ORIGINAL RESEARCH

Evaluation of the Clinical Efficacy of Heart Valve Surgery in Patients with a Cardiac Disorder and the Factors Contributing to Poor Patient Prognosis

Ruofan Liu, MM; Yuntao Li, MM; Guangyu Pan, MM

ABSTRACT

Objective • We aimed to investigate the clinical efficacy of heart valve surgery in patients with heart disease and the factors contributing to poor patient prognosis.

Methods • This was a retrospective analysis of 172 patients with heart disease treated in Peking University International Hospital between January 2019 and December 2021, with surgical treatment in the study group (86 patients) and conservative treatment in the control group (86 patients), by comparing factors such as patient age, preoperative cardiac function status, type and degree of valve lesion, surgical method and time of aortic block and perioperative treatment in both groups with clinical cure rate. The risk factors for early postoperative death were analyzed by single-factor and multi-factor logistic regression methods.

Results • Regression analysis showed that age, peripheral artery disease (PAD), diabetes mellitus (DM), hypertension (HTN), dietary habits and medical compliance were prognostic factors in patients after heart valve surgery. The incidence of complications was lower in the study group than in the control group ($P < .05$). The left anterior descending artery (LAD), left ventricular end-diastolic internal diameter (LVEDD), cardiothoracic ratio (CTR) and left ventricular end-systolic internal diameter (LVDS) was decreased in both groups, whereas the left ventricular ejection fraction (LVEF) and peak early diastolic flow rate/peak late diastolic flow rate (E/A) were increased. The changes were greater in the study group than in the control group ($P < .05$); life function scores and survival rates were higher in the study group than in the control group ($P < .05$).

Conclusions • The analysis of relevant clinical risk factors identified some independent prognostic factors affecting early death after valve replacement. These can be used for preoperative risk assessment, identification of high-risk surgical patients and guiding daily clinical work. Rationalizing the indications for surgery, choosing the timing of surgery, myocardial protection and appropriate surgical approach can further reduce the rate of surgical morbidity and mortality and complications in this patient population. (*Altern Ther Health Med.* 2023;29(8):30-35)

Ruofan Liu, MM; **Yuntao Li,** MM; **Guangyu Pan**, MM; Department of Cardiac Surgery, Heart Center, Peking University International Hospital, Beijing, China.

Corresponding author: Guangyu Pan, MM
E-mail: 18402017@masu.edu.cn

INTRODUCTION

With the advances and continuing progress in medical technology, improvement in the standard of living and increase in average life expectancy, the future of cardiac surgery is facing a major challenge with the widespread implementation of transcatheter interventional techniques. In addition, the landscape has changed significantly with the rise in heart valve surgery and the increase in valve complexity, and the difficulty of performing coronary artery bypass surgery is increasing year by year.[1,2] Heart valve disease is a common clinical heart disease, mainly caused by rheumatic fever, mucus degeneration, degenerative changes, congenital malformation, ischemic necrosis, infection or trauma that results in gradual thickening of the valve leaflets, fusion of valve edges and shortening of tendon fusion. These pathological changes make the valve orifice area smaller, restrict ventricular filling and affect the normal flow of blood, causing abnormal heart function. The valve orifice is decreased and ventricular filling is restricted, affecting the normal flow of blood and resulting in abnormal heart function and eventually leading to heart failure with single or multiple valve lesions.[3,4] Coronary artery disease (CAD) is caused by thrombi blocking coronary arteries due to rupture of atherosclerotic plaques.[5] As the population ages, age-related valve disease and valve lesions caused by CAD and myocardial infarction are becoming more common.[6,7] The incidence of degenerative valve disease in the elderly is increasing rapidly, with the literature showing that

approximately 8% of people abroad aged 56 to 75 years and up to 18% of people aged 80 years or older[8] have severe calcified valve stenosis, Once a patient becomes symptomatic, the natural prognosis for heart valve stenosis is poor, with an average survival of only 2 to 3 years.[9]

