PRHSJ Vol. 27 No. 4
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Colacioppo-Saavedra R, et al.

Outcomes After Heart Valve Replacement Surgery at the Cardiovascular Center of Puerto Rico and the Caribbean

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Background: Heart valve surgery is the second most common type of cardiac surgery. However, there is limited information about the outcomes associated to these types of surgeries.

Methods: A retrospective review was performed in 91 Puerto Rican patients who underwent elective heart valve replacement surgery at the Cardiovascular Center of Puerto Rico and the Caribbean (CCPRC) between January 2004 and January 2005. Demographic features, comorbidities, electrocardiographic findings, surgical data, length of hospitalization, and associated in-hospital complications were determined. Data were examined using Fisher's exact test, chi-square test, analysis of variance and student t test to analyze differences between the study groups.

Results: The mean age of the study population was 61.1 ± 13.2 years; 48 patients (52.7%) were males. Sixty-one patients (67.0%) had aortic valve replacement whereas thirty patients (33.0%) had mitral valve replacement. Patients with aortic valve replacement were older (63.1 ± 13.5 years vs. 56.0 ± 11.2 years, $p < 0.05$) and more likely to present left ventricular hypertrophy (57.4% vs. 16.7%, $p < 0.05$) than patients with mitral valve replacement. On the other hand, patients with mitral valve replacement presented more frequently atrial fibrillation (43.3% vs. 9.8%, $p < 0.05$) than those with aortic valve replacement. The estimated in-hospital mortality rate was 1.1%.

Conclusions: A review of heart valve replacement surgery conducted between January 2004 and January 2005 at the CCPRC revealed that the in-hospital mortality rates, complications, surgical times, and length of hospitalization at the CCPRC compares favorably with those reported in the literature.

Key words: Aortic valve, Mitral valve, Surgery, Outcomes

Chronic valvular heart disease is among the leading causes of heart failure and premature cardiac death (1-2). During the past few decades, remarkable changes in the evaluation and management of patients with valvular heart disease have resulted in improvement of patient outcomes (3). Heart valve surgery is the second most common type of cardiac surgery, accounting for 20% to 35% of all cardiac surgical procedures, with an in-hospital mortality of 4% to 8% (1,4). Based on data from the Society of Thoracic Surgeons National Cardiac Surgery Database, the unadjusted operative mortalities during the years of 2004 and 2005 were 3.3% and 2.8% for aortic valve replacement as compared to 6% and 5.3% for mitral valve replacement. Approximately two thirds of valve operations are for aortic valve replacement, most often for aortic stenosis (1, 5).

Mitral valve regurgitation is the most common reason for mitral valve replacement, since most patients with mitral stenosis can be treated by a percutaneous procedure (1).

The first successful aortic valve replacement in the subcoronary position was performed by Dr. Dwight Harken and associates in 1960 (6-7). That same year, Starr and Edwards successfully replaced a mitral valve (6-7). Since then, hundreds of patients have undergone heart valve replacement in Puerto Rico; however, there is limited information about the outcomes for these types of surgeries. To evaluate the outcomes after valve surgery in our institution, we examined the baseline clinical characteristics, procedure-related data, comorbidities, and in-hospital mortality in a retrospective analysis of 91 patients that underwent heart valve surgery at the Cardiovascular Center of Puerto Rico and the Caribbean (CCPRC) from January 2004 to January 2005.

Methods

Patient population

All patients that underwent elective valve replacement at the CCPRC during the period between January

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PRHSJ Vol. 27 No. 4
December, 2008

Outcomes After Heart Valve Replacement
Colacioppo-Saavedra R, et al.

2004 and January 2005 were evaluated. Patients with either mechanical or bioprosthetic valve replacement were examined. Patients 18 years of age or older, with diagnosis of acquired or congenital valvular heart disease were included in the study. Patients were excluded from analysis if concomitant coronary artery bypass graft (CABG) was performed with valve replacement. Pregnant patients, patients with replacement of more than one valve, and/or reoperation of previous valve replacement were also excluded. During that period, a total of 91 patients meeting the inclusion and exclusion criteria were identified at our institution. Of these, 61 patients had aortic valve replacement, and the other 30 had mitral valve replacement.

