizontal mattress sutures with Teflon pledgets. The leaflet was checked for mobility. The aorta closed in 2 layers with 4-0 prolene. With the head end lowered, and with the root on suction, the cross clamp was released. Once the heart was beating well, the LV vent was removed. The aortic root cannula was then taken out and the aorta repaired. Two temporary epicardial pacing wires are placed on the RV surface. Inotropic support (Inj. Adrenaline) is commenced and patient weaned off bypass. Protamine was administered for complete heparin reversal. Drains were placed and hemostasis secured. Sternal wires were taken, followed by standard closure. The femoral cannulation sites were repaired with 5-0 prolene, the dissection site hemostasis achieved and wound was closed in layers. The patient was then transferred to the ICU with endotracheal tube in place.

Mitral valve replacement:

The aorta was cross clamped and a left atriotomy was made. Cold blood cardioplegia was infused through the root cannula. SVC snared. The left atriotomy was then extended. The mitral valve was inspected. The prosthetic / native diseased mitral valve was excised leaving behind most of the posterior leaflet. . The valve was sized and the desired prosthetic valve was placed using interrupted horizontal mattress sutures with Teflon pledgets. Fogarty catheter was introduced to make it incompetent. Left atriotomy closed in 2 layers. With root on suction the cross clamps were released. A minimal

inotropic support was commenced, 2 pacing wires were put on the heart. Once the heart was beating well, the Fogarty was removed and the LA repaired. The patient was weaned of bypass. The SVC cannula was clamped and removed. The cannulation site was repaired. The root cannula was taken off and the aorta repaired. Protamine was administered for complete heparin reversal followed by decannulation. Drains were placed and hemostasis secured. Sternal wires were taken, followed by standard closure. The femoral cannulation sites were repaired with 5-0 prolene, the dissection site hemostasis achieved and wound was closed in layers. The patient was then transferred to the ICU with endotracheal tube in place.

POSTOPERATIVE MANAGEMENT

Ventilation was accomplished with the Servo Ventilator (Siemens- Elema AB, Solna, Sweden) in all patients. Patients were ventilated in the pressure controlled mode with a tidal volume of 10-12ml/ kg. The minimum inspired oxygen fraction that provides acceptable arterial oxygen saturation was used (usually 50% of oxygen).

Sedation and analgesia consisted of intermittent boluses of injection Morphine. Neuromuscular blockade was achieved with intermittent boluses of Vecuronium if needed.

Hemoglobin value and serum electrolytes were checked and arterial blood gases analyzed in all patients at arrival to the ICU and appropriately corrected. A bed side chest roentgenogram was obtained to confirm the correct position of the endotracheal tube, drains, invasive monitoring lines and also to rule out pleural or pericardial collection or pneumothorax and acted appropriately. A pulse oximeter was used to

continuously monitor the perfusion of the lower limb which was used for vascular access during bypass.

The patient was extubated the next day morning if extubation criteria were satisfied. Inotropic dosage was adjusted according to the hemodynamic status and all the inotropes were usually continued till the time of extubation. The inotropic agents used in our patients were Adrenaline, Calcium gluconate, Dopamine as necessary. All the inotropes were gradually tapered over the next 24 hours provided the patient was hemodynamically stable.

ANTICOAGULATION

Postoperatively all patients received anticoagulation with Warfarin Sodium, aiming at an international normalized ratio of 2.0 to 3.0 for AVR and 2.5 to 3.5 for MVR. Prior to the use of the International normalized ratio for titration of anticoagulation, routine prothrombin time was performed in patients to assess the level of anticoagulation. Antiplatelet drugs (Aspirin-150mg) were routinely started on the 4^{th} postoperative day or earlier if the operation had entailed removal of a left atrial clot.

DEFINITIONS

In accordance with **STS guidelines** and its 2008 modifications (1,2), **early operative mortality** was defined as death occurring within 30 days of operation or before discharge from the hospital. Any abnormality resulting in stenosis or regurgitation of the aortic valve that was not intrinsic to the valve itself, such as pannus in growth, trauma, or surgical error, was considered non-structural dysfunction. In contrast, structural dysfunction was a change in valve function related to an intrinsic abnormality causing stenosis or regurgitation, such as calcification and leaflet tears. Any abnormality

that caused malfunction of the prosthetic valve that was deemed significant by the referring physician and operating surgeon and that was not caused by structural or non-structural dysfunction was classified as clinical dysfunction. Patients with preoperative serum creatinine level of 1.4 mg/dL or greater were considered to have **renal insufficiency**, whereas postoperative renal insufficiency was defined by a rise of creatinine level to 2.0 mg/dL or greater. Requirement for dialysis was considered a complication of surgery only if preoperative renal function was normal. **Myocardial infarction** was defined by the presence of these three criteria: (1) enzyme (creatine kinase MB fraction and troponin T) level elevation (2) serial electrocardiogram with ST-T segment changes or pathologic Q waves and (3) new occurrence of regional hypokinesia or dyskinesia.

Operations were considered **emergency** if patients had symptoms necessitating hospitalization for evaluation and admission to ICU for stabilisation, if operations were performed for cardiovascular instability necessitating a procedure outside the normal operative schedule or if another patient was displaced from a scheduled operation. **Neurologic symptoms** lasting less than 1 hour and neurologic deficits that resolved within 72 hours were considered transient neurologic deficits, whereas stroke was a central neurologic deficit persisting longer than 72 hours. **Gastrointestinal** complications included gastrointestinal bleeding necessitating transfusion or a change in anticoagulation protocol, cholecystitis necessitating cholecystotomy drainage or surgical intervention, pancreatitis according to elevated pancreatic enzymes, or ischemic or gangrenous bowel requiring surgical resection. Sternal wound infection was marked by antibiotic use, incision and drainage, or a positive wound culture. **Pulmonary complications** were

defined by the occurrence of new respiratory tract infections, pleural effusions, requirement of reintubation and requirement of tracheostomy.

STATISTICAL ANALYSIS

Perioperative data were collected through retrospective review of hospital records. Outcome analysis included early mortality (defined as death during postoperative hospitalization) and morbidity, cardiopulmonary bypass time, aortic cross clamp time, mean duration of ICU stay, total number of days stay in hospital and postoperative follow up at the end of six months and at last follow-up were also reviewed. Those who did not come for regular follow up were enquired about their status by postal letter and telephonic interview. Data are expressed as mean values, standard deviations, range and interquartile range.

All study variables were summarized either using frequencies and percentages or using means and standard deviations. Bar and pie charts were obtained to represent percentages using Excel applications. Univariate analysis was performed using the Chi-square test and a p- value of less than 0.05 was considered statistically significant. Variables associated with $P < 0.05$ on univariate analysis were included for multivariate analysis. Statistical processes were conducted with SPSS 16.0 for Windows package (SPSS Inc., Chicago.

REVIEW OF LITERATURE

Reoperations on cardiac valves have become increasingly frequent, in proportion to the number of patients in whom valve prostheses have been implanted in the past four decades. Thromboembolic complications in mechanical prostheses and structural failure of the same and of bioprostheses are usually time-related. As the time since implantation elapses, more cases will come to reoperation. Reoperations are certainly more difficult than the initial procedures and are still associated with major adverse events, most of which are predictable and can occur despite careful attempts to avoid them. Reoperations are technically demanding, and many patients present in a poor functional state that further increases their mortality, in some series up to 19%(10). Generally speaking, optimal planning for reoperation prior to deterioration to NYHA class III–IV levels and before unfavorable co morbid conditions have arisen is imperative to ensure good outcomes(7). Hence in the modern era, elective reoperation for malfunctioning native / prosthetic valves can be performed with results similar to those of the primary operation.

There are key differences between reoperative surgery and routine practice in non reoperative patients at every stage from patient selection and assessment, through to the sequence and technical aspects of the operation. Valvular reoperations encompasses a wide variety of concerns, including proper planning of the operation, re-entry into the mediastinum and the pericardial cavity, techniques of cardiopulmonary bypass, access to the faulty prosthesis, treatment or removal of this prosthesis, and minimizing hemorrhage and blood saving. Understanding not only the surgical plan but also the potential rescue strategies in the event of major intraoperative complications is vital for the entire surgical team. Whereas in the nonreoperative setting many automatisms within an institution develop allowing reflex-like management of the patient, this cannot apply

to reoperative cardiac surgery if a successful outcome is to be expected. Risk stratifying reoperative patients allows the team to develop a strategy tailor-made for the needs of the individual patient

PREOPERATIVE ASSESSMENT

In addition to a comprehensive cardiovascular and previous medical history, a detailed account of the previous cardiac surgery, including date and nature of operations, incisions used, and postoperative complications, particularly regarding respiratory failure, tracheotomy, and sternal wound infections, should be obtained. A history of mediastinal sepsis or irradiation, multiple cardiotomies, cardiac surgery within 3 weeks to 6 months when adhesions are at their densest, pericardiectomy, or prosthetic material such as assist devices or prosthetic grafts is associated with particularly challenging resternotomy and dissection. Previous thoracic surgery makes a thoracotomy approach difficult. In addition to the routine focused preoperative physical exam, wound location and healing and potential sites of peripheral cannulation in the groin and axilla should be assessed for scars and patency. The operative report from the initial surgery should be obtained and reviewed to ascertain the incision and cannulation sites, the number, location, and valve types and sizes implanted and the technique of suture. It is also important to know whether or not the pericardium was closed during the initial operation. The postoperative history is critical; a mediastinal infection, for example, is likely to produce more adhesions in the retro-sternal space and, therefore, makes the procedure more difficult and dangerous, unless special precautions are taken. However it is often seen in every surgeon’s practice where the operative report is not available and the patient do not know what surgery was performed previously.

Prior to proceeding with a resternotomy, the relationship between certain anterior mediastinal structures (e.g., the right ventricle and the aorta) and the posterior aspect of the sternum must be assessed carefully. This generally can be visualized on chest radiograph or more accurately with a computed tomography (CT) scan (7,13). The chest X-ray (left lateral view)(13) will reliably show the number of wire used in the previous operation and whether the right ventricle is against the sternum, in which case it is safer to institute cardiopulmonary bypass prior to sternal re-entry. The most recent technology employs multidetector computed tomography (MDCT) scanning(13), in combination with retrospective electrocardiographic gating as a noninvasive way to assess not only the heart's location in relation to the sternum but also graft location and patency. CT angiography of the chest or magnetic resonance angiography(13) both provide useful additional information about the proximity to the sternal incision of various structures, including the aorta, right ventricle, pulmonary artery, and allow assessment of the caliber of the aorta, and suitability of sites for cannulation and clamping, which may be further enhanced by 3 –dimensional reconstruction. Valuable information regarding the location of cardiac and large vascular structures can be obtained from a non contrast chest CT in patients with a contraindication to constrast (such as allergy or renal insufficiency) or who do not have a history of prior bypass grafting. There may be evidence of previous surgery associated with dense adhesions in the form of pledgets, or any synthetic material. If these areas involve, or are in close proximity to, the atrium or the aorta, there is a higher risk of injury to these sites, and an extra thoracic option for cannulations should be planned. In patients with renal insufficiency or prior mediastinal irradiation, a

Risk category	Preoperative assessment	Intra-operative strategy
Low risk resternotomy	→Prior Cardiac surgery without patient coronaries →Aorta mediastinal structures a safe distance from the sternum, clearly shown in the non-contrast CT Chest opposite	Sternotomy, Mediastinal dissection, standard aorta-caval cannulation, initiate bypass, proceed with residual dissection, cross clamp as indicated and perform procedure Optional: expose potential peripheral cannulation sites prior to sternotomy
Medium risk resternotomy	→Patient vein grafts that lie a safe distance from the sternum →Patient LIMA to LAD graft that lies laterally (arrowed in the 3D reconstruction of a CT angiogram opposite)	Peripheral arterial cannulation performed (need 5000 units of heparin). Sternum is then opened and dissection proceeds as above (if injury to vital structure occurs then bypass instituted using pump suckers until venous cannulation can be obtained). Optional: arterial and venous cannulation with full heparinization prior to sternotomy
High risk resternotomy	→Mammary artery crossing the midline close to sternum (arrowed in the CT angiogram opposite) with some native or collateral protection →Right ventricle adherent to the sternum →Normal aorta in close proximity to the sternum	Peripheral arterial and venous cannulation, with full heparinisation prior to sternotomy, with dissection as described above Optional: Institute cardiopulmonary bypass and drain patient prior to sternotomy
Very high risk resternotomy	→Mammary artery crossing the midline close to sternum, with no collateral flow →Aortic tube graft or pseudoaneurysms adhrent to sternum	Peripheral arterial and venous cannulation, with full heparinisation and institution of bypass, cooling and deep hypothermic circulatory arrest to open sternum.

