

Right Thoracotomy Beating Heart Technique in Emergency Re-Do Mitral Valve Surgery: Is it Still Justified?

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Abstract

Background:

With the progressive aging of the western population, cardiac surgeons are faced with treating an increasing number of critically ill and elderly patients. Controversy exists as to whether the ordinary mid-sternotomy approach to these malfunctioning mitral valves will do the job or if the new right thoracotomy approach without cross clamping the aorta is better suited to take care of the problem. The potential to avoid mid-sternotomy surgery in re-do patients with little chance of survival and poor quality of life postoperatively would spare unnecessary suffering, reduce operation mortality, and enhance the use of resources.

Methods: We managed 125 cases of severely ill patients admitted to our department on referral from rural areas with malfunctioning prosthetic mitral valves from July 15, 2000 through to August 30, 2012. In our study of 23 patients with right thoracotomy approach, 13 patients were women. Preoperatively most of the patients were not moribund, but 59% had ischemia. All of the patients had prosthetic mitral valves. Hospital mortality and morbidity modes, based on our overall experience with 125 patients operated on for malfunctioning mitral valves during the period of the study were developed by means of multivariate logistic regression with preoperative and intra operative variables used as independent predictors of outcome.

Results: Our overall hospital mortality was 13% compared with 21% of standard median sternotomy procedures. There was no intraoperative mortality. All patients who survived had one or more postoperative complications. Mean hospital stay was 17 days with an average of 10 days in the intensive care units. All of the survivors (21 patients) discharged from the hospital were able to function

independently and their survival at 6 months was 100%. Statistical analysis of the overall experience with this new operation for malfunction of prosthetic mitral valves confirmed that via Right Thoracotomy, the cross-clamping of the aorta is the most important independent patient risk factor associated with 30-day mortality and morbidity.

Conclusion: Operations for critically ill patients involve increased hospital mortality and morbidity. Short-term survival is unfavorable and is associated with poor quality of life. With additional corroborative studies to endorse the present findings, the use of right thoracotomy approach to have access to malfunctioning mitral valve without the cross-clamping of the aorta remains a substantiated concept. In the context of these critically ill patients, the hypothesis that right thoracotomy approach without the cross-clamping of the aorta should be advocated for surgical intervention to save these patients and to conserve resources is supported by the presented data.

Key words: Emergency heart surgery, mitral valve malfunction, thoracotomy

Introduction

With important demographic changes taking place in cardiac surgical practice, critically ill patients are more frequently undergoing complex operations (1-4). Controversy exists as to whether the classical mid-sternotomy approach with cross-clamping of aorta is better tolerated by patients compared to right thoracotomy without the cross-clamping of the aorta. Published studies on elective coronary bypass graft and valve surgery reveal that elderly and critically ill patients should not be denied these procedures, although the treatment of older patients involves increased hospital mortality and morbidity, and longer hospital stays (1-3).

Malfunctioning prosthetic mitral valve is generally an acute condition and mortality from this remains high despite important advances in operative therapy. Recent reports indicate that cardiac function is a risk determinant of early results after emergency valve surgery. The study reviews our experience with a particular subset of patients with malfunctioning prosthetic mitral valves referred to our center.

Patients and Methods

We reviewed the records of 23 malfunctioning mitral valve patients who underwent surgery via right thoracotomy from July 15, 2000, to August 30, 2012 at Heart Hospital, in Tehran, Iran. They represented 18% of 125 operations for prosthetic valve malfunction performed in the same period.

The clinical characteristics of these patients, consisting of 13 women and 10 men are presented in Table 1. The mean age of patients was 43.8 years (median 33; range 20-55 years). All the patients had associated diseases. On admission, no patient was moribund and none required external chest compression for cardiopulmonary resuscitation, although 67% of the patients had hemodynamic instability. One patient was unconscious on admission, and 2 had a preoperative stroke. Renal and respiratory insufficiency was present before admission in 29% and 70% of the patients, respectively. A total of 57% of the patients had a reduction in renal function preoperatively, which was largely attributable to hemodynamic instability.

Ischemia was encountered in only one patient. Moderate to severe chronic cardiac failure was present before admission in 29% of the subjects.

