

Aortic Valve Surgery

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ABSTRACT

Background: Rheumatismal, organic or congenital valvular heart disease (**RVHD**) is an important cause of mortality and heart failure in developed and developing countries, yet. It frequently affects older male peoples whose ages 24-70 years. Factors associated with the choice of treatment for heart valve disease remain variable. Our aim was to report the outcomes of aortic valve surgery in our young's and elderly patients who underwent heart valve replacement or repair.

Methods: Between 1999-2015, we operated 796 patients who have had rhematic valvular disease. According to propensity score mathing analyses, 312 patients with isolated aortic valve disease or concomitant with mitral valve disease after rhematismal fewer have been selected as group 1 and group 2. The most concomitant pathology was severe mitral valve disease, and/or tricuspid valve insufficiency which did not requirement of replacement or valve plasty. All patients had rhematic valvular heart disease (**RVHD**). Surgery was performed on one valve (aortic valve surgery) in 144 patients (46.1 %) (group 1), two valves in 168 patients (group 2). Transthoracic

and if needed transesophageal echocardiography (**TEE**) has been used for preoperative right and left ventricular functions. In patients whose ages older than 45 yrs or have severely depressed myocardium, coronary angiography, the right and the left heart catheterisation has been performed preoperatively. All operations were performed under cardiopulmonary bypass (**CPB**) using with aortic cross-clamping. Clinical outcomes, demographics, co-morbidities were analysed.

Results: RVHD patients were younger, more likely to be female, to have atrial fibrillation (**AF**) and previous percutaneous balloon valvuloplasty for mitral valvular stenosis (PMVP). Factors associated with receipt of mechanical valves in RVHD were AF (OR:2.29) and previous PBV (OR:1.66) and valve surgery (OR:2.90). Predictors of valve replacement included being Indigenous (OR 2.89) and having fewer valves requiring surgery (OR 0.10). Overall there was a significant increase in the use of mitral mechanical prosthetic valves over time.

Conclusions: Isolated mechanical or bioprosthetic valves can be used safely in every patient with valvular heart disease to treatment of rheumatic heart disease. In older patients and in young female who want to pregnancy in her life span, bioprosthesis could be choose in the surgical valve replacement. Our experiences shows that treatment of RVHD due to calcific stenosis or valvular insufficiency, surgery can be perform are more common in older males. Anticoagulation and antiaggregant use for future management after valve surgery is related morbidity, pregnancy in young females and lifestyle plans.

Keywords: Rheumatic valvular heart disease; Aortic stenosis; Mitral valve disease; Prosthetic valve replacement

INTRODUCTION

Valvular heart disease due to senile calcification or rheumatismal disease is an important health problem in our country [1-7]. 15-19 million people are living with RVHD, with almost 80% of those residing in low and middle-income countries [8-10]. RVHD remains an important cause of preventable heart disease in some indigenous populations in developed countries [10]. In our populations at risk of RVHD, outcomes following cardiac surgery can be inferior despite being of younger age at time of surgery. This is likely to be related to factors including comorbidities, barriers to specialist health care and the ability to achieve safe anticoagulation during long-term follow-up. The most common heart valves affected by RVHD and non-RVHD causes are the mitral and aortic valves, less commonly the tricuspid and rarely the pulmonary valve in around the world. Rheumatic valve disease most commonly leads to regurgitation [12-16] and less commonly to valve stenosis or mixed regurgitation and stenosis [17]. Although the majority of patients with rheumatic valvular heart disease are only mildly affected, [1] a minority progress to more severe disease requiring valve surgery [18]. The options for surgical management of rheumatic valve disease are valve repair or replacement with a mechanical prosthesis or bioprostheses. There are limited data available about factors which might affect the choice of surgery in patients with rheumatic valve disease. This decision is likely to be influenced by patient geography, medication

access and use, timing and venue of referral, gender and access to ongoing care and follow-up. The aim of this study was to examine the rural area patient population having valve surgery for RVHD and review the pre-operative factors associated with the choice of surgical management of RVHD in our hospital. Recently, in selected population, transcatheter aortic valve implantations (**TAVI**) have been introduced in aortic valve surgery [19-22]. Early diagnosis and the institution of appropriate measures without delay is important in minimizing postoperative morbidity and mortality. Transesophageal echocardiography (**TEE**) and direct echo to aortic valve surgery.