Table 2: Risk stratification of low, medium, high and very high sternotomies with a summary of operative strategy tailored to address risks. (Adapted from Akujuo A, Fischer GW, Chikwe JC: Current Concepts in Reoperative Cardiac Surgery. Seminars in Cardiothorac Vasc Anaes 2009 13(4) 206-14)

noncontrast CT scan of the chest may be indicated to identify calcification of the ascending aorta.

In addition to standard preoperative studies, venous ultrasound studies to assess central venous access are advisable because previous central line placement can lead to central venous stenosis and occlusion.

Based on the above information, the reoperation may be stratified as low risk, moderate risk, high risk, or very high risk for adverse events (13). This risk stratification informs the choice of operative and to a certain extent, anesthetic strategies.

PRIOR TO INDUCTION

From an anesthetic standpoint no additional laboratory values are required solely because the surgery is reoperative. It may also be beneficial to withhold angiotensin-converting enzyme inhibitors for 48 hours before reoperative cardiac surgery, in view of the longer bypass times and increased risk of vasoplegia in the postoperative period. Concerns regarding airway management are always present regardless of the number of times the patient has come for previous surgeries. The ability to provide lung separation is very helpful if a thoracotomy approach, which may be indicated when resternotomy is very high risk, is planned (5).

Adhesive external defibrillator paddles (14) should be applied prior to induction and remain on the patient throughout the case because internal paddles cannot be used to defibrillate the heart until the mediastinal dissection, which itself can trigger ventricular tachycardias, has been completed. The positioning of the external paddles should be discussed with the surgeon as standard placement may compromise the surgical field, which not infrequently requires other access than a standard median sternotomy. Many

patients presenting for reoperative surgery have internal pacemaker devices or automatic internal defibrillator devices in place. The functionality of the pacemaker should be checked prior to surgery; it is helpful to know what make of device is in situ because that dictates the make of programming device used to interrogate the pacemaker. The treatment mode of the AICD (automatic implantable cardioverter defibrillator) needs to be turned to off, either by using a programmer or by placing a magnet over the device (13). Once deactivated, the patient should be kept in a monitored setting with the external defibrillator pads applied until the device can be reactivated and checked.

Previous scars, including the primary incisions, sites of drains, and extrathoracic cannulation should be marked clearly, and it may also be helpful to mark the femoral pulses in case emergent femoral cannulation is required. The patient should be prepped and draped in such a way that access is readily available within the sterile field to extra thoracic cannulation sites (axillary and femoral), conduit harvest, and permanent pacemakers and defibrillators. Between 5 and 10 g of aminocaproic acid may be administered intravenously prior to incision (14).

Because of the fact that the potential for rapid blood loss is constantly present, and there may be a considerable delay in achieving surgical access with the ability to transfuse from the bypass circuit, large – bore venous access, normally with the side arm of the introducer, is essential to guarantee timely volume substitution, and this should be obtained using ultrasound guidance as outlined above. As a consequence of prolonged bypass times, difficult cardio- protection, and frequently increased requirements for inotropic and vasopressor support while weaning from bypass, it is prudent to insert 2 indwelling arterial catheters at the beginning of the case. Because of the frequently

encountered blunting of peripheral arterial tracings, 1 arterial catheter should be placed in a large central artery (femoral or axillary artery). If axillary cannulation is planned contra lateral arterial catheters should be placed, with an additional ipsilateral catheter if cannulation via s side graft is planned (see below). Some surgeons request placement of a 16F catheter in the femoral vein and or artery, so that if it becomes necessary to go on bypass emergently, the catheters may be changed over guide wires to femoral cannulae. By pass lines should be brought up to the field and the pump primed prior to sternotomy, irrespective of whether cannulation is carried out prior to sternotomy or once the mediastinal dissection has been completed (13).

ANESTHESIA

Both balanced and high-dose narcotic techniques can be used in the reoperative setting, and this is primarily left to the discretion of the anesthesiologist. Particular attention must be paid to those patients at high risk of cardio vascular collapse during induction, such as patients with critical aortic stenosis, or tamponade. These patients can decompensate extremely rapidly, and because surgical access is so difficult, they are significantly more difficult than nonreoperative patients to salvage once this has happened.

SURGICAL APPROACH

Fundamental to a flawless surgical procedure is excellent and consistent exposure of the valve in question. Historically, the mitral valve has been exposed through a variety of surgical approaches, including median sternotomy, right thoracotomy, left thoracotomy, and transverse sternotomy (5). The aortic valve has been consistently

exposed through a median sternotomy. Minimally invasive techniques have been used for both valves.

Median sternotomy

Resternotomy is still the most common approach in reoperative valve surgery. In many cases, this incision provides full and adequate exposure. This is especially true when concomitant procedures are necessary. However, reoperative median sternotomy has known risks, including inadvertent cardiac injury, sternal dehiscence, excessive hemorrhage and injury to or embolism from prior grafts. Patients with valvular heart disease may be especially prone to these complications because atrial dilatation can result in significant cardiomegaly, atrial thinning, and adherence of the heart to the posterior sternum (21).

Technique

Sternal re-entry can be performed using a technique similar to that used in the initial operation which will hitherto be referred as a conventional sternotomy or after instituting cardiopulmonary bypass. Hence exposure of the femoral vessels and preparation for emergency femoral-femoral cardiopulmonary bypass should be always be considered and kept ready prior to resternotomy. The sternal skin incision is usually made in the standard fashion, unless local infection or keloid scarring requires excision of the scar. Electrocautery is used to dissect down to the sterna wires. Sternal wires from the previous operation should be carefully untwisted, cut and bent to the sides, but left in place as a safeguard during initial sternal division. Some surgeons leave the sternal wires in situ posterior to the sternum to act as a “guard” for the saw with the hope of protecting the mediastinal structures. The disadvantages of leaving the wires in situ are, first, the

likelihood of blunting the saw during the sternotomy and second, if a critical structure is injured during the sternotomy, which is possible despite leaving the wires in situ, the surgeon then has to deal with multiple fragments of wire which can cause additional lacerations, prior to addressing the acute problem.

The soft tissue at the sternal notch is dissected. Electrocautery and sharp dissection may then by used to dissect the xiphoid process away from the heart. The assistant used either handheld retractors at the sterna notch and the xiphoid or periosteal sutures to gently elevate the sternum. This may help increase the distance between the saw blade and the mediastinal structures. Some surgeons elect to perform an initial dissection under the sternum using thoracoscopic guidance. In very-high-risk cases, a small transverse incision may be made in the second or thirds intercostals space to allow the aorta to be dissected free from the sternum prior to the median sternotomy (13).

An oscillating (not reciprocating) bone saw should be used to divide the anterior sternal table and the intermediate space in a caudal-cranial direction. Most authors recommend dividing the mediastinal or posterior table under direct visualization using a combination of cutting with a straight Mayo scissors and anterolateral rake retraction. in order to prevent perforation of the right ventricle or the right atrium when they are enlarged. Another method is the use of the stryker saw (14), starting from below, while the first assistant holds the rake retractors, pulling the sternum upwards.

The posterior table is then divided along then entire length also in a caudal – cranial direction, either with the oscillating saw or using straight mayo scissors facilitated by an assistant progressively splinting open the sternum with a retractor. Two to three centimeters of the sternum are cut at a time, and the dissection progresses upwards until

the sternum is completely open. This part of the sternotomy poses the most risk to underlying structures, and in addition to attempting to elevate the sternum, surgeons may try to decompress the mediastinal structures by holding ventilation or, in the case of patients who have been cannulated, allowing the perfusionist to exsanguinate the patient into the pump temporarily. Very occasionally, the safest option will be to go on cardiopulmonary by pass, cool the patient down, and arrest the circulation prior to sternotomy. Once the sternotomy is completed, the wires may be removed if they were left in situ.

Dissection

The sub-xiphoid space is dissected with scissors, separating the pericardium and/ or the heart from the back of the sternum. Assuming that the ventricle has not been injured, the adhesions behind the sternum are then dissected further laterally, using scissors or electrocautery. Using electrocautery, fibrous structures at the notch are released. This should be done carefully to avoid injury to the innominate vein. Meticulous hemostasis of the sternum and soft tissue should then be performed.

Electrocautery is used to dissect the heart away from the left sternal edge, followed by the right sternal edge. Retraction of the sternal edges at this time is performed cautiously to avoid right ventricular rupture from excessive traction. Care should be taken to keep the plane of dissection close to the sternum to avoid injury to the cardiac structures, which places the in situ mammary artery or vein at slightly increased risk of injury, especially at the superior aspect of the sternum on the right where they lie medially. Only about an inch is needed at each side of the sternum to allow a sternal retractor to be placed, but more extensive dissection is best done after a precocious

bilateral pleurotomy starting inferiorly (14). This ensures that the right ventricle, which adheres to the anterior mediastinal structures, is not placed under excessive tension when the retractor is opened.

This is followed by careful dissection of other mediastinal structures. The primary goal of subsequent mediastinal dissection is to free potential cannulation sites namely, the aorta and right atrium- and the superior and inferior vena cava, if mitral or tricuspid surgery is planned and if patients have not been peripherally cannulated prior to sternotomy, as well as a cross-clamp site. The pericardial space is then entered. If from the previous notes, it is known that the pericardium was closed at the end of the previous operation, then the small window in the lower part of the mediastinum where the serosa was not completely closed for passage of the drain is searched for and defined. This window is easily identified because of the bulging of the congested right ventricle. Sometimes the previous suture line can be seen. However, if the pericardium was not closed in the previous operation, its edges will be found more laterally. Here the pericardial dissection plane should be developed by starting at the cardiophrenic angle and advancing slowly cephalad and laterally on the surface of the right side of the heart. Cephalad dissection should start with freeing the innominate vein prior to spreading the retractor to avoid its injury. Further dissection then is carried down to the superior vena cava, being careful to note the location of the right phrenic nerve. An area of consistently dense adhesions is the right atrial appendage, and caution should be used here. If there are extensive adhesions to the right atrium, it is reasonable to leave a piece of pericardium on the atrium to avoid injury. Excessive manipulation of an atherosclerotic aorta should also be avoided. In addition, particular care should be taken to avoid

"deadventializing" the aorta which predisposes to aortic rupture(19). The area where the aorta apposes the pulmonary artery is another site of potential injury.

To help keep hemorrhagic complications to a minimum, dissection of the pericardium over the left side of the heart is avoided and limited to the area over the aorta and main pulmonary artery, where the aortic cross -clamp is to be applied. On the other hand, complete dissection of the right side over the lateral wall of the right atrium, is essential, especially for mitral valve procedures. It is also required for aortic procedures, if venting of the left ventricle is done through the right superior pulmonary vein and left atrium. In severely congested patients, the dilated right atrium often complicates dissection, and it may be easier to commence bypass with the arterial cannula in the aorta and one single drain in the right atrium to decompress the heart. This may also be done in emergency situations once the aortic area and the right atria1 appendage are exposed. The aorta is always easily identifiable and the atria1 cavity can also be rapidly reached through the right pleural cavity, entered immediately after the sternal split. Electrocautery may be used for dissection as this may improve hemostasis. It is important, however, to stay in the appropriate planes because cauterization of the ventricle may result in ventricular arrhythmias, in addition to tissue trauma. Most importantly, as much dissection as is safe should be done prior to heparinization and bypass initiation, although decompressing the heart greatly facilitates most dissection.

The incidence of resternotomy hemorrhage is between 2% and 6% per patient reoperation(22). Prevention of this ominous complication by interposition of pericardium or other mediastinal tissue at the time of the first operation has been suggested 10) but has debatable relevance. Active hemorrhage during a second sternotomy usually is due to

adherence of the heart or great vessels to the posterior sternum(20). When major hemorrhage does occur on sternal entry, attempts at resternotomy should be abandoned, and the chest should be reapproximated by pushing toward the midline. The patient should be heparinised immediately while obtaining femoral arterial and venous cannulation. Blood loss from the resternotomy should be aspirated with cardiotomy suction and returned to the pump. Once bypass has been established, core cooling should be commenced with anticipation of the need for circulatory arrest. Once cool, flow rates can be reduced, and the remaining sternal division can be completed, followed by direct repair of the underlying injury. In cases of heightened concern for right ventricle or graft injury, or in patients with a patent LIMA to left anterior descending (LAD) artery graft, cardiopulmonary bypass and cardiac decompression should be initiated prior to sternal reentry. After safe sternal entry, the patient may be weaned from bypass for further dissection of adhesions to avoid prolonged pump times. Repair of small ventricular or atrial lacerations should not be attempted before releasing the tension of the surrounding adhesions. Repair of great vessel injuries or severe right ventricle injuries is best done under cardiopulmonary bypass.