No patient was refused surgery because of age or concomitant disease. On admission, all the patients had severe coagulation disorders. Platelet aggregation (aggregometry) and homeostasis (thromboelastography) were markedly reduced in all the patients. In addition, variable degrees of thrombocytopenia, low levels of the thrombin inhibitor angiotensin III, and coagulation factors (fibrinogen, V, VU, \mi, and DC), and high levels of plasmin degradation of cross-linked fibrin (D-dimer) were measured. All procedures were performed with emergency status within 24 hours after the initial onset of dyspnoea on

exertion and chest pain, and all the patients were operated on within 4 hours of their arrival. The operative techniques used are summarized in Table 2.

Operative Technique

All the operations in this series of 23 cases were performed through right thoracotomy incision according to previously described standard surgical techniques. In the last case, ascending aortic cannulation was done instead of femoral cannulation, which was due to a history of recent bilateral femoral artery embolectomy procedure. Preoperative coagulation disorders were aggressively treated from the time of admission with the aid of blood bank products, antithrombin III, aprotinin and coagulation factor concentrates.

Continuous ultra filtration during CPB was occasionally used as was a cell saver device (Haemonetics Corp., Braintree, Mass). Arterial pressure monitoring lines were routinely placed in radial arteries. Systemic anticoagulation for CPB was accomplished with heparin at an initial dose of 3 mg/kg body weight. Adequate heparinization for CPB was assessed with the activated clotting time (Hemochron FTK-ACT; International Technique Corp., Edison NJ), with further dose of heparin administered as required so as to maintain an activated clotting time greater than 750 seconds. At the end of the procedures, heparin was neutralized with protamine (0.8 mg of protamine per milligram of heparin). CPB was established with cardiac indices of 2.0, 2.5 L. Min⁻¹ m⁻². Cooling was stopped at 33° C in patients operated on without the cross-clamp technique under mild hypothermia. Arterial inflow adequacy was assessed clinically. Acid-base management during mild hypothermia was via an alpha-stat approach. Before opening the left atrium, the head-down position (Trendelenberg) was established and immediately after opening the left atrium, provision was made to render the mitral valve incompetent so that the left ventricle would pump into the left atrium instead of the aortic root.

The postoperative homeostasis protocol used was derived from that proposed by Szefer, and included tests for platelet function, thrombin formation and its regulatory pathways, and for the fibrinolytic system. Treatment included the administration of small doses of protamine, modulated doses of aprotinin, fresh frozen plasma as well as fibrinogen. Dosages were adapted to each patient's clinical profile as well as to test interpretation criteria in order to provide personalized treatment.

Statistical Methods

Medical records of all the 125 patients operated on for malfunctioning mitral valve between July 18, 2000, and August 30, 2012, were reviewed and preoperative variables that were believed to have an impact on outcome were obtained (Table 1). Data were studied by descriptive and statistical analyses. The SPSS application software version 10.0 (SPSS Inc., Chicago, ILL) was used for statistical analyses.

Table 1: Clinical data

Incision Clinical data	Right thoracotomy	Media sternotomy
Mean age \pm SD (range) (y)	43.8 \pm 3.3 (22-55)	41.2 \pm 2.9 (24-59)
Female	13 (46%)	99 (80%)
Hypertension	6 (28%)	16 (13%)
Smoking	8 (33%)	23 (22%)
Diabetes	0	13 (13%)
PVD	2 (14%)	9 (7%)
Angina	2 (14%)	9 (7%)
COPD	7 (28%)	22 (20%)
Cardiac Insufficiency	21 (86%)	113 (93%)
Hypotension	16 (71%)	94 (75%)
Mitral valve Regurgitation	8 (32%)	81 (65%)
Pericardial effusion	10 (43%)	86 (69%)
Cardiac tamponade	3 (14%)	34 (28%)
CPR	3 (14%)	16 (13%)
Myocardial ischemia	3 (14%)	12
Oligoanuria	12 (43%)	24
Visceral Ischemia	1 (8%)	20
Coagulation disorder	20 (86%)	117