Extensive patient history of cardiac disease, which often leads to multiple heart valve lesions, severe myocardial damage and often secondary systemic impairment of multiple organs, the systemic immune system and low nutritional status increase the risk for heart valve surgery and mortality.[10] Heart valve replacement is an effective treatment for severe heart valve disease, and although the maturation of anesthesia technology, the improvement of extracorporeal circulation, surgery and postoperative monitoring technology have significantly reduced surgery mortality rates, the number of patients with preoperative combined diabetes (DM), hypertension (HTN), chronic obstructive pulmonary disease (COPD) and renal abnormalities is increasing, and the number of elderly patients undergoing surgery is also gradually increasing.[11] These high-risk factors make the mortality rate of complications after valve replacement is high, reported to be 5% to 8% in some studies.[12,13] Because of the differences in the etiological characteristics of the heart and patient characteristics in China and abroad, the types of valve lesions prevalent in China are different from those in other countries.[14] At this stage, the main cause of valve disease in western developed countries is degenerative valve lesions, whereas heart valve lesions in China are mostly combined mitral and aortic valve lesions.[15] Of patients with both severe aortic stenosis and moderate mitral regurgitation, 66% will have worsening regurgitation after mitral valve repair.[16]

Active enhancement of perioperative management of high-risk patients has effectively prevented postoperative complications and reduced mortality early in patients who are post-heart valve replacement. We retrospectively collected clinical information from adult heart valve replacement patients in our cardiac surgery department to evaluate the in-hospital mortality rate after heart valve replacement and to study the related risk factors and analyze early prognoses. We retrospectively analyzed the causes of early mortality and associated risk factors in heart valve surgery, and provided cardiac surgeons with effective treatment options to improve the patient cure rate. Through the collection of perioperative data on heart valve disease, an in-depth analysis of the risk factors associated with death after heart valve replacement is important to better grasp the surgical indications and reduce the incidence of perioperative death and complications.

MATERIALS AND METHODS

General Data

A total of 172 patients with heart disease admitted to Peking University International Hospital between January 2019 and December 2021 were selected to participate in our study. In the control group, there were 45 men and 41 women, mean age 46.32 ± 2.45 years, mean disease duration 3.51±0.24 years. Medical history included 21, 22 and 25 patients with combined diabetes mellitus (DM), hypertension (HTN) and hyperlipidemia (HLD), respectively, and 9, 14, 42 and 21 patients with cardiac functional classification of I, II, III and IV, respectively. In the study group, there were 46 men and 40 women; mean age 45.17±2.39 years, mean duration of illness 3.54±0.23 years. Medical history included 24, 21 and 23 patients with combined DM, HTN and HLD, respectively, and 10, 13, 41 and 22 patients with cardiac functional classification of I, II, III and IV, respectively. The profiles of the 2 groups were compared and approved by the hospital ethics committee.

Inclusion Criteria

Patients were included in the study who: (1) underwent heart valve surgery; (2) were ≥18 years of age; (3) also underwent coronary artery bypass grafting (CABG); (4) had smooth anesthesia during heart valve replacement, good myocardial protection and smooth surgery; and (5) had routine and timely symptomatic management after valve replacement surgery. All patients included in the study signed an informed consent form.

Exclusion Criteria

Patients were excluded from the study who: (1) had indications for surgery but did not undergo surgery; (2) developed acute heart failure and died before surgery; (3) developed low cardiac output syndrome and died during surgery; (4) were under long-term intensive care treatment after heart valve replacement and were discharged automatically because their families decided to stop treatment.

Methods

Conventional drug treatment. After admission, the patient underwent electrocardiogram (ECG) and other routine evaluations. The severity and clinical type of heart disease in each patient was determined, and drugs such as cardiac pain killer tablets, heart and brain health capsules, positive inotropic drugs and diuretics were administered in accordance with the patient's specific situation.