The aim of this chapter is to describe the details of preoperative assessment and clinical outcomes of patients undergoing aortic and/or mitral valve surgery between 1999 and 2015 in our clinic.

PREOPERATIVE MANAGEMENT

The ascending aorta is an important factor for operation of the aortic valve procedures. In the surgical procedures, intraoperative embolus and/or aortic dissection during arterial cannulation and cross clamping can be present. The assessment of aorta for severe calcification preoperative three dimensional multi detector computed tomography was performed in our older patients. Improved visualization is obtained through the left atrium and right pulmonary artery as an acoustic window [23,24]. Another is the X-Plane mode. In the Aortic Valve Surgery midesophageal ascending aorta long-axis view with the probe tip anteфлекed, the orthogonal scanning plane is tilted upward [25]. Both the distal portion of ascending aorta and the aortic arch can be visualized through the left atrium as an acoustic window. From the upper esophageal arch long- and short-axis views, the ascending aorta can be visualized by tilting the orthogonal scanning plane downward [26]. The ascending aorta should be assessed for calcification and atheromatous plaque to provide peroperative atheromatous embolus. When the aorta is severely calcified or porcellane aorta, it may be necessary to change the perfusion routes to the axillary artery or femoral artery during the cardiopulmonary bypass procedure. When femoral arterial perfusion is chosen, the atheromatous lesion in the descending aorta should be assessed. If the calcified aorta is clamped, it is checked for a new dissection immediately following declamping to minimize a delay in recognition and treatment.

The gold standart is selective coronary angiography in older patients with severe aortic stenosis. However, the proximal portion of the coronary arteries, which can be visualized with TEE. The ostium of the right coronary artery is found in the right coronary sinus. Although only a few centimeters of right coronary artery can be visualized due to the large distance from the transducer, the posterior descending artery can be visualized in the posterior interventricular groove in the transgastric mid-short-axis view [27]. The left coronary ostium is visualized in the left sinus of Valsalva by rotating the TEE probe counterclockwise from the midesophageal aortic valve short- or long-axis view [28].

PATIENTS AND METHODS

We collected database of two hospitals for analysis of aortic valvular heart surgery. The study has been approved the Local Ethics Committee. A propensity score analysis was used to minimize patient’s selection bias for our research. Demographic variables of female sex, preoperative NYHA functional class IV, end-stage renal disease, and emergent operation were used in propensity matching. This model had an area under the receiver operating characteristic (**ROC**) curve of 0.65. A p-value less than 0.20 were defined for selecting variables for entry into the final model. As a result, the propensity score adjusted sample included 312 patients. The database included patient demographics, co-morbidities, pre-operative status, previous interventions summarized in Table 1. Haemodynamic data, surgery type, surgical and post-operative outcome data have been analysed. The most concomitant pathology was mitral valve disease, and/or moderate type tricuspid valve insufficiency which has not been required replacement or tricuspid valve plasty. Surgery was performed on one valve (aortic valve surgery, **AVR**) in 144 patients (46.1 %), and mitral valves replacement (**MVR**) in the remaining 168 patients (53.9 %). The mean age of study population was 58±18.7 years [24-70].

Table 1: Patient Demographics (n=312).