Variables

Data were collected using a standard data sheet, and the following baseline information was included: age, gender, etiology of valvular disease, comorbid conditions, and electrocardiographic findings. The electro-cardiographic findings examined included atrial fibrillation, presence of paced rhythm, left ventricular hypertrophy (LVH) by voltage criteria (Sokolow-Lyon criteria for LVH), left atrial enlargement, right bundle branch block and left bundle branch block. In addition, information regarding the surgical procedure was also collected including type of valve (mechanical vs. bioprostheses), position of implanted valve, cardiopulmonary pump time, aortic clamp time, length of stay at intensive care unit (ICU), and time required to extubate patient after surgery. Furthermore, estimate of left ventricular systolic function was collected as determined by echocardiogram or ventriculogram, whichever was available on record review. The following complications were also considered: endocarditis, shock state, valve reoperation, vascular events and neurologic complications.

In-hospital mortality was defined as death occurring during hospitalization. In addition, prolonged ICU stay was defined as 48 hours or more in the intensive care unit, and prolonged mechanical ventilation was defined as requirement of this adjunctive measure for more than 24 hours.

Morbidity outcomes

Valve dysfunction was defined as structural valve deterioration or thrombosis. Structural valve deterioration describes dysfunction or deterioration of the operated valve, excluding infection or thrombosis (8). In addition, the term describes changes intrinsic to the valve, such as fracture, wear, leaflet tear, and suture line disruption (8). The term valve thrombosis was defined as any thrombus not caused by infection involving the operated valve that

occludes blood flow, does not allow proper valve function, or requires treatment (8).

Vascular events included any embolic or neurologic event. Embolism describes any event in the absence of infection occurring after the immediate perioperative period, presenting as a neurologic or non-cerebral embolic event (8). A neurologic event was defined as any new neurologic deficit (focal or global) after the patient emerged from anesthesia, whether temporary or permanent (8). Operated valve endocarditis was defined as any infection involving a valve on which an operation was performed (8).

Statistical analysis

Statistical Package for the Social Sciences (SPSS, Inc., Chicago, Ill) was used to perform univariable and bivariable analyses. Univariable analysis described the frequencies of demographic parameters, risk factors, comorbidities, baseline electrocardiographic findings, valve pathologies, type of heart valve prostheses, outcomes and mortality rates. Differences between patients with mitral or aortic valve prostheses and other categorical variables were analyzed by chi square test or Fisher's exact test. Analysis of variance and Student *t* test were used to evaluate differences in means of continuous variables. Differences between variables before and after valve replacement surgery were evaluated with the Mc Nemar test. Logistic regression test was used to evaluate multiple variable relationships. The P value used to determine statistical significance was set at 0.05.

Results

The study sample comprised 91 patients, 48 (52.7%) were males, and the mean age of patients was 61.1± 13.2 years. The mean age of patients with aortic valve replacement was 63.1±13.5 years, as compared to 56.0 ±11.2 years in patients with mitral valve replacement (p<0.05). The most common comorbidities identified were high blood pressure (73.6%), diabetes mellitus (24.2%), atrial fibrillation (20.9%), dyslipidemia (11.0%), and coronary artery disease (9.9%). The mean left ventricular ejection fraction prior to surgery was 53.2±11.6%. Demographic characteristics, lifestyle behaviors, and clinical manifestations are summarized in Table 1.

The baseline electrocardiographic findings are detailed in Table 2. The most common electrocardiographic rhythm was sinus (75.0%), followed by atrial fibrillation (20.9%). In addition, the most common electrocardiographic findings were left ventricular hypertrophy by voltage criteria (44.0%), left atrial enlargement (7.7%), and interventricular conduction defects (9.9%). Patients with

PRHSJ Vol. 27 No. 4
December, 2008

Outcomes After Heart Valve Replacement
Colacioppo-Saavedra R, et al.