Heart valve surgery. The surgery was performed under general anesthesia; albumin was added to the pre-flush solution and ice chips were used to cool the surface of the heart. An incision was made in the median sternum, extracorporeal circulation was instituted and the appropriate valve replacement was selected according to the patient's situation. In patients with atrial thrombus, the thrombus needs to be removed after cardiac arrest. The mitral structure is preserved, the tricuspid structure is evaluated and the mitral valve is replaced. If the tricuspid valve failed to close, DeVega angioplasty was performed and a temporary epicardial pacing lead device was placed on the heart surface. If the heart's visceral resuscitation enabled observation of the status of the tricuspid valve closure, nitroglycerin and dobutamine were administered. After completion of the procedure, conventional medication such as sildenafil and furosemide were given.

Analysis of poor prognostic factors. A custom hospital questionnaire was distributed to the patients, and the nursing staff explained its content and purpose to the patients, who filled it out by themselves. The content of the questionnaire mainly contained the patients' age, peripheral arterial disease, DM status, HTN status, dietary habits and compliance behavior. The questionnaires were collected immediately after completion.

Observation Indicators

Cardiac function. The parameters of left atrial internal diameter (LAD), left ventricular end-diastolic internal diameter (LVEDD), left ventricular ejection fraction (LVFF) and left ventricular end-systolic internal diameter (LVDS) were measured by echocardiography, and the peak early diastolic flow rate/peak late diastolic flow rate (E/A) and cardiothoracic ratio (CTR) were calculated.

Complications. The number of cases of cerebral infarction, arrhythmia, low cardiac transfusion syndrome, sternal infection and secondary open-heart hemostasis was determined and the incidence was noted. The incidence was inversely related to the patient's prognosis.

Life functions. The 36-Item Short-Form Health Survey (SF-36) scale[6] was applied to assess patients' physiological, physical function, health, energy and somatic pain functions, with a total possible score of 100. A higher score was positively correlated with improvement in life functions.

Survival status. Patients' survival time was determined and cumulative survival function curves were plotted.

Survival rate. The number of patients surviving at 1, 3 and 5 years was counted and the survival rate was calculated.

Statistical Analysis

Data analysis was performed using IBM SPSS 22.0 statistical software (IBM Corp, Armonk, New York USA). If the data conformed to normal distribution, the count data were described by composition ratio and rate, the chi-square test was used for analysis of inter-group variability, measurement data were expressed as mean ± standard deviation), and $P < .05$ was determined to be statistically significant. Logistic regression was used to analyze the factors influencing patients' prognosis. The graphing software used in this study was GraphPad Prism 8 (GraphPad Software, Boston, Massachusetts USA).

RESULTS

Multifactor Analysis of Patient Prognosis After Heart Valve Surgery

Table 1 shows the factors influencing the prognosis of patients including age, PAD, DM, HTN, dietary habits and compliance behavior via logistic regression analysis.

Comparison of Cardiac Function in the 2 Treatment Groups

Before treatment, there was no significant difference in cardiac function in the 2 groups ($P < .05$). After treatment, LAD, LVEDD, CTR and LVDS decreased and LVFF and E/A increased in both groups, with a greater change in the study group than in the control group ($P < .05$) (see Figure 1).

Table 1. Multifactorial Analysis of Patient Prognosis After Heart Valve Surgery

Independent Variable	β-value	SE-value	Wald χ^2 value	*P* value	OR value	95% CI
Constant	1.441	0.285	9.046	-	-	-
Age	1.093	0.262	5.849	0.011	2.751	2.201-3.855
PAD	1.267	0.302	6.311	0.004	3.285	2.695-4.169
DM	1.302	0.329	7.387	0.006	3.785	3.195-4.149
HTN	1.398	0.353	10.296	0.031	4.375	3.263-5.112
Dietary habits	1.185	0.294	8.701	0.045	2.995	2.088-3.865
Medical compliance	0.901	0.212	7.735	0.021	1.998	1.228-2.735

Abbreviations: DM, diabetes mellitus; HTN, hypertension; PD, peripheral artery disease.

Figure 1. Cardiac function in both groups.