| Variables | Group A (n=144) | Group MA (n=168) | P-value |
|----------------------------------------------------|-----------------|------------------|---------|
| Age (years) | 59.7 ±1 3.5 | 66.1 ± 9.6 | 0.96 |
| Range | 24–70 | 39-71 | – |
| Gender,M/F | 58/86 | 56/112 | 0.53 |
| Body surface area (m ²) | 1.54±0.10 | 1.60±0.20 | 0.543 |
| NYHA functional class IV | 11 | 7 | 0.74 |
| Hypertension | 136 | 91 | 0.66 |
| Diabetes mellitus | 48 | 57 | 0.72 |
| Hyperlipidemia | 45 | 53 | 0.78 |
| Coronary artery disease | 0 | 0 | 1 |
| Atrial fibrillation/flutter | 56 | 44 | 0.85 |
| Chronic renal failure | 10 | 6 | 0.099 |
| COPD | 9 | 11 | 0.59 |
| Etiology | | | |
| Stenosis | 79 | 90 | 0.61 |
| Mixed | 65 | 78 | 0.58 |
| Echocardiographic findings | | | |
| Ejection fraction (%) | 56.2 ± 14.3 | 57.9 ± 13.5 | 0.72 |
| ≤35% | 32 | 44 | 1 |
| Peak pressure gradient (mmHg) | 72.4 ± 29.4 | 78.3 ± 32.2 | 0.7 |
| Left ventricular mass index (g/m ²) | 163 ± 49 | 161 ± 50 | 0.79 |
| Aortic valve area (cm ²) | 0.89 ± 0.25 | 0.77 ± 0.30 | 0.64 |
| Annulus diameter (mm) | 20.6 ± 2.1 | 19.9 ± 1.9 | 0.78 |
| COPD: Chronic obstructive pulmonary disease | | | |
| NYHYA: New York Heart Association | | | |

STATISTICAL ANALYSIS

Data are presented as the mean \pm standard deviation. The chi-square test (Fisher's exact test when appropriate) or t-test was used to analyze categorical variables. A p-value < 0.05 was considered to indicate statistical significance. The Kaplan–Meier method was used to calculate the overall survival curve and freedom from valve-related death, cardiac events, bleeding events and stroke events, and tested for significance using the log-rank test. All statistical analyses were performed using the JMP 17.0 software package (SAS, Cary, NC, USA).

SURGERY FOR REPLACEMENT

Midline total sternotomy incision was performed in 118 AVR and 110 MVR operations. A partially sternal incision and a right thoracotomy was performed in the remaining 26 AVR and 58 MVR operations, respectively. An antegrade and retrograde myocardial perfusion using a blood cardioplegia was performed prior to aortic cross-clamping. There are two ways in antegrade cardioplegia via a root cannula. If patients with a severely calcified aorta, the aorta may not be used for antegrade cardioplegia delivery or incompletely clamping. As a result, cardioplegic solution can be washed out by leaking blood. When a patient goes into ventricular fibrillation, mild aortic regurgitation may be responsible for regurgitation of cardioplegic solution, leading to distension of the left ventricle. In this problem, the left ventricle sucked from the right upper pulmonary vein. In all patients with aortic disease, the selective root cannula fit the ostium during the surgery. Thus, an adequate myocardial protection has been provided. The myocardium was also protected by retrograde cardioplegia via coronary sinuse which can be cannulated prior to cardiopulmonary bypass.

The study cohorts (AVR group and MVR Group) was divided into two groups according to type of prosthetic valves: In AVR group, In AVR group, mechanical valve has been used in 86 patients (75.4 %). In the remaining 28 patients, bioprosthetic valve was used. Mechanical valves was used in patients less than 65 years of age at our institution. In young males, in the case of small aortic annulus, anatomical issues (supravalvular stenosis, low position of coronary ostium), ghrnic kidney disease patients, or conditions requiring anticoagulant therapy, a mechanical valve is used in patients aged 65 years old or older.

For MVR groups, we used mechanical heart valves in 134 patients (79.7%). If there was an mixed regurgitation, details of every cusp and the valsalva sinuses were reported peoperatively using TEE. Because the direction of blood flow is nearly perpendicular to the ultrasound beam in both views, Doppler measurements as an assessment of the pressure gradient in patients with aortic stenosis are done in TEE echocardiography may be used following patient sedation and lochal anaesthesia in the operating room. Because of the aortic cusps and the sinus of Valsalva visualization is limited in two-dimensional doppler imaging, we propose 3D TEE for visualizing all cusps.

Prior to aortic valve replacement, we have many of artificial valves choices such as mechanical bi-leaflets, bioprosthetic or conduits which including an artificial mechanical valve. Totally 62 bioprosthetic valves were used for aortic or mitral position (19.8 % of patients). Bioprostheses are being used increasingly in our clinic because of its long-term durability in older patients as well as its lack of dependence on anticoagulation such as coumadin, or in seven females who want to be a pregnancy in the future life span.

