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Surgical Treatment of Valvular Disease in the Elderly: Clinical, Hemodynamic, and Long-term Results in age 60～69 years versus over 70 years

Tomio ABE, Toru MAWATARI,
Raimi URITA and Sakuzo KOMATSU
Second Department of Surgery, Sapporo Medical University School of Medicine, Sapporo, Japan

ABSTRACT **Results of open heart surgery in 22 consecutive elderly patients aged 70-76 are presented and compared with results of that procedure in 135 younger patients aged 60-69. The elderly patients presented with valvular disease between August 1, 1987, and September 30, 1994. They consisted of 12 men and 10 women with a mean age of 72.3 years. Fifteen of 22 patients had isolated aortic valve replacement (AVR) or mitral valve replacement (MVR) or repair and 7 patients had combined two or three surgical procedures; 14 of them underwent AVR, 8 underwent MVR or repair, 3 had both mitral and tricuspid valve repair and 2 had coronary artery bypass graft. Preoperatively 54.5% of the patients were in NYHA functional class III and 27.3% were in class IV. Mechanical and biological valves were replaced in 10 and 12 patients, respectively.**

Preoperative organ dysfunctions in the present patients were associated with the heart in 32%, the lung in 18%, the liver and kidney in 9% and the gastro-intestinal tract in 18%. The only significant correlation between pre and postoperative organ dysfunction was noted in the lung. The younger group averaged 64.2 years old at the time of surgery. Preoperative hemodynamic data in the aortic and mitral valve position indicated lower pressure and LV function in the elderly group than in the younger group, but there were no significant differences between the groups before and after surgery except for in the mean values of m-PCWP in AVR and m-PAP in MVR, which were also significantly improved in the younger group after surgery.

The operative mortality rates were 9.1% for elderly patients and 3.0% for the younger patients. Late follow-up of 20 survivors was 86.4±2.9% in the elderly and 82.7±3.9% in the younger patients. There were one late death (1.5%) in the elderly and 10 late deaths (7.4%) in the younger groups. The incidences of freedom from valve-related morbidity were 1.2%/pt-y with 94.7±2.9% being event free in the elderly group and 1.9%/pt-y with 92.4±4.1% being event free in the younger group; these showed no significant differences. These early and long-term results indicate that valve surgery in the elderly has acceptably low mortality and morbidity, and overall survival rate and improvements in symptoms and functional class are comparable to those of younger patients.

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Key words: Valvular disease, Elderly patients, Valve replacement, Mechanical prosthesis, Biological prosthesis

Because of the increasing number of people living to an old age in good health and the recent remarkable improvement in surgical results[1-2], more and more elderly valvular patients are being referred for surgical treatment[3-6]. Generally, aortic valve disease in the elderly is calcific stenosis, and the degenerative changes are mitral valve lesions. Valve replacement and repair have become established

treatments for these patients, but most studies have found higher surgical mortality and morbidity in the elderly than in younger patients[2),4),8-9)].

This report presents the experience at our institution with valvular operations in elderly patients. By examining early and late mortality, morbidity and risk factors predictive of our outcomes have been identified. Also, by comparing hemodynamics and events with a younger group, we have attempted to indicate the influence of valvular disease on surgical results in the elderly.

Material and Methods

Patients: This study reviews the data for patients aged 70 years or older who underwent aortic and mitral valvular disease between August 1, 1987 and September 30, 1994 at Sapporo Medical University Hospital. Patients whose operations included surgical repair to ascending aortic aneurysm, left ventricular (LV) aneurysmectomy and LV rupture repairs were excluded from this study. Table 1 indicates the preoperative clinical data, age, sex, types of lesions, causes of valvular disease, New York Heart Association (NYHA) classification, and previous surgery in these patients. There were 22 patients: 15 of 22 patients had isolated aortic valve replacement (AVR) or mitral valve replacement (MVR) or repair and 7 patients had combined two or three surgical procedures; 14 of them underwent aortic valve replacement (AVR), 8 underwent mitral valve replacement (MVR), one had mitral valve repair, 3 had aortic and mitral valve repair, 3 had mitral and tricuspid repair and 2 had coronary artery bypass graft surgery (Table 2). Preoperatively, 18.2% of the patients were in NYHA functional class II, 54.5% were in class III and 27.3% were in class IV.