In general, in the setting of reoperative surgery, though resternotomy is the most commonly used method, it is also the most dangerous part of the operation. Thus came into use alternate techniques that avoid resternotomy, such as right thoracotomy.

Right thoracotomy

The right anterolateral thoracotomy approach was one of the first surgical approaches to the mitral valve, and it has become a safe alternative to resternotomy for

mitral valve replacement. This approach provides excellent exposure of the valves (mitral and tricuspid) with minimal need for dissection within the pericardium. Patients with previous aortic valve replacements can have difficult exposure of the mitral valve owing to anterior fixation and probably are best served by a right anterolateral thoracotomy approach(5).

Technique

All patients are intubated using double-lumen endotracheal tubes and operations were performed in the right lateral thoracotomy position. The right groin is prepared for a femoral cannulation, if necessary. A right thoracotomy was made, and the chest was entered through the bed of the fourth or fifth rib. Adhesions of the right lung to the chest wall or pericardium were divided by electrocautery. The pericardium is entered anterior to the phrenic nerve. Arterial cannulation was performed via the ascending aorta with the use of a flexible aortic cannula or, alternatively, through the groin. Bicaval venous cannulation was carried out using flexible venous cannula in the inferior vena cava. Patients then are cooled to 20 to 25°C. Fibrillatory arrest occurs spontaneously in the majority of patients. If care is used to avoid left ventricular ejection by keeping the left ventricle empty (i.e, maintaining laminar, nonpulsatile arterial line tracing), a beating-heart technique also may be used. In the absence of aortic insufficiency, aortic cross-clamping usually is not required. Regurgitant flow through the aortic valve occasionally may require temporary low pump flow at appropriate temperatures to avoid cerebral injury. The mitral valve then was approached through the left atrium directly by dissection of the intra-atrial (Sondergaard's) groove or through the right atrium via the atrial septum. As the valve procedure was completed, rewarming was initiated. Perfusing

blood via a cannula (e.g., the left ventricular vent) positioned across the mitral valve and into the left ventricle will serve to displace residual air. An aortic root vent kept on suction in the ascending aorta is used to remove any ejected air. Patients should then be placed in the Trendelenburg position and de-airing ascertained under 2D TEE guidance. When core temperatures reached 37°C, the patient is weaned from cardiopulmonary bypass. Temporary atrial and ventricular pacing wires were placed and exteriorized through the chest wall. Closure then was routine. At the conclusion of the procedure, patients were returned to the supine position and reintubated with a single-lumen endotracheal tube for postoperative ventilation. Reduced blood use and decreased risk of LIMA or cardiac structural injury during sternal reentry make it a desirable approach for many complicated mitral reoperations. Deep hypothermia (~20°C) and low-flow femoro-femoral bypass perfusion, without the necessity of aortic cross-clamping, provide adequate myocardial protection. Cardiopulmonary bypass times, blood loss, blood product usage, and LIMA injury rates have been lower in reoperative patients undergoing right thoracotomy than in those with resternotomy (5).

Certain issues must be considered before the right thoracotomy approach is entertained. Patients who require simultaneous coronary artery bypass grafting generally will require a median sternotomy, although isolated right-sided grafting may be performed with a thoracotomy. Simultaneous replacement of the aortic valve is difficult from a thoracotomy approach and generally should be performed through a resternotomy. Significant aortic insufficiency can make effective perfusion on cardiopulmonary bypass difficult because, after opening the left atrium, blood will be returned to the pump via the cardiotomy suction. Unless the ascending aorta is clamped, effective end-organ perfusion

will not be achieved. Also, in the setting of aortic insufficiency (AI), exposure of the mitral valve may be difficult owing to this regurgitant flow into the surgical field. Left ventricular distension and myocardial stretch injury also can occur with fibrillatory arrest in patients with and occasionally without AI. Patients with greater than minimal aortic insufficiency therefore should either be excluded from a right thoracotomy approach or expected to require aortic cross-clamping either with traditional clamping or rarely with balloon occlusion. Significant right pleural disease, especially scarring in the right hemithorax, is a relative contraindication to a right thoracotomy.

Left thoracotomy approach

The left thoracotomy has been used in recent years to gain access to the mitral valve in situations in which a right thoracotomy is precluded (e.g., mastectomy/radiation or pleurodesis)(5). This incision is made through the fourth intercostal space, and the left pleural cavity is entered in the standard fashion. Surgery is performed under fibrillatory arrest or with beating-heart technique. Of importance, the mitral valve orientation is noted to be upside down with this approach, with the posterior annulus found anteriorly. While occasionally useful, this approach provides limited access to the other cardiac chambers as well as poor visibility. This left-sided approach is rarely needed and typically reserved for patients in whom reoperative sternotomy or right thoracotomy is considered unacceptable.

Transverse sternotomy

A bilateral anterior thoracotomy (i.e., transverse sternotomy) carried out through the fourth intercostal space also has been described (5). Rarely used today, this incision transects the sternum transversely, requiring ligation of both internal mammary arteries.

Minimally invasive/port access right-sided techniques

A final approach to the reoperative mitral/aortic valve is with minimally invasive or port access techniques. A large incision that increases the operative exposure also has been associated with a higher risk of injury to cardiac structures and coronary artery bypass grafts and results in greater bleeding with its associated transfusion requirements. A smaller incision with a limited sternotomy or anterolateral thoracotomy on the other hand, reduces the area of pericardiolysis, thus mitigating these effects. The intact lower sternum that remains also preserves the integrity of the caudal chest wall, thereby enhancing sternal stability and promoting earlier extubation. Minimally invasive valve procedures gradually have become more accepted as new technologies and instrumentation have been developed (5).

CANNULATION

Cannulation for bypass can either be peripheral or central the choice for cannulation depends on the risk of the case and the quality of the vasculature. The presence of multiple patent graft anastomoses to the aorta may favor peripheral arterial cannulation. In patients who are at high risk of catastrophic injury to mediastinal structures, arterial and in certain cases venous, cannulation may be carried out peripherally, prior to sternotomy. The axillary artery, which is readily accessed via a 5-to 6-cm incision in the deltoid crease, offers less risk of limb ischemia and cerebrovascular events than the femoral artery, which is less well collateralized and produces much more extensive retrograde flow. The commonest complications of axillary artery cannulation involve trauma to the branches of the brachial plexus (5), which is closely involved with the artery. The femoral artery may be accessed either using a Seldinger technique or more

usually via a 3- to 4-cm incision in the inguinal skin crease, the femoral artery is more affected by atherosclerotic disease, and a careful check of distal pulses is mandatory after decannulation. Occasionally, the arteriotomy will need revision or patch repair to ensure distal flow. If arterial cannulation alone is carried out peripherally, it is not necessary to fully heparinize the patient initially (5) : Single dose of 5000 units of heparin together with asking the perfusionist to flush the arterial cannula every 10 – 15 minutes or so once it is connected will be sufficient to keep the line free of thrombus. Full heparinization to an activated clotting time of greater than 480 seconds is required prior to venous cannulation, use of pump suction, or institution of cardiopulmonary bypass. Cannulating via a side-graft reduces the risk of distal limb ischemia that comes with direct cannulation, but takes significantly longer and has been associated with distal hyper perfusion. If a side-graft is used a distal arterial catheter should be placed in addition to a contra lateral one to detect hyper perfusion intra-operatively.

The only indication to cannulate the peripheral veins prior to sternotomy, which mandates full heparinization, is if the surgeon anticipates very high risk of injury requiring bypass on sternal entry. The axillary vein may occasionally be used, but the femoral vein affords better access. Either a Seldinger technique or an open cut-down may be used, a wire inserted into the right atrium under transesophageal guidance, and the cannula advanced into the right atrium. The most serious immediate complication of femoral venous and arterial cannulation is retroperitoneal hemorrhage from perforation of the femoral or iliac vessels (19,20,21), which may not become apparent until late in the case when the perfusionist notices low flows and poor venous drainage, and the patient's abdomen is already distended. If a soft tipped wire is inserted without excessive force,

not forced against resistance and is kept under tension with free mobility backwards and forwards at all stages, then dissection and perforation are rare.

CARDIOPULMONARY BYPASS

Cardiopulmonary by pass can be initiated prior to or after the sternotomy as dictated by the risk. Many surgeons concerned about opening the sternum in the presence of adhesions advocate the use of femoral-vein-to-femoral-artery bypass before sternal reentry with the aim of decompression of the heart and increasing the distance between the mediastinal structures and the sternum. After moderate cooling, the heart is emptied. As it collapses and pulls away from the sternum, the bone can be opened with an oscillating saw without danger to the heart. Once sternotomy is complete, the patient may be weaned off bypass (14). On the other hand, if bleeding occurs a cardiotomy can be immediately inserted through the wound of the right ventricle or right atrium, while the aorta or the femoral arteries are cannulated in extremis, but this situation is very rare indeed. In high-risk situations, the femoral or iliac artery may be preventively cannulated. Generally, the most commonly used method is the right atrium to aorta cardiopulmonary bypass. A single- or double-stage cannula may be used for venous drainage, but two vena cava cannulae are used for mitral procedures. Although commencing bypass prior to sternotomy increases bypass time, it reduces the risk of injury and catastrophic bleeding and does not appear to increase morbidity or mortality. The disadvantage is that total bypass time is prolonged, and dissection is performed in a fully heparinized patient leading to increased transfusion requirements. In patients with aortic insufficiency, it may be necessary to place a left ventricular vent to prevent the heart from distending, which may be done in advance of instituting bypass through a small left anterior thoracotomy if

standard routes are not accessible. Transesophageal echocardiography should be used to monitor left ventricular distension.

MYOCARDIAL PROTECTION

Myocardial protection in reoperations may be delivered in exactly the same way as in first-time surgery with several additional considerations relating to the longer operation times, poor myocardial function, and more advanced native disease associated with reoperative procedures: challenges in the placing of the cardioplegia catheters; and finally, the presence of patent bypass grafts that will wash out the cardioplegic solution from the myocardium throughout the case unless they can be occluded. The presence of proximal coronary bypass graft anastomoses on the ascending aorta may mean that finding a suitable place to locate an antegrade cardioplegia catheter could be challenging. Correct placement of a retrograde catheter cannot be assisted or confirmed by palpation if the diaphragmatic surface of the heart has not been dissected free, and the surgeon has to rely on transesophageal echocardiography. It is therefore important to ensure that the cannula is in adequate position while giving cardioplegia by monitoring the pressure in the coronary sinus or observing blood return from the left and right main coronary arteries if the aorta is open.

Retrograde cardioplegia offers the advantage of better distribution than ante grade cardioplegia to territories subtended by severely diseased native coronaries(18). If the patient has patent mammary artery bypass graft or the cross-clamp has been placed proximal to any patent aortocoronary graft, noncardioplegic blood flow will continually wash out cardioplegia throughout the case. There are several options in this setting. Traditional teaching was that the left anterior descending artery should be dissected out

and clamped or even occluded percutaneously using a ballon-tipped guide wire under fluoroscopic guidance. A useful alternative is to leave the patent grafts intact and perform the surgery with the patient cooled to about 25 C, which affords good myocardial protection because the heart is supplied with oxygenated blood continuously. The operative field will remain blood filled for the duration of the case, which can be dealt with by reducing the pump flow for very short periods of time when unimpaired vision is essential. A third option is to perform surgery without cardioplegic arrest, either off-pump (for coronary artery surgery) or on by pass (for mitral valve surgery) with the heart beating and with intermittent fibrillatory arrest. The latter option is not feasible in the setting of more-than-mild aortic insufficiency.