Table 1. Baseline Demographics, Lifestyle Behaviors, and Clinical Characteristics

Characteristics	Mitral Valve n = 30	Aortic Valve n = 61	Total Valves n = 91
Mean age, years (SD)	56.0 (11.2) *	63.1 (13.5)	61.1 (13.2)
Gender, % women	19 (63.3)	24 (39.3)	43 (47.3)
Smoking, n (%)	1 (3.3)	8 (13.1)	9 (9.9)
Alcohol use, n (%)	2 (6.6)	2 (3.3)	4 (4.4)
High blood pressure, n (%)	20 (66.7)	47 (77.0)	67 (73.6)
Diabetes mellitus, n (%)	8 (26.7)	14 (23.0)	22 (24.2)
Coronary artery disease, n (%)	3 (10.0)	6 (9.8)	9 (9.9)
Dyslipidemia, n (%)	1 (3.3)	9 (14.8)	10 (11.0)
Hypothyroidism, n (%)	2 (6.7)	5 (8.2)	7 (7.7)
Congestive heart failure, n (%)	1 (3.3)	1 (1.7)	2 (2.2)
Chronic kidney disease, n (%)	0 (0)	3 (4.9)	3 (3.3)
Renal transplant, n (%)	0 (0)	1 (1.7)	1 (1.1)
Peripherovascular disease, n (%)	0 (0)	1 (1.7)	1 (1.1)
PPM/ICD, n (%)	1 (3.3)	1 (1.7)	2 (2.2)
HIV infection, n (%)	0 (0)	2 (3.3)	2 (2.2)
Left ventricular ejection fraction, mean (SD)	54.1 (10.3)	52.8 (12.2)	53.2 (11.6)

*$p < 0.05$, PPM/ICD = Permanent pacemaker/Implantable Cardioverter-Defibrillator, HIV = Human Immunodeficiency Virus

aortic valve replacement were comparable to those who were implanted a mitral valve in terms of their baseline clinical characteristics and comorbidities. However, atrial fibrillation was more common in the mitral valve replacement group (43.3% vs. 9.8%, $p < 0.05$). Furthermore, patients with aortic valve replacement were more likely to present with left ventricular hypertrophy (57.4% vs. 16.7%, $p < 0.05$).

Aortic valve replacement accounted for 67.0% of the total heart valve surgeries, followed by mitral valve replacement in 33.0% of cases. The most common valve

Table 2. Baseline Electrocardiographic Findings

Features n (%)	Mitral Valve n = 30	Aortic Valve n = 61	Total Valves n = 91
Atrial fibrillation	13 (43.3)*	6 (9.8)	19 (20.9)
Paced rhythms	1 (3.3)	1 (1.7)	2 (2.2)
Left ventricular hypertrophy	5 (16.7)*	35 (57.4)	40 (44.0)
Left atrial enlargement	3 (10.0)	4 (6.6)	7 (7.7)
Right bundle branch block	1 (3.3)	5 (8.2)	6 (6.6)
Left bundle branch block	0 (0)	3 (4.9)	3 (3.3)

*$p < 0.05$

pathology was aortic stenosis in 51 patients (56.0%), followed by mitral regurgitation in 21 patients (23.1%), aortic regurgitation in 10 patients (11.0%), and mitral stenosis in 9 patients (9.9%). A total of 64 (70.3%) patients had mechanical prosthetic valve replacement as compared to 27 (29.7%) that were implanted bioprosthetic valves. In the mitral position, mechanical valves were used in 27 (90.0%) patients, with the residual 3 patients (10.0%) accounted for by bioprostheses. Similarly, mechanical valves were more common in the aortic position, with a total of 37 (61.0%) patients versus bioprosthetic valve implant in 24 patients (39.0%), (data not shown).