The surgical procedure in 22 patients and pre, and postoperative criteria[10)] of major organ dysfunction are listed in Tables 3 and 4. Preoperative major organ dysfunction was noted in the heart in 7 (32%), in the lung in 4 (18%), in the liver in 2 (9%), in the kidney in 2 (9%) and in the gastrointestinal (GI) tract in 4 (18%).

The surgical mortality, morbidity and hemodynamics in the elderly group were also compared to those recorded in 135 consecutive patients aged 60-69 years (the younger group) who underwent similar surgery over the same period.

Preoperative angiographic and hemodynamic evaluations were performed in all patients except those who had severe congestive heart failure. Two-dimensional and pulsed Doppler echocardiography were also carried out in all patients before and after the operation.

Surgical procedure: In all cases, operations were performed with cardiopulmonary bypass (CPB) and moderate systemic hypothermia (25-30°C). Intraoperative myocardial protection was provided by topical cooling combined with cold blood cardioplegia. In AVR, coronary sinus (retrograde) perfusion with cold blood cardio-

Table 1 *Preoperative data in 22 patients aged 70 and over who underwent surgery (1987. 8-1994. 9)*

• No of patients	22
• Male/female	12/10
• Age (mean ± SD)	70~76(72.3±1.9)
• Types of lesion	
Aortic regurgitation	8
Aortic stenosis	6
Mitral regurgitation	4
Mitral stenosis	2
Tricuspid regurgitation	4
Malfuntioning prostheses	3
Coronary artery disease	2
• Causes	
Degenerative	12
Rheumatic	6
Others	4
• Preop NYHA class	
II	4
III	12
IV	6
• Previous cardiac surgery	5

plegic solution has been used in 8 of 14 patients since 1992[11]. Twelve patients received a bioprosthetic valve (11 Carpentier-Edwards and 1 Hancock II) and 10 received a prosthetic valve (6 St. Jude, 2 Sorlin, 1 CarboMedics and 1 Omnicarbon).

Anticoagulation regimen and follow-up studies: Anticoagulation with warfarin and bucolome was routinely commenced on postoperative day (PoD) 3 and usually resulted in therapeutic levels by PoD 6 or 7, using the thrombo-test (T-T) of 15~25%, corresponding to an international normalized prothrombin time ratio of 2 and 3.5.

Table 2 *Surgical procedures in 22 patiencts aged 70 and over*

Procedures	No. of patients
• Aortic valve replacement (AVR)	10
• AVR+Mitral valve replacement (MVR)	1
• AVR+Mitral valve plasty (MVP)	2
• AVR+Coronary artery bypass graft (CABG)	1
• MVR (re-MVR)	4(3)
• MVR+Tricuspid annuloplasty (TAP)	2
• MVR+TAP+CABG	1
• Open mitral commissurotomy	1
Total	22

Table 3 *Criteria of organ dysfunction before and after valve surgery*

Organ	Preoperative	Postoperative
Heart	Forrester class (Ⅳ) LV ejecrion fraction<0.4	Forrester (Ⅳ) IABP or Assist Devis
Lung	%Vital capacity<80% $EFV_{1.0}$%<70%	5 days or mare Ventilator support
Liver	Total bilirubin (TB)>3.0 mg/d*l*	TB>3.0 mg/d*l* Hemofiltration
Kidney	Creatinine (Cr)≧2.0 mg/d*l* Cr. clearance<30 m*l*/min	Cr.>3.0 mg/d*l* Hemodialysis
Gastric & Intestine (GI)	Ulcer (+) Hematemesis (+)	GI-bleeding Transfusion>2 unit

Table 4 *Organ dysfunction (OD) before and after valve surgery in 22 patients aged≧70*