ACCESS TO CARDIAC CHAMBERS

For access to an aortic prosthesis, the usual oblique or longitudinal incision of the aortic root should be used. By contrast, regardless of the actual approach, once cardiopulmonary bypass has been established and the heart exposed, there are several incisions that can be employed to view the underlying mitral valve, including that which is classically used for primary operations(5). The standard left atriotomy begins with blunt dissection of the interatrial groove (i.e., Waterston's groove), allowing the right atrium to be retracted medially and anteriorly. The right superior pulmonary vein at its junction with the left atrium then is exposed, and the left atrium is opened at the midpoint between the right superior pulmonary vein insertion and the interatrial groove. This incision is extended longitudinally both superiorly and inferiorly to give enough exposure of the mitral valve. Care must be taken to avoid inadvertent injury to the posterior wall of the left atrium, and when closing, one must avoid including the posterior wall of the right

pulmonary vein an incision posterior to the interatrial groove and anterior to the right pulmonary veins. The exposure of the mitral valve given by this incision in reoperation is clearly more limited than that which it gives in the primary valve procedure, especially in small atria and where the adhesions of the left side of the heart have not been released. In some cases, wide opening of the left pleural cavity allows a leftward rotation of the heart and facilitates exposure. The superior approach, through the root of the left atrium, also provides excellent exposure, probably as good as in the first operation. A modification of the Dubost technique, which has recently been described by the Edinburgh group, starts with the classical approach. If there are difficulties in the visualization of the valve, a T-incision through the right atria1 wall and the interatrial septum is carried out which gives a clearer view of the mitral valve. The right atrial transeptal approach has become more popular in recent years, especially in reoperative valve surgery. After opening the right atrium, the interatrial septum is incised starting at the fossa ovalis and moving vertically upward for a few centimeters. This technique is especially helpful in reoperative surgery because it minimizes the amount of dissection required. All these alternative approaches create additional difficulties, since the surgeon must first dissect and snare the superior and inferior venae cavae. Also, the integrity of the interatrial septum may be affected. Finally, a right anterolateral thoracotomy during femoro-femoral bypass without aortic cross-clamping or cardioplegia has been recommended, especially for multiple reoperations on the mitral valve.

Removal of the prosthesis

Retrieval of the abnormal prosthesis presents some technical difficulties. They can be removed with the whole valve intact or in two stages. Removal of the whole valve

intact is accomplished by cutting the sutures and dissecting the interface between the sewing ring and the tissues, leaving the annulus virtually ready for the new sutures and prosthesis. However, others suggest cutting through the sewing ring, removing first the body of the prosthesis, and retrieving the remains of the ring at a second stage. This may be simpler, but there is the risk of embolisation by particles left behind.

All techniques must be tailored according to the circumstances. Importantly, however, utmost care must be exercised to preserve the integrity of the patient's annulus, especially in the case of the mitral valve, where the atrioventricular junction may easily be disrupted with disastrous consequences (5).

Finally, treatment of annular abscesses in the case of prosthetic valve endocarditis may be another very delicate technical problem. Bovine pericardial patches have been used to reconstruct the disrupted annular areas. Whenever possible, however, aortic root abscesses should be left open to the bloodstream to facilitate sterilization, and the prosthesis should be sutured either to the inferior or superior edge, whichever appears more convenient. Nevertheless, if the abscess threatens rupture into the pericardium, or in other very extensive annular destructions, homograft aortic root replacement may be the best option (3,5). Other composite grafts may also be used, but homografts are more resistant to reinfection. Transplantation has also been suggested in situations of uncontrolled infection accompanied by extensive destruction of cardiac tissues.

ADDITIONAL TECHNIQUES OF REOPERATIVE MITRAL SURGERY

A less common indication for reoperative mitral valve surgery but one that can be challenging is periprosthetic leak. The incidence of perivalvular leak for both mechanical and biologic valves is about 0 to 1.5% per patient-year(3). Of note, perivalvular leak is

slightly more common with mechanical than with tissue valves-possibly owing to differences in suture technique for each and sewing ring characteristics. The regurgitant flow across the perivalvular area frequently leads to hemolysis and, through denuding of the endocardium, endocarditis.

In evaluating patients with a periprosthetic leak, an assessment of valve function is important. If the valve itself is competent, direct repair of the leak avoids the hazards of valve replacement. While pledgetted suturing may be attempted for smaller leaks, fibrotic tethering of surrounding tissue and the size of the defect may require a bovine or autologous pericardial patch. In cases of significant dehiscence or associated valvular dysfunction, removal of the valve is necessary. Replacement in this situation, however, is prone to leak recurrence because the annulus is partially intact, often calcified, and otherwise less than ideal for suture placement. In these cases, a bovine pericardial skirt can be fashioned and sewn to the sewing ring of the valve. Annular sutures then are placed in a typical fashion through the sewing ring, and the valve is seated. A running suture then can be used to sew this skirt to the left atrium.

An additional risk of reoperative mitral valve replacement is atrioventricular disruption. Care must be used in removing the original valve sewing ring because it is frequently "socked in," and inadvertent removal of excessive annular tissue may occur. Any evidence of disruption of the posterior annulus necessitates patch repair with pericardium (autologous or bovine) prior to placement of annular sutures. When faced with less than ideal annular tissue, and in an attempt to ensure stability, bites must not be overly aggressive in depth. Left circumflex injury can occur and will lead to significant morbidity and mortality.

IMPLANTATION OF A NEW PROSTHESIS

The choice of prosthesis for re-placement is sometimes very difficult. Is it correct to insert a mechanical valve when reoperating for a degenerated bioprosthesis in a young but noncompliant patient? Or to implant a biological valve in a similar patient reoperated on for a thrombosed mechanical prosthesis? The decision must consider the individual and collective characteristics of the patients and the surgeon's experience with that particular population. Additionally, the pathology and the anatomy of the annulus may influence the decision. Bioprostheses, for example, conform better with annular irregularities and are allegedly more resistant to reinfection(5,6). A continuous suture may be used for mitral valve reimplantation as for the first valve replacement if the annulus is still fairly regular after removal of the previous prosthesis. Most often, however, interrupted sutures must be used to ensure that the tissues hold, because the annulus is not as soft and pliable as in the initial procedure. On the other hand, interrupted sutures are usually preferred for aortic valve implantation. The use of Teflon pledgets is not always warranted, but when necessary they should be placed on the atria1 or on the aortic side.

WEANING FROM BYPASS

When de-airing the heart in reoperative surgery, particularly after mitral valve surgery, it is worth spending several extra minutes filling the heart and performing alveolar recruitment maneuvers while still on bypass because the pulmonary vasculature and left ventricle are splinted open by adhesions and tend to entrap much more air. Protamine should certainly not be given until several minutes after bypass is discontinued and most of the air appears to have been vented. If bypass is discontinued too rapidly, this

air is expelled once the heart starts ejecting, embolizing down the coronary arteries and any grafts, resulting in hemodynamic compromise that may be severe enough to require reinstitution of bypass. If Protamine has already been given, not only will reinstitution of bypass be delayed until the patient has been reheparinized, but the hemodynamic instability may be mistakenly attributed to a Protamine reaction and incorrectly treated as such.

COAGULATION MANAGEMENT, POSTOPERATIVE HEMORRHAGE AND BLOOD SAVING

A systematic approach requires that hemostasis be carried out in exactly the same fashion used in first-time surgery. Because of large surface areas of dissection and, frequently, prolonged bypass times, reoperative patients may experience more profound coagulopathy after separation from bypass. For this reason, many clinicians have a lower threshold for stopping antiplatelet medication preoperatively in reoperative patients. Obtaining point-of-care testing with platelet function assays and thromboelastography is prudent(14), so that the dysfunction within the patient's coagulation system can be specifically targeted and the risks of transfusion minimized. Antifibrinolytics, specifically aminocaproic acid (150 mg/kg bolus prior to skin incision followed by a continuous infusion of 25 mg/kg/h for the duration of the case) may be used if there is no contraindication, in all patient.

Some aspects of the surgical technique may alter postoperative hemorrhage(13,14). These include limitation of the initial dissection of the pericardium to that essential for cannulation and access to the prosthesis. On the other hand, closure of the pericardium may not be possible, particularly if it had not been closed during the first

operation. Because multiple reoperations are often required it still is advantageous to close the pericardial sac. Bovine pericardium has been used as a pericardial substitute, although the results do not appear to be very favorable. The Gore-Tex membrane has apparently had better results. Closure of the pericardial space not only facilitates an eventual re-reoperation(14) but also helps prevent the accumulation of free blood and clots, itself a factor which tends to perpetuate hemorrhage. Substitution or pharmacological manipulation of the clotting factors is important in these patients who are often on anticoagulation therapy. Additionally, congestive cardiac failure frequently leads to hepatic failure which results in lower prothrombin activity. Aprotinin has been shown to reduce perioperative bleeding, and its use is optional during reoperations. The cardiotomy reservoir can used to collect the chest tube drainage; the reservoir is simply attached to the drains using the bypass circuit tubing. As a very inexpensive and unsophisticated method of reinfusion, a regular blood transfusion and filter are attached to the outlet of the reservoir and to one of the three-way tap bridges used during the operation. Blood is reinfused manually with a 50-ml syringe, which should never be detached from the system, to avoid infection. Alternatively, an automatic pumping system may be utilized(14).

EMERGENCY SCENARIOS

Intraoperative adverse events occurred in 7% of 1847 reoperative cardiac procedures in a recent analysis focusing on these outcomes(10). The adverse events were characterized on the basis of the structures injured, the timing of the event during surgery, and associated lapses in workup that may have contributed. Only 23% of complications

occurred during sternotomy(21); the majority of intraoperative adverse events occurred during the mediastinal dissection and before clamping.

Catastrophic injuries on sternotomy include trauma to arterial structures-namely, patent bypass grafts (which are the most frequently injured structures) and the aorta and venous structures-namely, the right atrium, right ventricle, and in nominate vein. Injury to venous structures necessitates rapid volume replacement, which may be carried out via large peripheral or central venous lines but most optionally via an arterial bypass cannula. Venous structures are particularly at risk in patients with right heart failure. Injury to arterial structures is immediately life threatening, either from hemorrhage or from myocardial ischemia, and usually mandates emergency cannulation and institution of bypass.

If injury that results in life-threatenting bleeding occurs as a result of sternotomy but before the patients has been cannulated, the anesthesiologist should give a full dose of heparin immediately while the surgeon reapproximates the sternum using towel clips or an assistant in a temporizing measure to take any tension off the injured structure and tamponade bleeding (13,14). Extra thoracic sites should then be cannulated emergently and bypass initiated prior to attempted repair, and the patient cooled. Once fully heparinized, it is possible to go on “suction bypass” as soon as arterial cannulation is secured, with all venous return coming from the pump suckers placed in proximity to the site of hemorrhage, until venous cannulation can be established. During this time, the anesthesiologist and perfusionist must work closely to maintain adequate perfusion of both brain and heart. In the case of a major injury to the aorta, this is rarely possible, and the dire outcomes reflect this.

The onset of ventricular fibrillation associated with arterial bleeding on sternotomy or mediastinal dissection in this context can only be treated by instituting cardiopulmonary bypass and ensuring that the left ventricle is decompressed, followed by repair of the laceration.

The occurrence of a major intraoperative adverse event is associated with a moderately increased postoperative mortality and morbidity. It also affects intraoperative decision making. The surgeon may elect not to address lesions with borderline indications to reduce subsequent bypass and ischemic time, and not infrequently, it is necessary to defer chest closure to another day.

TECHNICAL PROGRESS IN RE-OPERATIVE VALVE SURGERY

Several improvements have been implemented over the last quarter of century. Some are related to technological evolutions, others to increased surgical experience (14).

1, Femoro-femoral Extra Corporeal circulation before sternotomy is done if the cardiosternal contact is important on lateral chest x-ray. Thin walled venous tubing development has considerably improved venous drainage in femorofemoral bypass. If required, active venous suction using a centrifugal pump may be helpful.

2, Redo sternotomy uses an oscillating saw to limit the risk of tearing underlying structures (innominate vein, ascending aorta, right atrium and right ventricle).

3, Defibrillation patches directly applied on to the patient's skin allow rapid external electric shock administration if the patient starts fibrillating during the early stages of the operation. Use of electro-cautery sometimes induces ventricular fibrillation. Defibrillation should be ensured in this situation as quickly as possible. Cardio-pericardial adhesions could impair the possibilities to internally defibrillate the heart.

External defibrillation should be used in such a situation. Another lifesaving procedure is the rapid opening of both pleural spaces and transpleural internal defibrillation.

4, Primary extensive cardio-pericardial adhesions liberation had been reported to facilitate mobilization and evacuation of intra-cardiac air and to make the intra-cardiac procedure easier and safer. Adhesiotomy using electro-cautery limits bleeding. This strategy is weighed against limited dissection as for isolated aortic valve replacement in redo patients.