The major disadvantage of bioprostheses was annular size limits in patients with small stature. In 27 patients from Group A, annular enlargement was performed prior to aortic valve replacement. We preferred Nicks or Manougiu technique for enlarging the aortic annular diameter to provide patients' properties and aortic valve size mismatch in the operations. Calcifications after valve replacements in the annulus can be seen in the follow-up period. To provide between the native aortic annulus and bioprostheses, we are using transthoracic echocardiography, for detailed annular size measurement with TEE in the operations. Aortic annulus and the proximal right coronary artery is visualized with the hinge points of intraoperative TEE for patients' safety. The internal dimension of the aortic sinuses can then be measured easily. In those older patients with a heavily calcified aortic annulus, the external margin of calcium is calipered in order to assess the largest implantable valve size that would accommodate a single U-shaped or mattress suture after the calcium is meticulously removed using a ronger. One size smaller prosthetic heart valve can be chosen for intraannular placement if needed. The internal diameter at the sinotubular junction level is important as well as annular diameter. When it is equal to or smaller than the annular dimension it is difficult to insert the prosthetic valve down to the annular level and a very narrow space for ligation is anticipated.

FOLLOW-UP

The patient's condition and data after hospital discharge were determined by hospital visits, telephone interviews, and consultations with the family physician. Follow-up was 100% complete. The median follow-up period for all patients was 44.9 months (range: 8–104 months). There was no significant difference in the mean follow-up period between the Aortic and Mitral groups (43.9 vs. 53.8 months, respectively, $p = 0.241$).

ANALYSIS

The aim of the analysis was to describe patients who underwent valve surgery for rheumatic valve disease, to compare patients with isolated aortic valve disease or mitral valvular disease. Demographic data included age, and gender as defined by the statistical standard. Co-morbidities assessed included chronic kidney disease, preoperative serum creatinine, blood urea nitrogen, diabetes mellitus and hypertension.

The pre-operative status relating to underlying heart disease included symptomatic status based on the New York Heart Association (NYHA) classes I to IV, pre-operative arrhythmia,

myocardial function (left ventricular ejection fraction) (**LVEF**) (stratified to $\geq 50\%$ or less than 35 %), previous percutaneous balloon valvuloplasty. Valvular lesions were analysed according to the valve(s) affected, the type of valvular dysfunction (regurgitation, stenosis or mixed), the number of valves affected. The type of prosthetic valve replacement has been analysed. According to valve replacement procedures, the patients who underwent MVR or aortic valve replacement divided into two groups as mechanical and bioprosthetic valve replacement group.

DISCUSSION

Systematic review of the outcomes after surgical AVR and MVR showed that after bioprosthesis and mechanical prosthetic valve safely in accordance with patients' preoperative characteristics in our both groups in accordance with previous publications [29-34]. The postoperative results of the published studies demonstrated that individual patient outcomes is good and provides the cost-effectiveness of AVR surgery using mechanical heart valves [35-40]. Since 2012, TAVI or suturless aortic valve surgery were performed in selected patients in our clinic. According to the literature, TAVI is indicated in patients with severe aortic stenosis who are not suitable for surgery, and have a >1 year life expectancy [41-45].

There are several differences in the patient and study characteristics between the studies on bioprostheses and mechanical heart valves [46-49]. Patients in our studies on bioprostheses are older, they have more concomitant systemic disease and the mean follow-up duration of studies on bioprostheses is shorter than for mechanical prosthesis [50-52]. These differences make it impossible to draw meaningful conclusions about the differences in performance between bioprostheses and mechanical valves based on the results of the published studies. In many institutions, root replacement instead of subcoronary valve replacement is the technique of choice for implanting allografts in the aortic position. This trend is also reflected in our patients where studies with a larger proportion of root replacement as the surgical technique are generally studies with a more recent implantation period [54-57].

The early mortality risk after AVR is decreased because of improvements in the past in diagnosis and perioperative management of valve replacement patients [58-61]. Our results indicated that studies reported lower early mortality risks. In women whose ages more than 65, more symptomatic (advanced NYHA class), have smaller body surface areas, and more comorbidities, and more often require emergency operations [61-63]. Delayed presentation of valve problems and/or later referral of women to cardio-thoracic surgery may explain some of the differences in risk profile. Some studies found an increased early mortality risk in women undergoing AVR with concomitant CABG, but there is no evident association between gender and early mortality after isolated AVR [64-67].