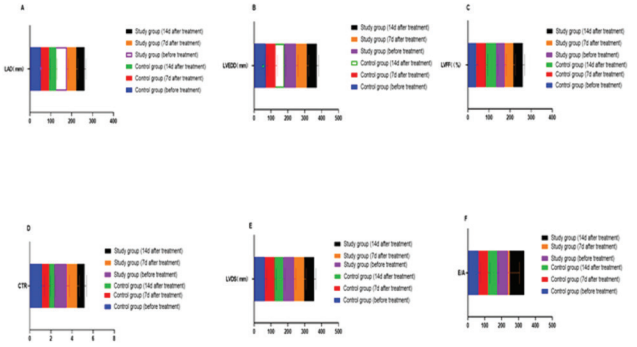
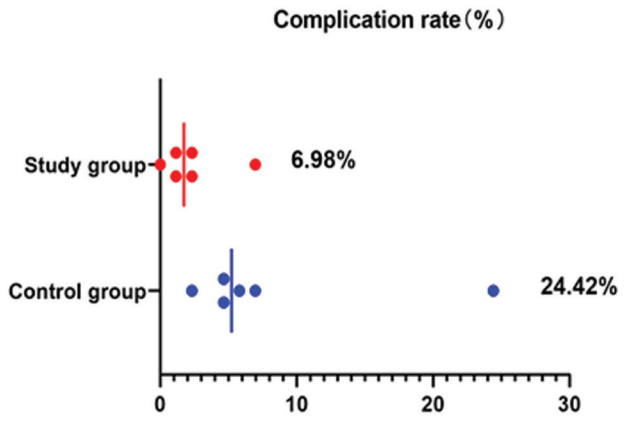


Figure 2. Complication rate in the 2 groups.



Comparison of Complications in the 2 Groups

The complication rates in the control group and the study group were 6.98% and 24.42%, respectively, with the study group having a lower complication rate than the control group ($P < .05$) (see Figure 2).

Comparison of Life Functions in the 2 Groups

The study group had higher scores in physiology, physical function, health, energy and somatic pain than the control group ($P < .05$) (see Figure 3).

Figure 3. Life function in the 2 groups.

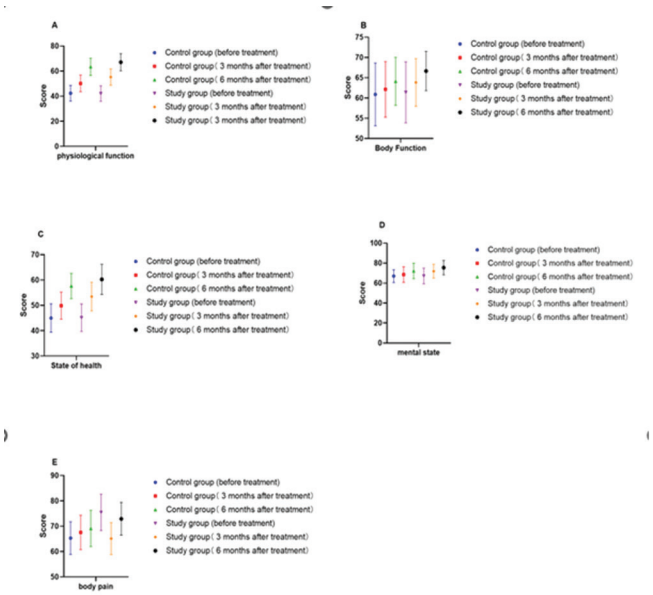


Figure 4. Survival rate in the 2 groups.

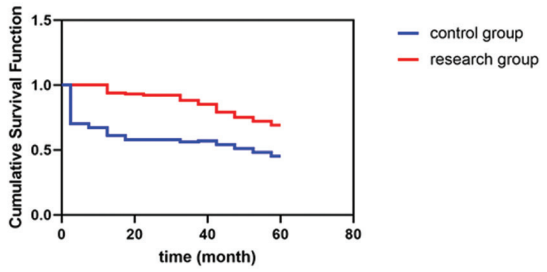
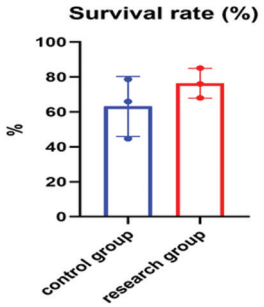


Figure 5. Survival rates in both groups.