5, Thoracotomy surgery: Atrio-ventricular valve surgery can be done through an antero-lateral thoracotomy as first reported in the late 80s (5). Stratagems used were femorofemoral bypass, profound hypothermia and low flow perfusion without aortic cross clamping or cardioplegia.

The indications for this strategy are previous mediastinitis, severe right ventricle and pulmonary hypertension with previous multiple sternotomies, intact coronary arteries bypass grafts (especially mammary pedicles) and previous aortic valve replacement (especially with high profile prostheses) without any new aortic valve indication for surgery

6, Mitral exposure during re-intervention can be hazardous. Cardio-pericardial adhesiotomy can be difficult and time consuming in some circumstances. Precocious left mediastinal pleurotomy through median sternotomy achieved ventricular mobilisation and improved exposure of the mitral valve(14). Moreover, this simple, safe and time-saving technique, if realized before sternal retraction, allows the avoidance of shear-stress on medial structures, such as the innominate vein, the right atrium and ventricle and the aorta. Right pleurotomy also serves the same purpose.

7, Improved ECC technology, particularly biocompatibility, have reduced the systemic inflammatory response syndrome. Systemic hypothermia, low flow and circulatory arrest can all help in the management of delicate redo-related technical difficulties.

8, Improved myocardial protection technique: Hypertrophied hearts, frequently found in heart valve disease, make myocardial protection critical. Antegrade cardioplegia associated with topical cooling of the heart can be impaired in redo valve surgery. Aortic regurgitation limits the efficacy of antegrade cardioplegia (unless given directly into the coronary ostia) and extensive adhesions oppose adequate topical cooling. Although retrograde cardioplegia efficiency had been challenged, especially in hypertrophied myocardium, it has been widely used in both valve and coronary surgery with success. Despite less complete right ventricle protection, retrograde cardioplegia is a safe alternative in conditions where myocardial protection is inadequate in valve surgery with aortic insufficiency.

9, Improved intensive care management may also have contributed to the general amelioration of the results. During the last 30 years, mechanical and pharmacological support of the failing heart has progressed greatly. Monitoring with the Swan Ganz catheter allows precise hemodynamic evaluation nowadays at the cost of an very rare catastrophic pulmonary hemorrhage.

10, The Cell Saver has proved useful in redo cardiac surgery patients, even if its efficacy in reducing transfusion requirements for redo valvular patients remains questionable.

10, Aprotinin: Peri-operative blood loss and blood transfusion requirements were reduced by Aprotinin use in primary cardiac surgery under bypass(10,14,23). This benefit should also improve blood loss during redo surgery. Hypersensitivity to Aprotinin should be tested in cases of recurrent administration of this drug.

Experience in redo valve surgery should influence first operation strategies. Large pericardial windows have previously been used by some to prevent cardiac tamponade, a benefit still awaiting demonstration. Experience in redo surgery should absolutely negate the usefulness of such practice. Eighty-eight percent of the hemorrhages during re-entry in redo cardiac surgery occur in situations in which the pericardium had not been closed in a first operation. Meticulous hemostasis during the first operation considerably limits the formation of adhesions. Hence some surgeons produce safer redo candidates than others.

RISK FACTORS IN REDO VALVE SURGERY

The experience acquired during the last 20 years in heart valve re-operations is considerable. Various prognostic factors influencing outcome after redo valve surgery have been identified(6,9,10,13,14,23).

1, **NYHA functional class**: The most frequently quoted risk factor associated with death in redo valve surgery is the New York Heart Association (NYHA) functional class. Mortality up to 30% has been associated with stage IV compared to less than 10% in stage II and III. One of the first reports of redo valve surgery clearly suggests that when significant valve dysfunction is first noted, re-operation should be undertaken to minimize operative risk. Later observations generally emphasized this recommendation. This is particularly true in patients who benefit from a bioprosthesis in the mitral

position. The most common cause of re-replacement of a prosthetic valve is bioprosthesis degeneration. Structural valve degeneration of a bioprosthesis generally appears after 8 years of follow-up, especially in young patients and in the mitral position. Early re-operation before irreversible deterioration occurs is advised, since myocardial function was found to be a major determinant of surgical results.

2, **Surgical priority**: The second most frequently reported risk factor is the degree of urgency in the re-operation of patients. The reported mortality risk of elective re-operation is as low as 5.4% to 11%, while, for emergency procedures, it could be as high as 38 to 61.5%.

3, **Valve position**: The influence of the valve position as a risk factor is controversial. Some data suggest that redo mitral surgery increases risks (19.6%) compared to aortic (5.9%). Another series reports the contrary, that mitral valve re-operation carries a 12% risk versus 26% in the aortic position. The valve position was recently found not to be a determinant risk factor. Double valve replacement compared to single, represents a significant risk factor : mortality increases from 3.2% in single to 25.0% in double valve recipients.

4, **Number of previous operations**: The number of previous operations has been reported as a risk factor. Hospital mortality had been reported as high as 21.7% for the second, 20% for the third and 55.6% for the fourth re-operations.

5, **Tricuspid valve surgery** requirement (replacement or annuloplasty) is associated with a higher mortality than the same operation without tricuspidal disease, probably reflecting more advanced disease and higher pulmonary artery pressures. Pre-operative morbid process bears a significant correlation with mortality.

6, **Prosthetic valve endocarditis** has been associated with a postoperative mortality of up to 50%(15,23).

7, **Mechanical valve thrombosis** also carries an important risk (43%) of death compared to structural deterioration of bioprostheses (9%)(15,23).

8, Associated coronary artery lesions and associated **CABG** requirements present a higher operative mortality.

9, **Gender** has been identified as a risk factor, female having been recently reported to present a higher operative mortality compared to male. Risk associated to gender, contradicted in the past in this particular surgery, is currently accepted as a general risk factor in cardiac surgery today(6,13,15,23).

10, **Renal impairment** was higher in non-survivors compared to survivors(6,9,15,23).

11, **Operation time, aortic cross clamp time and pump run** are reported to have been significantly longer in patients who died(6,9,12,15,16,23).

13, The **type of prosthesis** implanted originally seems not to influence patient outcome after heart valve re-operation. However, failing mechanical prostheses are associated with a higher mortality (21%) than bioprosthesis degeneration (a more progressive event: 10%).

14, The **era of operation** had been reported as a risk factor of mortality(15,17,23) . As previously mentioned, studies concerning patients operated on between 1980 and 1992 clearly exhibited a decreased mortality through the years. Cohn reported that mortality for re-replacement fell, between 1980 and 1992, in aortic valve from 15% to 10%, in double valve from 20% to 9%, and in mitral valve from 16% to 6% (2). Such improvements in mortality have been confirmed in other studies.

Observations & Results

The age of the patients ranged from 12 to 69 years with the mean age at the time of operation being 42.97 ± 14.53 years. There were 27 males and 16 female patients (M/F ratio = 1.68:1). 23 (53.5%) were older than 40 years of age. 32 patients (74.41%) had Rheumatic heart disease with only 10 patients (31.25%) still continuing Penicillin prophylaxis.

Of the total 43 patients, 17 patients (39.54 %) presented with NYHA class II symptoms, 19 patients (44.18 %) with NYHA class III and 7 patients (16.27 %) presented with NYHA class IV symptoms. Dyspnoea on exertion was the most common presenting symptom (86%).

24 patients (55.81%) were in atrial fibrillation with the rest being in sinus rhythm. Congestive cardiac failure was present in 9 (20.9%) patients. A history of neurological deficits was present in 3(6.9%) patients. 5 patients (11.62%) had history of infective endocarditis detected by blood culture or echocardiography. Renal dysfunction was present in 6(13.95%) patients.

The 43 patients formed a heterogeneous group in terms of the first open heart procedure they underwent. 15 (34.88%) patients underwent Aortic valve replacement. 12(27.9%) patients underwent Mitral valve replacement. 5 (11.62%) patients underwent open mitral valvotomy/valve repairs. 2 (4.65%) patients underwent double valve replacement(1 underwent a aortic and mitral valve replacement and another underwent a mitral and tricuspid valve replacement). 9 (20.93%) patients underwent intracardiac repair for congenital heart disease (including ASD, VSD closure, intracardiac repair for TOF, DORV).

30 (69.76%) had rheumatic heart disease at time of first operation and 4 (9.3%) had valve replacements for other etiologies like bicuspid aortic valve, degenerative aortic valve disease. Among the 9 patients who underwent surgery for congenital heart disease, 2 patients subsequently developed Rheumatic heart disease.

Echocardiography revealed 19 (44.18%) patients with normal left ventricular ejection fraction and an equal number with an ejection fraction between 35% and 55% (mild to moderate LV dysfunction). 5 (11.62%) patients had an ejection fraction less than 35% (severe LV dysfunction).

The average interval to reoperation was 12.3 ± 7.08 years with a range of 1 – 29 years. The duration of implantation after the first operation was longest when malfunction was due to primary valvular failure (progression of native valve disease).The shortest intervals were those associated with malfunction due to endocarditis and occurrence of paravalvular leak. 35(81.39%) patients underwent an elective operation and the 8(18.6%) underwent the operation as an emergency. The indications for emergency surgery were prosthetic valve thrombosis (2), CCF with severe paravalvular leak (2), native valve endocarditis (1) and prosthetic valve endocarditis (1).

The indications for reoperation were progressive native valve disease in 27 (62.79%) patients, Structural prosthetic valvular deterioration in 7 (16.27%) patients, Non structural dysfunction in 6(13.95%) patients, Prosthetic valve thrombosis in 2 (4.65%) patients and operated valvular endocarditis in 1 (2.32%) patient. The first reoperation was a Mitral valve replacement in 19(44.18%) patients, Aortic valve replacement in 18(41.86%) patients, Double valve replacement (aortic and mitral) in 4 (9.30%) patients and Tricuspid valve replacement in 2 (4.65%) patients.

In the mitral position, Starr-Edwards mechanical valves were the valve of choice though, the last year of study saw a shift to St.Jude Medical mechanical valves. In the aortic position, the Medtronic Hall mechanical valve was the valve of choice. In the tricuspid position, biological valves were utilized.

20 (46.51%) patients had a cardiopulmonary bypass time less than 120 min and 23 (54.48%) patients had a cardiopulmonary bypass time greater than 120 min. 36 (83.72%) patients had aortic cross clamp times less than 60 min and 7 (16.27%) patients had aortic cross clamp times greater than 60 min. The mean cardiopulmonary bypass time was 123.90 ± 25.14 min and the mean aortic cross clamp time was 49.46 ± 12.81 min.

No major incident of great vessel injury occurred in any of the cases. However minor injuries requiring control of bleeding with pledgetted prolene sutures were required in 11 patients. The minor injuries occurred in during course of the dissection to free the heart from the adhesions. The injuries were on the distended tense right atrium in 6 of the cases and minor right ventricular myocardial injuries in 5 of the cases. None of these injuries contributed to postoperative bleeding and was not the etiology in those cases which were returned for re-exploration.

Major adverse postoperative events

Operative mortality

Over a 10-year period, from January 2000 until December 2009, 43 patients (27 men and 16 women) with a mean age of 42.97 years (range 12-69 years) underwent first reoperation for a heart valve with an overall operative mortality(defined as death within 30 days of operation regardless of the patient's geographic location) of 11.62% (n=5). Mortality was 4/27 (14.81%) for men and 1 of 16 (6.25%) for women; P= 0.635. The

mean age of those patients who had an operative death was 39.0 years (standard deviation [SD] 17.07) compared with 43.5 years (SD 13.88) for those who survived surgery (P = 0.65). Of the 5 patients who had a operative mortality, 3 had an aortic valve replacement, 1 had double valve replacements and one had a mitral valve replacement.

The causes of operative mortality were low cardiac output in 2 patients and refractory arrhythmia in 1 patient. The non cardiac causes were septicemia in 2 patients. There was no other early mortality (defined as all-cause mortality at 30, 60, or 90 days).