Table 2: Operations

	Right thoracotomy	Median Sternotomy
No. of patients	23	125
Aortic cross-clamping	0	125 (100%)
Mean myocardial ischemic time \pm SD (range, min)	0	65 \pm 33 (43-127)
Mean pump time \pm SD (range, min)	71 \pm 27 (45-118)	120 \pm 43 (63-260)
Associated procedures		
CABG	1 (6%)	2 (2%)
Aortic valve surgery	0	5 (4%)

SD indicates standard deviation; CABG (Coronary Artery Bypass Grafts)

Significant differences between the two procedure groups (i.e. median sternotomy and right thoracotomy without aortic cross-clamping) were assessed with univariate analysis (Tables 1 to 3): categorical data were compared by means of the χ^2 test or the Fisher exact test (as appropriate) and continuous variables with the student t test. Data were further analyzed by univariate and multivariate logistic regression with the response variable on the one hand being hospital mortality (30 days mortality), and on the other hand, morbidity. All variables with a zero or near zero cell count were treated as continuous so that convergence could be obtained. Multivariate models were applied to isolate the effect of each factor adjusted for all other

factors: the 0.25 level ($P < 0.25$) was used as a screening criterion for the selection of candidate variables. In order that problems created by multi collinearity could be avoided, variables that were too highly correlated among them were included at different times in different models. A background procedure was used. A Wald χ^2 test was used for testing the significance of individual coefficients. The results are shown as odds ratios with 95% confidence intervals.

Results

Descriptive Analysis

Mortality: Overall hospital mortality was 13% (three patients, Table 3).

Table 3: Complications

	Right Thoracotomy (n=23) Without X-clamp	Median Sternotomy (n=125) With X-clamping
Hospital mortality (30 days)	3 (13%)	26 (21%)
No complication	0	14 (12%)
One or more complication	10 (44%)	109 (88%)
Intra-operative death	0	12 (9%)
Re-operation	0	9 (8%)
Prolonged inotropic support	12 (33%)	34 (28%)
Post operative death (30 days)	3 (13%)	19 (15%)
Multi-organ failure/ Sepsis (death)	3 (13%)	9 (8%)
Death	0	5 (4%)
Permanent stroke	1 (4%)	8 (7%)
Hemodialysis	0	5 (4%)
Prolonged Respiratory support	1 (4%)	39 (31%)

Intra-operative mortality was 9% (12 patients). Intra-operative deaths included all 9 patients with bleeding from coagulation disorders. The bleeding was due to the poor quality of the ventricular tissue at the site of adhesional release in 9 patients and to the technique of repair in the other patients.

Mortality from cardiac causes was 12% (15 cases); 12 patients could not be weaned off the CPB because of intractable cardiac dysfunction and 2 died postoperatively of low cardiac output on postoperative days 8 and 15 respectively. Permanent neurologic damage with cerebral death occurred in 9 (7%) patients. Sepsis complicated by multi-organ system failure (specifically renal and respiratory failures), was the cause of death in 10 (8%) patients. Multiple reoperation for bleeding were required in 9 (8%) other patients. Intravascular disseminated coagulation (DIC) in its different phases was present in all patients from the time of admission. Despite aggressive management and routine blood coagulation tests, coagulation factor levels and fibrinol: vsin remained abnormal for the duration of CPB. Factor V, factor VIII, Fibrin degradation products (FDP), antithrombin III, D-dimer levels, and platelet counts were the most evident defects before, during, and after CPB and in the postoperative period.

Prolonged postoperative inotropic support for low cardiac output was required in 34 patients. Respiratory failure necessitating tracheostomy for prolonged assisted ventilation occurred in 39 patients, of whom 9 died of sepsis before hospital discharge. Stroke with neurologic

damage complicated the postoperative course of 8 (7%) patients.

Five patients required hemodialysis treatment. The presence of renal failure in the postoperative period was associated with death in all patients with this complication. The mean duration of hospital stay was 38 days with an average of 10 days in ICU.

Late Mortality:

Six patients who had preoperative moderate COPD required prolonged ventilator weaning and were discharged from ICU from 32 days to 44 days afterwards. Of these, 3 died of pneumonia later on and the remaining succumbed to malignant arrhythmias during re-hospitalization later on for respiratory failure. One patient who had post operative renal failure died of cardiac arrest during dialysis 5 months after the operation.