During hospitalization, one death was reported in the aortic valve replacement group, with an estimated in-hospital mortality of 1.6%. No deaths during hospitalization occurred in patients that had mitral valve replacement. The most common in-hospital complications including atrial fibrillation (16.3% vs. 13.3%), acute renal failure (4.9% vs. 6.7%), vascular complications (6.6% vs. 3.3%), and the need for permanent pacemaker (3.3% vs. 6.7%) were not significantly different between aortic and mitral valve replacement respectively. In addition, prolonged intensive care unit stay (24.6% vs. 33.3%) and prolonged mechanical ventilation (9.8% vs. 20.0%) did not reach differences in the aortic or mitral valve groups. Multiple regression analysis confirmed the previous findings after adjusting by age, gender, and baseline electrocardiographic findings. However, prolonged intensive care unit stay was significantly higher (OR 4.5, 95% IC=1.3-15.3) in cases with atrial fibrillation at baseline.

Table 3 shows surgical data and in-hospital complications. There were no significant differences in length of surgery (clamp and pump times), time on mechanical ventilation, length of stay in ICU, length of hospitalization, in-hospital complications or mortality rates among patients with aortic and mitral valve replacement.

Discussion

The current study demonstrates that patients who had aortic valve replacement were older and more likely to present left ventricular hypertrophy than patients with mitral valve implants consistent with previous reports. On the other hand, patients with mitral valve replacement had more frequently atrial fibrillation.

The prevalence of aortic valve stenosis increases with age (9). The estimated prevalence of aortic stenosis is 2% to 4% of adults aged 65 years or older (10). Aortic stenosis represents the most common acquired valvular

PRHSJ Vol. 27 No. 4
December, 2008

Outcomes After Heart Valve Replacement
Colacioppo-Saavedra R, et al.

Table 3. Surgical Data and In-Hospital Complications

Features	Mitral Valve n = 30	Aortic Valve n = 61	Total Valves n = 91
Surgical data			
Pump time, minutes (SD)	103.5 (35.6)	94.4 (22.5)	97.4 (27.6)
Clamp time, minutes (SD)	76.5 (30.4)	71.6 (15.9)	73.2 (21.8)
Time on mechanical ventilation, days (SD)	1.4 (0.8)	1.4 (2.4)	1.4 (2.0)
Length of stay in ICU, days (SD)	2.7 (2.0)	2.7 (3.2)	2.7 (2.8)
Length of stay in hospital, days (SD)	10.4 (6.1)	8.7 (4.0)	9.2 (4.8)
Complications			
Death, n (%)	0 (0)	1 (1.6)	1 (1.1)
Shock, n (%)	0 (0)	2 (3.3)	2 (2.2)
Operated valve endocarditis, n (%)	0 (0)	0 (0)	0 (0)
Valve dysfunction, n (%)	0 (0)	0 (0)	0 (0)
Atrial fibrillation, n (%)	4 (13.3)	10 (16.3)	14 (15.4)
Vascular events, n (%)	1 (3.3)	4 (6.6)	5 (5.5)
Acute renal failure, n (%)	2 (6.7)	3 (4.9)	5 (5.5)
Prolonged mechanical ventilation (>1 days), n (%)	6 (20.0)	6 (9.8)	12 (13.2)
Prolonged intensive care unit stay (>2 days), n (%)	10 (33.3)	15 (24.6)	25 (27.8)
Need PPM, n (%)	2 (6.7)	2 (3.3)	4 (4.4)
Mediastinal bleeding, n (%)	1 (3.3)	1 (1.7)	2 (2.2)
Tamponade, n (%)	1 (3.3)	1 (1.7)	2 (2.2)
Pancreatitis, n (%)	1 (3.3)	2 (3.3)	3 (3.3)
Pneumonia, n (%)	2 (6.7)	1 (1.7)	3 (3.3)

*p< 0.05, *PPM = Permanent pacemaker*

disorder in developed countries (10). Valvular stenosis in older people usually results from stiffening, scarring, and calcification of the aortic valve leaflets (8). Edwards and Allareddy reported similar findings that patients with aortic valve replacement were older than those with mitral valve implants (11-12).