Postoperative complications

Reexploration was required for postoperative bleeding in 3 (6.97%) patients. Rhythm abnormalities (fast atrial fibrillation, ventricular arrhythmias and variable degrees of AV block) were noted in 31(72.09%) patients. A single patient required permanent pacemaker implantation; however this patient was one of the hospital mortalities. Duration of postoperative inotropic support greater than 48 hours was required in 11(25.58%) patients. Pulmonary complications occurred in 8(18.60%) patients. Readmission to the ICU was required in 8(18.60%) patients. Septicemia occurred in 7(16.27%) patients. Major sternal infections and mediastinitis were seen in 3(6.97%) patients. Minor wound infections were seen in 8(18.60%) patients. New onset postoperative renal dysfunction was noticed in 6(16.21%) patients, all of whom recovered with conservative management. Dialysis was required in only 1 patient (this patient had preoperative renal dysfunction). New onset neurological dysfunction was noticed in 3(6.97%) patients. Pericardial effusion was noticed in 8 (18.60%) patients and only 2 patients required pericardiostomy for evacuation of the effusion. There were less

common complications like hepatic dysfunction (n=1) and gastrointestinal bleeding (n=2) There were no vascular complications related to the femoral vessels secondary to the cannulation for vascular access.

Duration of ICU stay was less than 72 hours in 29 (69.44%) patients and greater than 72 hours in the rest (32.55%). The average duration of hospital stay was 13.34 days.

Table 3: Mortality according to principal valve procedure at reoperation

Principal procedure	Mortality	Percentage
Mitral valve replacement	1/19	5.2%
Aortic valve replacement	2/18	11.1%
Double valve replacement	2/4	50%
Tricuspid valve replacement	0/2	0

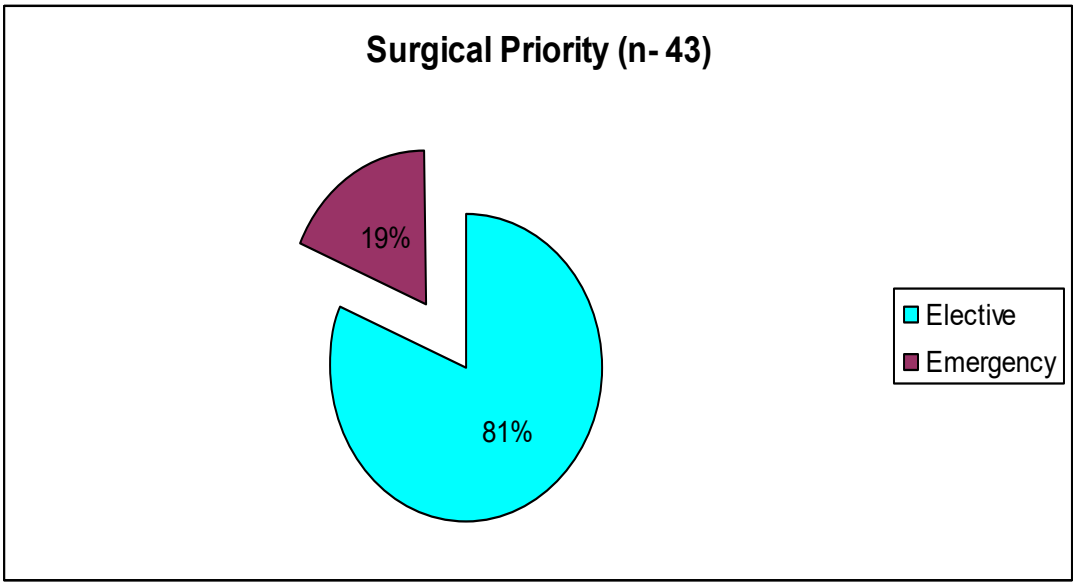

Fig 5: Priority of reoperation

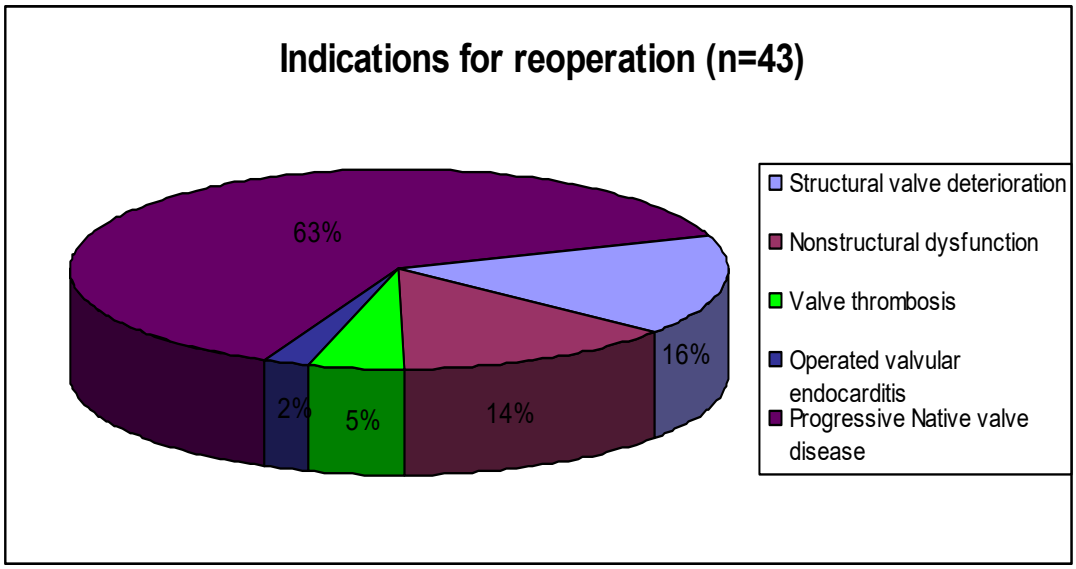

Fig 6: Indications for reoperation

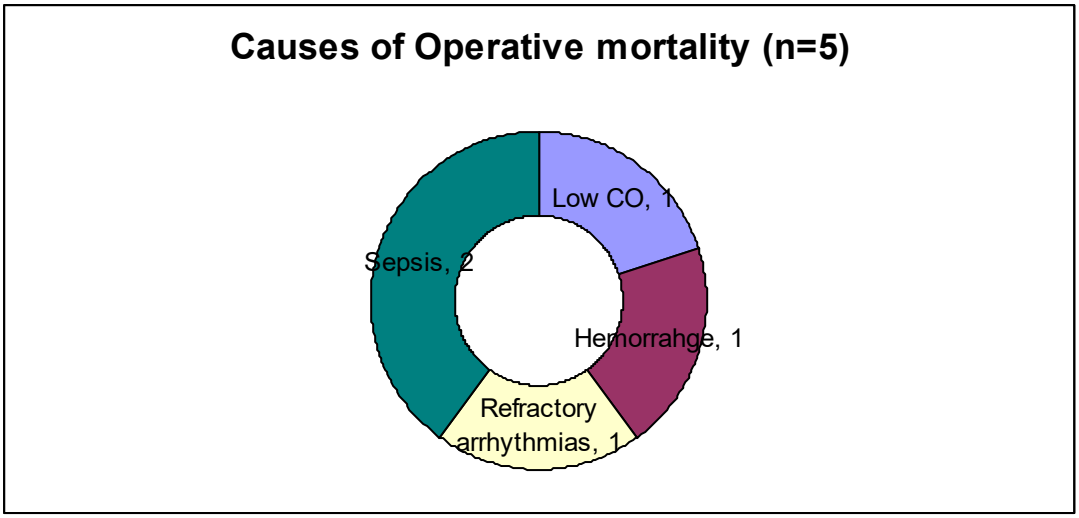

Fig 7: Causes of operative mortality

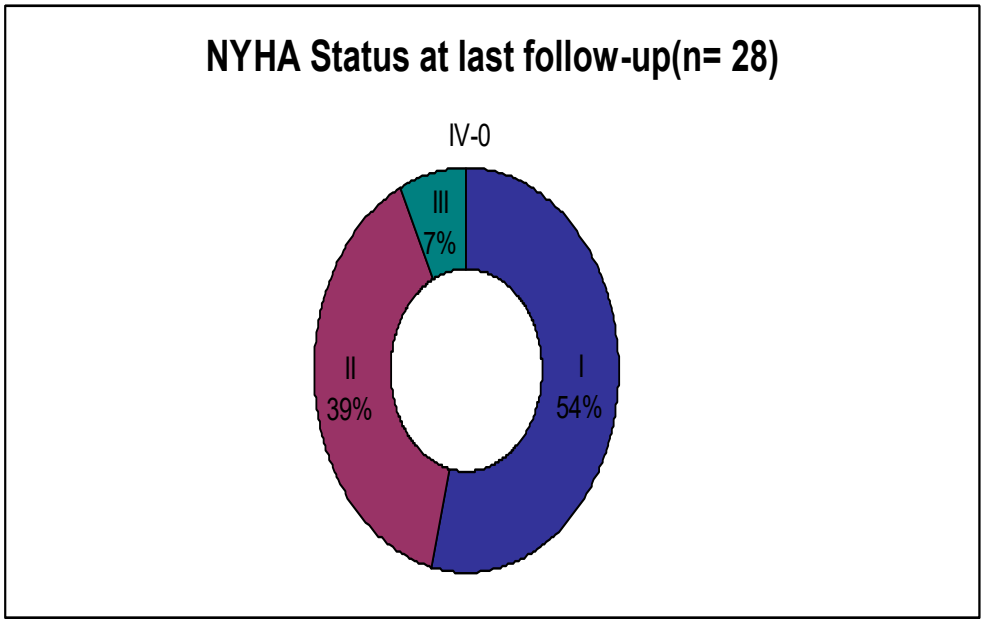

Fig 8 : NYHA status at last follow-up

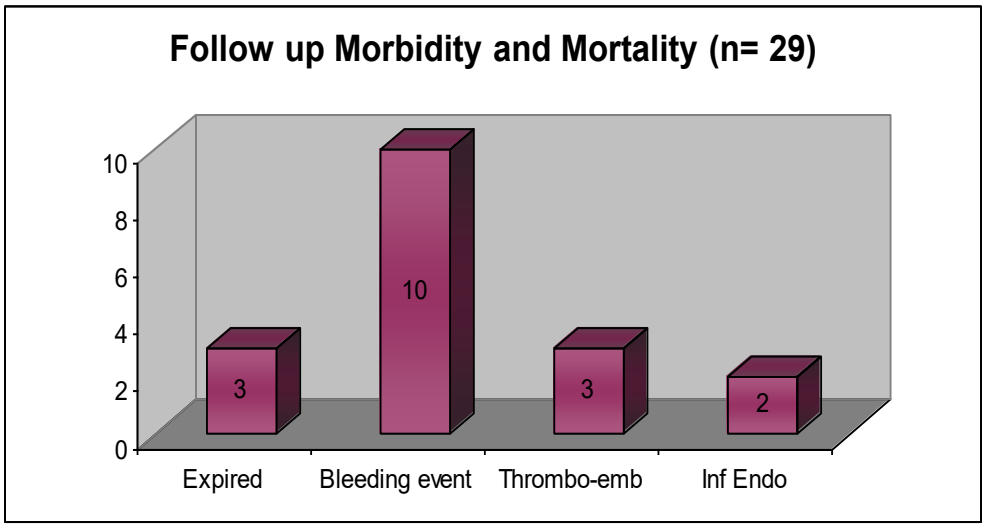

Fig 9: Follow-up Morbidity and mortality data

Table 4: Operative details and in-hospital outcome

Perioperative details	
Surgical priority	
Elective	35(81.39%)
Emergency	8(18.6%)
Preoperative inotropes	3(6.9%)
Congestive cardiac failure	9(20.93%)
Operative details	
Cross clamp time (min)	49.46 ± 12.81 (IQR 42-53)
Cardiopulmonary bypass time(min)	123.90 ± 25.14(IQR 106-141)
Nonfatal postoperative complications after re-operation	
Re-operation for bleeding	3(6.97%)
Pericardial effusion	8(18.60%)
Rhythm abnormalities	31(72.09%)
Septicemia	7(16.27%)
Pulmonary complications	8(18.60%)
Major sternal wounds/mediastinitis	3(6.97%)
Minor wound infections	8(18.60%)
Renal dysfunction	6(16.21%)
Neurological dysfunction	3(6.97%)
Inotropic support > 48 hours	11(25.58%)
Readmission to ICU	8(18.60%)
Outcome measure	
30-day mortality	5 (11.62%)
ICU stay(h)	102 (IQR 48-96)
Hospital stay(days)	13 (IQR 10-16)

IQR: Interquartile range

LATE OUTCOME

The follow-up ranged from 3 months to ten years with a mean follow-up period of 30.45 ± 31.26 months. The total cumulative follow-up period was 944 patient years. The follow-up was 81.57% complete. There were 3 late deaths (9.37%).Congestive cardiac failure was the cause of death in 2 patients and the reason was unknown in 1 patient.