Statistical analysis

The two procedure groups examined (right thoracotomy vs. median sternotomy) were not significantly different from each other with respect to the majority of perioperative characteristics that are believed to have an impact on outcome in patients with malfunctioning prosthetic mitral valve (Tables 1 and 2). As indicated by univariate analysis, perioperative patient variables correlated to operative mortality were median sternotomy ($P<0.001$), bleeding ($P<0.001$), and cardiac ischemia ($P=0.02$). For morbidity, univariate analysis indicated the following significant variables: median sternotomy ($P<0.0001$), and

preoperative myocardial ischemia ($P=0.05$). Mortality and morbidity models based on multivariate logistic regression analysis confirmed that median sternotomy (as a continuous variable) is by far the most important risk variable.

Discussion

In recent years, technical improvement in emergency redo mitral valve operation for malfunctioning prosthetic mitral valves, associated with better perioperative management and postoperative care of the patient, has resulted in an acceptable decline in hospital mortality rate. In our hospital, the results obtained in right thoracotomy incision without cross clamping of the aorta (Tables 1 to 3) confirm these achievements. The dismal outcome that we have observed in patients with median sternotomy with the cross clamping of the aorta indicates that the procedure and the consequent cross clamping of the aorta further exposes this population to the risk of complicated outcomes. Median sternotomy patients have higher hospital mortality and more complications, even though preoperative differences between the two procedural groups are trivial. This is particularly the case for the variable found to be critical in the statistical model of mortality and morbidity elaborated in this study. The same models indicate that many preoperative factors traditionally associated with a poor outcome such as renal insufficiency, stroke, cardiac insufficiency and chronic obstructive pulmonary disease, do not serve here as predictors of mortality and morbidity, thus confirming the advances made in the management of patients with acute malfunctioning mitral valve. The critical influence of median sternotomy as the most important variable on the postoperative outcome is demonstrated by our study. From a statistical point of view, the variable "redo median sternotomy with cross-clamping of aorta" condenses a variety of factors that are very difficult to categorize and quantify. These include physiologic and pathologic factors related to the normal degenerative processes of tissues that are beyond the control of the surgeon. As such, significant reductions in mortality rates appear very difficult to achieve. Our study corroborates the hypothesis that median sternotomy with the cross-clamping of the aorta goes beyond the limits of surgery in very ill patients, unlike other cardiac operations, which can be performed via right thoracotomy without arresting the heart with a high risk but with a favorable long-term outcome.

In this era of diminishing economic resources for health care, the question of whether such a new approach of surgical therapy should be offered to these patients is very relevant.

Society must always face the reality of limited medical resources and must find mechanisms for distributing these resources fairly and efficiently. In recent years the focus for the evaluation of health services has shifted from unnecessary treatment, especially unnecessary surgery, to the appropriateness of the treatment. Treatments that are extremely unlikely to be beneficial and are extremely cost-

ly may be considered inappropriate and hence inadvisable, but they should not be labeled futile. Three sources of value are defined that give meaning to "appropriateness" in patient care: the clinical point of view, the point of view of each individual patient, and the societal point of view(4). These concepts necessitate that the ethical and economic implications of medical services be integrated into outcome-based guidelines.

The aim of this study was to examine whether surgery for redo mitral valve malfunction in critically ill patients via median sternotomy and arresting the heart is beneficial to this population. In light of the data presented, we conclude that such surgical treatment is inappropriate while right thoracotomy without cross-clamping the aorta remains our other option.

In all these cases the surgeon is emotionally and ethically involved. As stated by Daniel J. Ulliyot(5) the appropriate application of technology begins early in the clinical encounter. Very often, in the presence of very ill subjects, what appears as inappropriate is to refer the patient for surgery. A surgical consultation offers the patient more than the simple agreement to do the procedure, because it creates expectations in the patient or patient's family, making the decision how to operate extremely difficult. So that these difficulties can be overcome, practice guidelines based on scientific data need to be written. The present work aims to provide a small contribution to this commitment.

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