The results of our study showed that low risks for most early events after AVR and MVR with bioprostheses. They reflect that AVR is a safe procedure; however, these low risks can also reflect underreporting since most included studies did not report early event occurrence. Of

note, although reports included an early event risk for endocarditis during the first postoperative month, the risk of experiencing endocarditis still increases until 6 months postoperatively after which it reaches a plateau close to zero in the literature. Occurrences of early valve-related events after AVR with bioprosthesis were not or rarely reported. Previous studies illustrated that late deaths after AVR or MVR could be cardiac or non- valve related. The remaining non-valve-related cardiac mortality can be ascribed to the excess mortality risk in patients after AVR, due to underreporting of valve-related events and left ventricular dysfunction associated with heart valve disease. Our results confirmed that the commonly reported finding that higher patient age at implant is associated with a higher risk of late mortality after AVR with bioprostheses.

For bioprosthesis, there was a lower late mortality in the studies with a high proportion of patients with pre-intervention NYHA class III/IV. This seems counterintuitive, but might be explained by the fact that the indication in most patients receiving bioprosthesis is endocarditis, which is often accompanied by a worse pre-intervention NYHA class [68-70]. The authors have shown that the late mortality of hospital survivors after AVR or MVR for endocarditis is comparable with the general population [71-73]. This indicates that although these patients have a worse functional class before surgery, after surgery their endocarditis is cured and their mortality hazard returns to that of the general population. This can also explain why the late mortality rate is lower in studies on allografts with a more recent implantation period; in recent years, the indication for using allografts for AVR is often endocarditis.

Three recent studies, where the indication for surgery was endocarditis in more than 40% of the patients, reported relatively low late mortality rates [74-76]. Furthermore, the low mean age of two studies with a high proportion of concomitant procedures might explain why studies with a high proportion of concomitant procedures report lower late mortality rates [76]. Surprisingly, prospective studies on different valve types reported lower late mortality rates than retrospective studies. This observation is probably caused by more common use of prospective design in more recent years.

For bioprostheses, the most commonly reported late valve-related event was not arrhythmia but thromboembolism, reflecting the advanced age of the patient population and the common occurrence of atrial fibrillation (**AF**) in this age group [77]. The occurrence of atrial arrhythmia was less than 1% per year and more common in studies with a lower mean patient age, which confirms previous observations. Prospective studies on bioprostheses reported lower AF rates compared with retrospective studies [78-80]. This was unexpected because one would expect that prospective studies report higher AF rates because of more accurate patient follow-up [81-83].

The occurrence of endocarditis after AVR or MVR was low in our series. This is remarkable because the indication for AVR or MVR with bioprosthesis was often endocarditis in young patients. Our study results confirm that bioprosthesis have a good resistance to infection. In

the meta-regression, several associations were observed related to late occurrence of different valve-related events after bioprosthetic aortic valve. However, given the observational design of studies included in the review, the small number of studies reporting late valve-related events after allograft AVR and the low event occurrence rates; these associations should be interpreted cautiously and will not be further discussed here. As would be expected, valve-related reinterventions in bioprostheses studies showed low occurrence rates and were usually for AF, whereas endocarditis was less common indication.

Studies with a relatively old patient population reported lower reintervention rates. This is in accordance with previous reports that show that older patients are less likely to be reoperated on. Valve-related reinterventions in allografts were most often for AF.

Although it should be noted that in stented bioprostheses studies, the proportion of males is higher, as is the proportion of patients undergoing concomitant cardiac surgery such as coronary artery bypass surgery, the results of the published studies indicated that early mortality risk and late mortality rate appeared lower in studies on stentless bioprostheses compared with stented bioprostheses.

The observed lower late mortality rate in stentless bioprostheses is in accordance with the hypothesis that the haemodynamic superiority of stentless bioprostheses results in survival benefits compared with stented bioprostheses, but may also be the result of patient selection. The lower late mortality rate in bioprosthesis studies makes it difficult to directly compare the durability of valve with that of stented bioprostheses as the risk of death competes with the risk of AF and reintervention. Many studies included AVR with concomitant CABG [16,28,64]. The results of our study did reflect the only outcomes after isolated AVR or MVR.