Functional class:

At the time of last follow-up, the NYHA functional classes of the 29 survivors were as follows: 53.57% patients were in class I, 39.28% in class II and 7.14% in class III. The noticed trend was that of those patients who were in class IV at time of reoperation were in class II/III while patients who had been in class III at time of the reoperation were in class I/II.

Anticoagulation related hemorrhage:

Nonfatal major bleeding events requiring treatment occurred in four patients for a rate of 0.12 per 100 patient years. Another six patients had minor bleeding events not needing medical attention.

Thromboembolic episodes:

Three patients had thromboembolic episodes with mild residual neurologic deficits for a linearized rate of 0.1 per 100 patient years.

Prosthetic valve endocarditis:

Two patients (0.06 per 100 patient years) developed infective endocarditis which was successfully managed with appropriate antibiotics.

STATISTICAL ANALYSIS:

Chi-Square test was done to assess the association between operative outcome (those who survived the operation and those who did not survive the operation) and risk factors namely; age, sex of patient, Preoperative NYHA class, surgical priority, presence of infective endocarditis, preoperative renal dysfunction, Presence of CCF, preoperative LV function, previous surgery, present indication for reoperation, present surgery, requirement of preoperative inotropes, total cross clamp time and total CPB time.

The following variables were significant at 5% level: Preoperative NYHA class, surgical priority, presence of infective endocarditis, preoperative renal dysfunction, Presence of CCF, preoperative LV function, previous surgery, present indication for reoperation and total CPB time.

Table 5: Univariate analysis of mortality by risk factors for valvular reoperation

Variable	Survival status		P value
	30 day operative mortality	Survivors	
Age			
<=40 years	3(60)	17(44.7)	0.65
>40 Years	2(40)	21(55.3)	
Gender			
Male	4(80)	23(60.5)	0.635
Female	1(20)	15(39.5)	
NYHA Class			
I	-	-	0.001*
II	-	17(44.7)	
III	1(20)	18(47.4)	
IV	4(80)	3(7.9)	
Surgical type			
Elective	2(40)	33(86.8)	0.037*
Emergency	3(60)	5(13.2)	
Previous Surgery			
Valve repair/Valvotomy	-	5(13.2)	0.003*
Mitral valve replacement	1(20)	11(28.9)	
Aortic valve replacement	-	15(39.5)	
Double valve replacement	2(40)	-	
Intracardiac repair	2(40)	7(18.4)	
LV function			
>55%	1(20)	18(47.4)	<0.001**
35-55%	-	19(50)	
<35%	4(80)	1(2.6)	
Prior Bacterial Endocarditis			
Present	3(60)	2(5.3)	0.008*
Absent	2(40)	36(94.7)	
Indication for reoperation:	-	7(18.4)	0.040*
Structural deterioration	1(20)	5(13.2)	
Nonstructural deterioration	1(20)	1(2.6)	
Valve thrombosis	1(20)	-	
Operated valvular endocarditis	2(40)	25(65.8)	
Progressive native valve disease			
Renal dysfunction			
Present	5(100)	1(2.6)	<0.001**
Absent	-	37(97.4)	
Preop Inotrope			
Yes	3(60)	-	0.551
No	2 (40)	38(100)	
CCF			
Yes	5(100)	4(10.5)	<0.001**
No	-	34(89.5)	
Cardiac pathology			
RHD	2(40.0)	27(71.1)	0.133
Congenital heart disease	3(60.0)	7(18.4)	
Others	-	4(10.5)	
Type of Surgery			
MVR	1(20.0)	18(47.4)	0.447
AVR	3(60.0)	15(39.5)	
DVR	1(20.0)	3(7.9)	
TVR	-	2(5.3)	
Clamp time	59 ± 15.11	48.13 ± 2.08	0.059
CBP time	152.60 ± 26.36	120 ± 22.74	0.005*

When bivariate analysis was performed using logistic regression, priority of operation and prior historyof a bacterial endocarditis or an active infection at time of surgery were significant contribution risk factors for hospital mortality.

Table 6: Logistic regression analysis of incremental risk factors for hospital mortality

Risk factor	Odds ratio	CI(95%)	P value
Surgical priority			
Elective	1	-	
Emergency	0.10	0.013-0.76	0.026*
Prior bacterial endocarditis			
Present	0.037	0.004-0.365	0.005*
Absent	1	-	

Discussion

Cardiac reoperations represent one of the main challenges of cardiac surgery. The number of patients undergoing reoperation for valvular heart disease is increasing and will continue to increase as the general population ages. Rheumatic valvular heart disease will continue to be a health problem for the next few decades in the developing countries. In addition to this, the initial cardiac operations have begun to be performed at an earlier age, and the life expectancy is increasing due to this. Improved management of non prosthesis related complications has led to this occurrence. All these factors will contribute to a higher frequency of redo operations in the future. However the operative risk for reoperations is no longer substantially higher than the primary operation and the reoperation itself is no longer a risk factor for a poor outcome and we believe that cardiac reoperations may be done effectively and with acceptable risks when specific multidisciplinary approaches are adopted. Mortality at heart valve reoperations is higher than at primary valve procedures. However, patients undergoing heart valve reoperations are a heterogeneous group. Patients differ in terms of their initial valve operation, as well as in factors relating to the reoperation.

This retrospective study includes 43 patients collected between January 2000 and December 2009. We retrospectively analyzed in-hospital data from January 1 2000 to December 31 2009, in these 43 patients. All patients had previous open heart surgeries for various etiologies, the bulk of them being valve replacement for Rheumatic valvular disease and needed a new valve operation. Indications for reoperation included native valve defect and mechanical valve complications. All were first redo valvular surgery for an isolated valvular disease. The present study aims at identifying the risk factors for operative mortality (major adverse postoperative event) and also the incidences of major

postoperative morbidity after cardiac reoperation, and thereby enables a fairly comprehensive evaluation of the risk of reoperation.

The observed mortality in this population was 11.62 %, which compares favorably with the results published by Cohn (4) (10.1%), Pansini(22) (9.6%), Tekumit(21)(4.2%). This mortality rate was found to be 37.5% for emergency cases and 5.7% for elective cases. Of these, two had an aortic valve replacement, two had double valve replacements and one had a mitral valve replacement. The cause of perioperative death was cardiovascular in 60% of cases in this cohort of patients undergoing reoperation. This cardiovascular morbidity resulted from especially myocardial failure reflecting the severely compromised hemodynamic conditions of the patients undergoing heart valve reoperations. These results illustrate considerable improvement related to surgical experience and technical progress.

The main factor making cardiac operations different and unique is the need for a sternotomy. Cardiac surgery requiring a re-sternotomy (hence called “redo” surgery) is technically difficult and carries a higher operative risk than the initial operation.[4] The pericardium may or may not be closed after a heart surgery depending upon the surgeon’s preferences, and injuries to the right atrium and ventricle, pulmonary artery, aorta and the innominate vein may occur during resternotomy.[5] Patients with valvular heart disease may be particularly prone to these complications, because right atrial dilatation can result in significant cardiomegaly, atrial thinning and adherence of the heart to the posterior sternum.

The incidence of catastrophic hemorrhage following a re-sternotomy is estimated at 0.5% - 1% (20). Follis et al (20) reported the results of 610 re-sternotomy cases in

which 10 (0.6 %) had an injury during the re-sternotomy and the initial dissection. The right ventricle was the second most commonly injured structure (21.4%). Injuries occurring during the reoperation have caused mortality rates as high as 21%.

In our study group, there were no cases of major cardiac injury/hemorrhage following the sternal re-entry. This result is due to the fact that in our institute, the protocol for re-do cases is the routine use of femoro-femoral bypass before re-sternotomy thus decompressing the cardiac chambers. There was also no instance of any major hemorrhage during adhesiolysis. Small myocardial injuries which occurred during adhesiolysis were tackled with pledgetted prolene sutures. Consideration should be given to the fact that the adhesions were noticed to become less inflammatory and less vascularized over time. Therefore, the longer the interval between the operations is, lesser the chances of injuries during resternotomy and adhesiolysis. Reoperation following a period six months to one year after the last operation are probably the most difficult surgeries.[10] In our study, the mean interval from the first operation to the reoperation was 12.3 ± 7.08 years(range 1 – 29 years).

In valvular reoperations, the following factors were analyzed as being significant predictors of mortality: age, sex of patient, Preoperative NYHA class, surgical priority, presence of infective endocarditis, preoperative renal dysfunction, Presence of CCF, preoperative LV function, previous surgery, present indication for reoperation, present surgery, requirement of preoperative inotropes, total cross clamp time and total CPB time.

By univariate analysis the following factors were determined to contribute to operative mortality: Preoperative NYHA class, surgical priority, presence of infective

endocarditis, preoperative renal dysfunction, Presence of CCF, preoperative LV function, previous surgery, present indication for reoperation and total CPB time. By multivariate analysis, only two factors were significant: surgical priority and the presence of infective endocarditis.

Some studies have shown that age is a factor in death after cardiac surgery, whereas another study disputes this conclusion. Age was not a significant factor in our study. Gender had no effect on the outcome, an observation that agrees with conclusions of Cohn et al (15) and Brandao et al (16). However, a study by Wauthy et al (7) showed evidence that female sex influenced death after cardiac surgeries.

Preoperative functional class was identified as an important determinant of early mortality in this study (P value < 0.001) and is a consistent finding in other series. Mortality for NYHA class IV patients was approximately 57%.This is in comparison with the approximately 5% mortality for class III patients and nil mortality for class II patients. Severe left ventricular dysfunction was probably responsible for the mortality that is associated with reoperation these patients. Cohn and associates also reported higher in patients with NYHA class III-IV. In our study, multivariable analysis failed to show the importance of NYHA functional class as an risk factor and this does not agree with most other studies. This probably is due to a limitation of this study, namely the small number of patients.

Univariate analysis revealed LVEF (p value < 0.001) and presence of CCF (p value < 0.001) as significant factors contributing towards operative mortality.

Emergency surgery was one of the most important factors determining reoperative outcome (OR- 0.1, 95%CI-0.013-0.76,p value=0.026) and the operative mortality for this

cohort in our study was 37.5 %. Other studies(7,9,18) also validate these findings. In this study, we had 18 % of patients undergoing reoperation on a emergency basis. These patients also presented with pronounced cardiac failure and secondary organ manifestations due to low cardiac output. This, in our view emphasizes the importance of minimizing the number of patients requiring emergency surgery reoperation and the most rational approach to this problem is prevention, ie early recognition and referral for surgery before severe ventricular decompensation has established and this suggestion appears logical as is evidenced by the above results. This view is endorsed by Vogt et al (9) in his study of reoperative aortic valve reoperation.

The influence of valve position as a risk factor is controversial. In our study, this factor was found not to be a determinant risk factor (P-value 0.447). Other series report contrary results with the aortic position being significant in some and mitral position being significant in others (7).

Univariate analysis showed the type of initial surgery (P-value 0.003) and the present indication for operation (0.040) to be significant. However multivariate analysis failed to show any significance. The risk at reoperation for those patients who had an initial reparative procedure or those who were undergoing surgery for new native valve disease was extremely low. In this cohort of patients, we had no operative deaths. However, both patients who underwent double valve replacement as the initial procedure experienced operative mortality during reoperation. Such patients were probably not as severely compromised as those requiring surgery on a prosthetic valve. Expectedly, the extent of surgical dissection within the heart would have been less in those who did not require explantation of a previously inserted prosthetic valve. Such a view is endorsed by

Wauthy et al (7) also who had a low operative mortality (3%) for patients undergoing reoperations after an initial reparative procedure or those who were undergoing surgery for new native valve disease.

Infective endocarditis (native or prosthetic valve endocarditis was one of the most significant factors identified in this study (OR-0.037, 95%CI- 0.004-0.365, p=0.005) and other studies (18) as a determinant of early mortality following reoperative valve surgery. Patients with endocarditis are a heterogenous group, many of whom have severe hemodynamic compromise and associated illness. It is therefore intuitive that many of these patients would be at high risk of reoperative surgery, which is often performed on an emergency basis which itself constitutes on of the foremost contributing risk factor for reoperation.

The presence of preoperative renal insufficiency was a predictor of hospital mortality by Univariate analysis ($p < 0.001$). Potter et al (10) and Pansini et al (22) identified renal insufficiency as an independent predictor of morbidity and mortality in patients submitted for valvular reoperations.

Cardiopulmonary bypass time was found to be a significant factor at univariate analysis (P -0.005). However Aortic cross clamp time was not a significant factor (P-0.059). Longer CPB times were associated with other factors such as lengthy operations, multivalvular procedures, or patients with ventricular dysfunction that needed prolonged circulatory assistance. This factor was reported as significant by Brandao et al (16) and Jones et al (10) too.