Survival Rate in the 2 Groups

With the extension of time, the value of cumulative survival function decreased significantly in the control group, while there was no significant change in the study group. From the overall trend, survival time in the study group was significantly longer than in the control group ($P < .05$) (see Figure 4).

Comparison of Survival Rates in the 2 Groups

The survival rates at 1, 3 and 5 years were 78.72%, 65.96% and 44.68% in the control group and 85.11%, 76.00% and 68.08% in the study group ($P < .05$) (see Figure 5).

DISCUSSION

With advances in cardiac surgery, patients who were previously considered "inoperable" due to poor left ventricular function can now be considered for surgery.[17] The clinical presentation (stable, acute coronary syndrome, recent infarction, chronic heart failure), nature and extent of cardiac disease (pure coronary artery disease, associated valve disease, pulmonary HTN) and the degree of cardiac insufficiency are important factors in determining surgery risk. In most patients with low to moderate risk, surgical risk is generally not significantly increased. However, in rare situations such as recent infarction (within 24 hours), severe left ventricular insufficiency (ejection fraction <20%) and cardiogenic shock with or without post-infarction mechanical complications (septal perforation or papillary muscle rupture) are strong risk factors for surgical mortality.[18,19] Abnormal cardiac function after cardiotomy can exacerbate organ insufficiency in associated preoperative comorbidities, such as chronic kidney disease, which can increase surgery mortality.[20] In patients undergoing cardiac surgery, the goal is to return to as normal a life as possible, including employment.

As patients age, complications become more numerous and the degree of cardiac damage becomes more severe.[21] Preoperative surgical risk assessment has also become increasingly important. Large clinical databases are available to evaluate the outcomes (including complications and morbidity and mortality rates) of common procedures such as CABG and valve replacement surgery.[22] Identification of preoperative organ insufficiency or risk factors associated with its occurrence is necessary to reduce postoperative complication rates and mortality.[23] This is particularly important in older patients, who are more likely to develop renal insufficiency, ventilatory problems, stroke, hemorrhage and atrial arrhythmias. To prevent these complications or to minimize the adverse effects of their occurrence, special measures should be taken promptly.

Heart valve replacement remains the most common and effective treatment for severe valvular lesions, and postoperative recovery is dependent on a variety of factors, including the length of the patient's cardiac disease history, vital organ function, changes in cardiac pathophysiology and timely management of the perioperative period.[24] With the progress made in cardiac surgery technology, the mortality rate of heart valve surgery is gradually decreasing, but complicated factors such as longer patient cardiac disease history, heavier heart valve lesions and poorer cardiac function, heart valve surgery still has a certain morbidity and mortality rate, which is reported to be 5% to 8% both in China and abroad. The in-hospital mortality rate is related to age, cardiac function, extracorporeal circulation time, surgical method, postoperative complications and other risk factors; the total in-hospital mortality rate for patients undergoing valve surgery is 55%.[25]

The results of multivariate logistic regression analysis showed that age ≥60 years, cardiac function class IV, extracorporeal circulation time ≥2 hours, simultaneous CABG,

and postoperative complications were independent risk factors for early death after valve surgery. Therefore, it is important to pay attention to the risk factors associated with valve surgery affecting early mortality, so that the preoperative assessment of surgical indications and surgical risks and preoperative active and effective treatment can be clinically significant in reducing heart valve perioperative complications and mortality.