To explore the influence of including studies reporting on outcomes of AVR with concomitant CABG, we have performed a subgroup analysis in the studies on bioprostheses comparing the outcomes of studies excluding concomitant CABG. This subgroup analysis showed that there are differences in the outcomes of AVR with CABG. Furthermore, concomitant CABG could be required in AVR patients, and therefore, to provide conflicts of the our surgical experiences we presented only the first time isolated aortic or mitral valve surgery.

This comprehensive systematic review provided an overview of the outcomes after surgical AVR with bioprostheses during the last 6 years. The results of this systematic review could supported the patients and surgeons in the prosthetic or mechanical valve choice and could be used in microsimulation models to predict patient outcomes and estimate the cost-effectiveness of AVR and MVR with or with our bioprostheses compared with current and future heart valve prostheses.

Table 2: Operative Data in Propensity-Matched Groups (n = 312).

| Variables | Group A (n = 144) | Group M (n = 168) | P-value |
|-----------------------------------|-------------------|-------------------|---------|
| Urgency or emergency | 3 | 3 | 1.000 |
| Resternotomy | 0 | 1 | 1.000 |
| Operation time (min) | 194 ± 66 | 166 ± 55 | 0.54 |
| Cardiopulmonary bypass time (min) | 89 ± 24 | 87 ± 19 | 0.97 |
| Aortic cross-clamp time (min) | 66 ± 21 | 61 ± 24 | 0.67 |
| Mean labeled valve size (mm) | 19.6 ± 1.4 | 27.3 ± 2.6 | |
| Combined procedure | | | |
| PV isolation | 3 | 2 | 1.000 |
| Myectomy | 14 | 0 | 0.80 |
| Aortic annular enlargement | 49 | 0 | |

Table 3: Early outcomes in both groups.

| Variables | Group A (n=144) | Group M (n=168) | P-value |
|-------------------------------------------------|-----------------|-----------------|---------|
| Early outcome | | | |
| Complications | | | |
| Complete AVB | 3 | 4 | 1.000 |
| Re-exploration for bleeding | 2 | 3 | 1.000 |
| Stroke | 2 | 1 | 0.363 |
| Ventricular fibrillation | 4 | 2 | 1.000 |
| Sepsis | 1 | 1 | 1.000 |
| Mediastinitis | 3 | 2 | 0.495 |
| Death | | | |
| 30 days | 5 | 6 | 0.618 |
| In-hospital | 3 | 4 | 1.000 |
| Echocardiographic findings | | | |
| Ejection fraction (%) | 51.1 ± 9.5 | 54.8 ± 8.3 | 0.466 |
| Peak pressure gradient (mmHg) | 25.0 ± 7.5 | 21.2 ± 8.6 | 0.392 |
| Left ventricular mass index (g/m ²) | 144 ± 36 | 153 ± 59 | 0.670 |
| Indexed EOA (cm ² /m ²) | 0.88 ± 0.12 | 0.79 ± 0.20 | 0.813 |
| <0.80 cm ² /m ² | 17 | 13 | 0.387 |
| <0.60 cm ² /m ² | 4 | 1 | 0.363 |
| Late outcome | | | |
| Variables | Group B (n=144) | Group M (n=168) | P-value |
| Congestive heart failure | 4 | 3 | 0.76 |
| Myocardial infarction | 2 | 4 | 0.87 |
| Angina pectris | 1 | 0 | 1.000 |
| Complete AVB | 4 | 2 | 0.595 |
| Bleeding | 3 | 7 | 0.91 |
| Stroke | 6 | 3 | 0.65 |
| Reoperation | 2 | 4 | 0.90 |
| Death | | | |
| Valve-related | 3 | 5 | 0.720 |
| Noncardiac related | 2 | 4 | 0.820 |
| NYHA functional class | | | |
| I | 51 | 112 | 0.020 |
| II | 26 | 34 | 0.034 |

AVB: Atrioventricular block; **EOA:** Effective orifice area.

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