Early morbidity

Re-exploration for bleeding was required in 3 patients and rhythm abnormalities were noted in a majority of patients (atrial fibrillation was most common) and these very well controlled with medications. Patients who required a greater period of postoperative inotropic support were expectedly those patients who had low preoperative low ejection fractions. The most important cause of morbidity in survivors is pulmonary complications and these in return contributed to readmission to the ICU. Septicemia occurred in 16.27% patients and only one of these patients accounted for an operative mortality. Aggressive medical management is required for those patients who develop sepsis as is evidenced by this study. Major sternal infections and mediastinitis were seen in 3 patients. This also requires aggressive management and intervention through debridement and resuturing. New onset postoperative renal dysfunction was noticed in a few patients, all of whom recovered with conservative management. Dialysis was required in only one patient (this patient had preoperative renal dysfunction). Lass common morbidities noted were new onset neurological dysfunction, pericardial effusions (2 patients required pericardiostomy for evacuation of the effusion), hepatic dysfunction and gastrointestinal bleeding. There were no vascular complications related to the femoral vessels secondary to the cannulation for vascular access. This should encourage the liberal use of femorofemoral bypass in reducing the possible complications of sternal re-entry as is evidenced by our study where we report a zero incidence of catastrophic hemorrhage.

Follow up has not been long enough to allow us to draw any conclusions about the effect of operation on late survival. The bulk of reoperations were done in the last 4 years of the study period. Nevertheless it is quite encouraging that we have observed no

late cardiac related deaths to date. Moreover, the quality of life has been substantially improved with most of the followed up patients having resumed normal physical activity following corrective surgery.

Notably, various technical strategies described to reduce the risk of reoperation have focused on techniques of resternotomy, alternative surgical access including minimally invasive incisions and thoracotomy, myocardial protection and avoiding cardiopulmonary bypass. Different combinations of these techniques have also been associated with good outcomes. Improved monitoring facilities in intensive care units would also have contributed to a reduction in operative mortality despite an older population.

Matsuyama et al (4) reported a low operative mortality rate of 4.2% for reoperative mitral valve surgery with Rheumatic heart disease. They demonstrated that higher age and advanced NYHA class were independent risk factors of lower survival rate. This study has also focused on late morbidity and higher age, previous MVR, and preoperative advanced NYHA class were independent risk factors in multivariate analyses. Of these risk factors, patient age was the most significant risk factor of cardiac events.

Cohn and coworkers found that New York Health Association class IV and emergency operation were significant factors in raising the mortality of reoperation. Otherwise, they found no difference in the mortality of reoperation and primary heart valve replacement (15).

Pansini et al (22) reported a operative mortality of 8.7% and according to their study, Advanced NYHA functional class, emergency operation and previous

thromboembolism were independent determinants of operative mortality. Postoperative complications were not significantly greater than after a re-do procedure than after a primary operation. They also agree that survival can be improved if conditions leading to myocardial damage can be prevented, ie, reoperation is prompt when necessary.

Kuralay et al (19) reported cardiac reoperation using the Carpentier Bicaval femoral venous cannula which was specifically designed for minimally invasive procedures. They reported six severe cardiac injuries in the group where cardiopulmonary bypass was initiated after sternal re-entry in comparison with no injury when cardiopulmonary bypass was initiated first. Similar to our opinion, they concluded that although the policy of initiating cardiopulmonary bypass first increases total bypass time, it has its share of advantage in that the operation time, bleeding and blood transfusion requirement were significantly reduced.

Tekumit et al (21) reported a mortality rate of 4.2% after valvular reoperations. However the study did not look into the contributing factors towards mortality.

Wauthy et al (7) in a review of redo valve surgery reported that the mortality has decreased over the years from as high as 41% in the early 80's to 8% at present. Functional statuses at reoperation, the degree of urgency of reoperation were reported as the primary risk factors for operative mortality. Other risk factors of secondary influence were valve position, double valve replacement, need for tricuspid valve surgery and prosthetic valve endocarditis.

Kumar et at (8) reported an overall mortality following reoperation at the mitral position. They concluded that factors responsible for higher mortality are active infective

endocarditis, higher preoperative NYHA class and valve thrombosis. Emergency surgery and previous thromboembolism were reported to be significant factors.

Potter et al (6) reported an overall mortality of 4.9% following reoperation at the aortic position and concluded that advanced functional class and reduced ejection fraction were the most important predictors of operative risk and reiterated the importance of early referral of patients for surgery before decompensation.

Brandao et al (16) reported an overall mortality of 10.9%. Consistent with our findings, they also reported NYHA functional class, renal insufficiency, cardiopulmonary bypass time and aortic cross clamp time were important factors that determined operative mortality.

Ahujuo et al (6) in areview of reoperative cardiac surgery opined that reoperative cardiac surgery is still an independent factor of operative mortality. According to their study, operative mortality for reoperative surgery was almost 2-fold compared to the primary operation.

Jones et al (10) reported on their study of repeat heart valve surgery which included CABG. They reported an operative mortality of 8.6%.Highest mortality was for patients who underwent reopearation for endocarditis or valvular throbosis((~30%).Mortality was 6.4%,7.4% and 11.5% for aortic, mitral and double(mitral and aortic) valve replacements. They identified age,CABG,indication for surgery and replacement of a mechanical valve rather than a tissue valve as significant variables for operative mortality.

Limitations of the Study:

1, Most information was collected retrospectively, a process that may reduce the validity of some data. We used personal and telephone enquiry, mailed questionnaires as well as outpatient clinical visit records. In view of this detailed method followed and an acceptably good rate of follow-up, we believe this data to be satisfactory and accurate.

2, The small sample size is also a major limitation of the study.

3. A good majority of patients (24 patients) were operated in the last 3 years of study. Hence even a five years follow up will not be completed for patients who were operated after 2007.

4, The inclusion of patients who underwent the first operation for varied etiologies, thus forming a heterogenous study group. The patient group includes reoperation for progressive disease along with patients in who valve failure has resulted from prosthetic dysfunction and thrombosis. This category has nothing in common with the title except for the fact that they may have initially had rheumatic valve disease.

5. The predictors of adverse outcome were not identified separately for aortic and mitral valve reoperations because of the small number of events in the patients undergoing the specific operations. While we accept that aortic and mitral valve reoperations provide different surgical challenges, the preoperative status of the patient can have a profound influence on the surgical outcome. Advanced aortic and mitral valve disease would both present with severe symptoms, which is identified in this study as an independent predictor of major adverse postoperative event.

CONCLUSION

In conclusion, we have shown in this small series that repeat heart valve surgery can be performed with an acceptable operative mortality that compares favorably with results in other published series. However, several categories of patients have an increased risk of death at reoperation. These include patients with higher NYHA class, surgical priority, presence of infective endocarditis, preoperative renal dysfunction, Presence of CCF, preoperative LV function, previous surgery, present indication for reoperation and total CPB time. In addition, the indication for reoperation, especially thrombosed valves or prosthetic valve endocarditis, carries an increased risk.

It is important that patients with prosthetic valves undergo regular follow-up with assessment of valve function and should undergo earlier reoperation before severe ventricular dysfunction occurs. In spite of regular follow-up, it is noted that majority of patients present with severe symptoms at reoperation, which is a predictor of major adverse postoperative event, including death, after valve reoperation. Hence, surgery should be considered early in the management of recurrent or progressive cardiac disease before severe symptoms develop and compromise the outcome of reoperation.

In patients undergoing re-operative surgery, our unit protocol is to establish cardiopulmonary bypass before resternotomy and this is a valid and reproducible option to render cardiac reoperations safer and more expeditious in the reentry phase. The absence of cannulae in the operating field makes the procedure more comfortable. The liberal use of this strategy is recommended in redo cases is recommended. In our experience, there was no single instance of catastrophic hemorrhage and also it results in decreased total operative times and also decreased need for blood transfusions. No patient

experienced complications related to femoral cannulation. The Seldinger method allowed little vascular trauma and intraoperative patency of femoral vessels.

Reoperative surgery continues to pose a significant challenge to the entire cardiothoracic team. Careful patient selection and assessment, a tailored strategy based on accurate risk stratification, and a team approach in the perioperative period can decrease the incidence of adverse events, reducing morbidity and mortality. Further minimization of the risk is obtained by strict adherence to sound basic surgical principles and techniques. Generally speaking, optimal planning for reoperation prior to deterioration to NYHA class III–IV levels and before unfavorable co-morbid conditions have arisen is imperative to ensure good outcomes. Following these guidelines in the modern era, elective reoperative surgery can be performed with results similar to those of the primary operation.

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APPENDIX

PROFORMA FOR RETROSPECTIVE STUDY OF A 10 YEAR FOLLOW UP PERIOD OF PATEINTS UNDERGOING REOPERATIVE VALVE SURGERY

NAME : HOSPITAL NO:

AGE : SEX : M/F

ADRESS :

DATE OF ADMISSION :

DATE OF SURGERY :

DATE OF DISCHARGE :

DATE OF DEATH :

FINAL DIAGNOSIS :

PREOPERATIVE DETAILS:

SYMPTOMS

TYPE OF LESION :

SYMPTOMS :

NYHA CLASS I/ II/ III/ IV :

PRESENCE OF ATRIAL FIBRILLATION :

PRESENCE OF CCF :

HISTORY OF RHEUMATIC HEART DISEASE :

PENICILLIN PROPHYLAXIS :

HSTORY OF INFECTIVE ENDOCARDITIS

HISTORY OF NEUROLOGICAL EVENT

SMOKING/HYPERTENSION/DIABETES MELLITUS

RENAL DYSFUNCTION

PREVIOUS CARDIAC ETIOLOGY –RHEUMATIC HEART DISEASE /CONGENITAL HEART DISEASE/OTHERS

PREVIOUS OPERATIVE PROCEDURE

INTERVAL TO REOPERATION(YEARS)

OPERATIVE DATA OF THE PATIENTS AT REOPERATION:

PRIORITY OF SURGERY

SURGICAL PROCEDURE(MVR/AVR/TVR/DVR(MVR+AVR/MVR+TVR)

CARDIOPULMONARY BYPASS TIME (MIN)

AORTIC CROSS-CLAMP TIME (MIN)

INOTROPIC SUPPORT

REQUIREMENT OF IABP SUPPORT

POSTOPERATIVE PERIOD/COMPLICATIONS:

RE-EXPLORATION FOR BLEEDING

DURATION OF IONOTROPIC SUPPORT-HIGH/LOW

DURATION OF VENTILLATION-LESS THAN 24 HRS/MORETHAN 24HRS

CODUCTION DEFECTS REQUIRING PPI

PERICARDIAL EFFUSION

NEUROLOGICAL DEFICIT

WOUND INFECTION

RENAL DYSFUNCTION

RESPIRATORY COMPLICATIONS

HEPATIC DYSFUNCTION

GASTROINTESTINAL COMPLICATIONS

ANTICOAGULATION RELATED BLEEDING

CAUSES OF OPERATIVE MORTALITY:
CARDIAC

LOW CARDIAC OUTPUT

REFRACTORY ARRHYTHMIA

ENDOCARDITIS

ANTICOAGULATION-RELATED BLEEDING

NON-CARDIAC

AIR EMBOLISM/NEUROLOGICAL EVENT

SEPSIS

RESPIRATORY COMPLICATIONS

MEDIASTINITIS

REVIEW AT FOLLOW-UP VISIT

DATE: 6MONTH/2YR/5YR/10YR

DURATION FROM SURGERY

TIME OF DEATH AFTER SURGERY

SYMPTOMS AT FOLLOW-UP

NYHA CLASS I, II, III, IV

LATE MORTALITIES AND MORBIDITIES.

CAUSES OF MORTALITY

CARDIAC

VALVE-RELATED

ENDOCARDITIS

ANTICOAGULATION-RELATED HEMORRHAGE

VALVE THROMBOSIS

NON-VALVE-RELATED

CCF

ARRHYTHMIA

NON-CARDIAC

RENAL FAILURE

RESPIRATORY COMPLICATIONS

UNKNOWN

FOLLOW UP COMPLICATIONS

ANTICOAGULATION-RELATED HEMORRHAGE

MINOR

MAJOR REQUIRING HOSPITALIZATION

THROMBOEMBOLIC EPISODES

ANEMIA

POSTOPERATIVE IE TREATED MEDICALLY