Logistic regression analysis revealed that age, PAD, DM, HTN, dietary habits and compliance affect the prognosis of patients after heart valve surgery. Advanced age was an important factor affecting patient prognosis, with increasing age corresponding to increasing incidence of postoperative complications, as well as affecting the recovery of vascular endothelial cell function and adversely affecting the synthesis of vasoactive substances. Patient prognosis is also associated with underlying diseases such as HTN and DM. The degree of atherosclerosis in patients is closely related to insulin resistance, which produces direct damage to the vascular endothelium and accelerates the development of the disease. The results of this study are consistent with the results of the 2021 study by Aalaei-Andabili, et al.[26] In patients with combined HTN, local shear stress and blood vessel turbulence are altered, platelets are activated, smooth muscle cells proliferate and the chance for atherosclerotic lesions increases. Therefore, patients with DM and HTN should undergo regular physical examinations and need to perform moderate daily exercise. In addition, poor dietary habits can lead to metabolic disorders, thus accelerating the rate of atherosclerosis and making it easy for lumen restenosis and intra-arterial thrombosis to occur with high postoperative risk. Therefore, patients should follow a rational healthy diet. Studies[27] have confirmed that low compliance, low awareness of disease prevention and failure to review lipids, blood pressure and blood glucose indicators in a timely manner in some patients with heart disease can affect their prognosis. Therefore, active return visits and supervision by relevant hospital personnel are necessary. Secondly, cardiopulmonary protection measures should also be developed for patients during the treatment process to control the pulmonary artery pressure index, improve the success rate of the procedure and improve patient prognosis. Routine inspection of the tricuspid valve is also required during treatment, and tricuspid regurgitation should be corrected in a timely manner if it occurs.

After treatment, the patients in our study showed substantial reductions in LAD, LVEDD, CTR and LVDS, and an increase in LVFF and E/A. This treatment can improve the patients' myocardial ischemia symptoms in a timely manner, and the diastolic and systolic functions of the heart will also improve accordingly, which has a better effect on the recovery of patient cardiac function. The patients' quality of life improved significantly after surgery, and the cumulative survival function values in the control group decreased significantly over time, while those in the study group did not change significantly. The overall trend was that patients in the study group had a significantly longer survival time than the patients in the control group. The results suggest that transvalvular valve replacement therapy in patients with heart disease is safe and reliable and worth promoting.[28,29] The survival period of patients with heart disease treated with transvalvular valve replacement was prolonged and more effective than drug therapy.[30]

Prior to this study, data on heart valve surgery for heart disease were collected and a multicenter large sample study was conducted to ensure the accuracy and feasibility of the study. The study aim was innovative in that it analyzed the factors affecting patient prognosis on the basis of treatment. However, continued efforts are needed in future studies to extend the years of prognostic follow-up and to provide post-hospital guidance for patients to speed up their recovery.

CONCLUSION

Our study found that the independent predictors of early mortality after heart valve replacement in hospital inpatients included patient age, preoperative cardiac function, degree of cavity enlargement, type of valve lesion and surgical approach and time to extracorporeal circulation transfer for combined coronary artery lesions. In this study, we systematically evaluated patients' general condition, heart disease and postoperative cardiac comorbidities, and evaluated the results in light of findings from relevant domestic and international literature in order to draw prospective conclusions. Our aim was to enable surgeons to clarify surgery risks and the optimal treatment time and protocol needed. We believe that patients with heart valve disease should be adjusted to below the threshold values of these risk factors before surgery in order to reduce risk and mortality.

Study Limitations

The analysis provided by this pilot study provides a reference for clinical selection, diagnosis, and patient treatment. However, the small sample size of this retrospective trial and the incomplete nature of the data collected during the review of clinical cases may still have limitations. Based on the clinical indications cited under specific conditions, the risk of surgery and the decision regarding whether or not to operate and the surgical plan should be evaluated according to different types of patients. The statistical results of this study may be different from actual situations, which should be further investigated by future studies with large sample populations. In addition, the number of patients included in the study varied because the general condition of heart valve disease varies among different study groups, and our main reference data come from the American College of Thoracic Surgeons (STS database), so there may be some differences between our results and the results from other similar studies.

We believe that as the overall level of cardiac surgery and monitoring improves, as well as the understanding of this disease, the perioperative mortality rate of valve replacement in heart valve disease will be further reduced and the near-term and long-term survival rate and quality of life of this patient population will be improved.

In the meantime, we look forward to more studies in the future with larger patient samples to provide more objective references and clinical experience in patients undergoing valve replacement for heart disease.

CONFLICT OF INTEREST

None.

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