Our patients who had aortic valve replacement presented more frequently with electrocardiographic criteria for left ventricular hypertrophy. The response of the left ventricle to chronic pressure overload imposed by valvular aortic stenosis is concentric hypertrophy (13). Thus, hypertrophy develops to sustain a large pressure gradient across an aortic valve with stenosis. Aortic valve replacement is recommended for symptomatic patients with severe aortic stenosis in order to improve their symptoms and increase survival (14).

The higher frequency of atrial fibrillation observed in our patients with mitral valve replacement is consistent with other studies. Atrial fibrillation is present in approximately 30-40% of patients with mitral valve surgery (15). One of the most common conditions producing atrial fibrillation is rheumatic heart disease, typically manifested as mitral stenosis (16). On the other hand, atrial fibrillation is commonly associated to mitral valve incompetence and

has been identified as an independent predictor of survival after surgery for mitral regurgitation (17). Hammermeister and colleagues presented higher frequency of this arrhythmia among patients with mitral valve replacement (18).

The in-hospital mortality rates reported in the literature for isolated aortic valve replacement and mitral valve replacement are 4.3% and 10.0% respectively (12). The present study is comparable to these earlier reports. No significant differences were noted for adverse events or length of stay between patients who had aortic valve replacement and those who had mitral valve replacement. The length of stay reported in both groups of our population compares favorably with those reported in the literature (11-12).

The present study has several limitations. For instance, the inherent characteristics of a retrospective design limit data collection to that available on record review. Also, the size of the sample is small. In addition, the timeframe for assessment of complications was limited to the hospital stay, and this may underestimate the mortality rates and complications.

Research about the outcomes in valve replacement surgery has been limited. The current study shows similar in-hospital complications and outcomes among patients with aortic and mitral valve replacement. This study may contribute to improve quality of care among patients undergoing heart valve replacement surgery.

Resumen

La cirugía de válvula cardíaca es el segundo tipo más común de cirugía cardiovascular. Sin embargo, la información que existe acerca de los resultados de estos tipos de cirugías en Puerto Rico es limitada. Un análisis retrospectivo se realizó en 91 pacientes puertorriqueños que recibieron reemplazo electivo de válvula cardíaca en el Centro Cardiovascular de Puerto Rico y del Caribe (CCPRC) entre enero de 2004 y enero de 2005. Las características demográficas, comorbilidades, hallazgos electrocadiográficos, datos de la cirugía, tiempo de hospitalización, y complicaciones dentro del período intra-hospitalario fueron determinadas. La edad promedio para la población estudiada fue de 61.1 ±13.2 años; 48 pacientes (52.7%) eran hombres. Un total de sesenta y un pacientes (67.0%) tuvieron reemplazo de la válvula aórtica, mientras que treinta pacientes (33.0%) tuvieron reemplazo de la válvula mitral. Los pacientes con reemplazo de válvula

PRHSJ Vol. 27 No. 4
December, 2008

Outcomes After Heart Valve Replacement
Colacioppo-Saavedra R, et al.

aórtica eran mayores (63.1 ± 13.5 años vs. 56.0 ± 11.2 años, p < 0.05) y más frecuentemente presentaron hipertrofia del ventrículo izquierdo (57.4% vs. 16.7%, p < 0.05) que los pacientes con reemplazo de válvula mitral. Por otro lado, los pacientes con reemplazo de válvula mitral presentaron con mayor frecuencia fibrilación atrial (43.3% vs. 9.8%, p < 0.05) que los que recibieron reemplazo de válvula aórtica. La tasa de mortalidad estimada para el período intra-hospitalario fue de 1.1%. El estudio acerca de la cirugía de reemplazo de válvula cardíaca realizado en el CCPRC durante el período de enero de 2004 a enero de 2005 reveló que la tasa de mortalidad intra-hospitalaria, las complicaciones, los tiempos de cirugía, y el largo de hospitalización comparan favorablemente con los estudios reportados en la literatura.

Acknowledgments

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