Orgen	Preop	No. of Patients	Postop OD (YES)	Death
Heart	OD YES	7(32%)	1/ 7(14%)	1(14%)
	OD NO	15(68%)	2/15(13%) NS	1(7%) NS
Lung	OD YES	4(18%)	3/ 4(75%)	1(25%)
	OD NO	18(72%)	2/18(11%) *	1(6%) NS
Liver	OD YES	2(9%)	1/ 2(50%)	1(50%)
	OD NO	20(91%)	2/20(10%) NS	1(5%) NS
Kidney	OD YES	2(9%)	0/ 2(0%)	0(0%)
	OD NO	20(91%)	2/20(10%) NS	2(10%) NS
G. I.	OD YES	4(18%)	2/ 4(50%)	1(25%)
	OD NO	18(72%)	4/18(22%) NS	1(6%) NS

*: $P<0.05$ NS: Not significant

Follow-up was completed in 100% of the patients, the cumulative patient follow-up being 84.2 patient-years (pt-y), ranging between 5 and 96 months, with a mean follow-up period of 52.7 months. The linear incidence of events was calculated as the total number of events divided by the total number of patients or valve years. Actuarial survival analysis and morbidity were calculated by the method of Kaplan and Meir. Measurements are expressed as the mean ± standard deviation (SD) and the range. Statistical analysis was made using Student's non-paired t-test with a p-values of less than 0.05 considered significant.

Results

Early results: Death within 30 days of surgery occurred in 2 of the elderly group; the causes were bleeding from severely calcified aortic wall and involved myocardium in one at 3 days after surgery and congestive cardiac failure in the other at 20 days after surgery. Mortality was 7.7% (1/13) following AVR, 12.5% (1/8) following MVR or repair, and zero (0/1) following AVR and MVR (DVR).

The relationship between preoperative and postoperative organ dysfunction and early death is listed in Table 4. The only significant correlation was in the lungs, that is, three (75%) of 4 patients who had preoperative lung dysfunction and two (11%) of the 18 patients who had normal lung function required respirator support for more than 5 days PoD, respectively ($p<0.05$). There were no significant correlations between pre-and post organ dysfunction and early death in the other major organs of the heart, liver, kidney or GI tract (Table 4) in the elderly group.

Hemodynamic evaluations: Cardiac function before and 2-5 months after surgery, measured at a mean of 3.1 months, was evaluated in the aortic and mitral positions by cardiac catheterization, angiography and pulsed Doppler echocardiography. In the present study, 9 patients (5AR, 4AS) who received an isolated AVR and 6 patients (3MR, 3MS) who received MVR were evaluated. They were compared with 10 younger patients aged 60～69 (mean 63.4±4.9) years (5AR, 5AS) receiving an isolated AVR and 6 (3MR, 3MS) receiving MVR at identical follow-up periods.

In the aortic valve position (Fig. 1), the mean values of mean pulmonary artery pressure (m-PAP) were 17.9±1.9 mmHg in the elderly group and 16.5±0.7 mmHgin the younger group. These decreased, but not significantly, to 16.2±1.4 mmHg and 12.9±0.7 mmHg, respectively, after surgery. Preoperative mean pusmonary capillary wedge pressure (m-PCWP) was 11.4±1.1 mmHg and 9.3±0.7 mmHg, respectively; this significantly decreased to 4.5±0.3 mmHg in the younger group, but no significant decrease occurred in the elderly group. Subsequently, a significant improvement was noted in the younger group.

The mean values of cardiac index (CI) before surgery were 2.56±0.4 l/min/m^2 in the elderly group and 3.09±1.1 l/min/m^2 in the younger group; these increased but not significantly to the respective values of 3.07±0.8 and of 4.13±0.9 l/min/m^2 after surgery.

The LV ejection fraction (EF) before surgery was 65.1±4.7% in the elderly group and 67.7±5.2% in the younger group. This rose to 69.2±7.4% in the elderly group, whereas it dropped slightly to 61.7±3.9% in the younger group after the operation.

In the mitral valve position (Fig. 2), the mean values of m-PAP before surgery were 27.4±7.4 mmHg in elderly group and 26.3±5.7 mmHg in the younger group. In the younger group this fell significantly to 18.3±3.4 mmHg ($p<0.01$) after surgery, but did not significantly change in the elderly group.

The mean values of m-PCWP were 16.8±0.9 mmHg in the elderly group and 16.4±1.2 mmHg in the younger group. These fell, but not significantly, to 9.4±0.9 mmHg and 11.7±0.6 mmHg, respec-

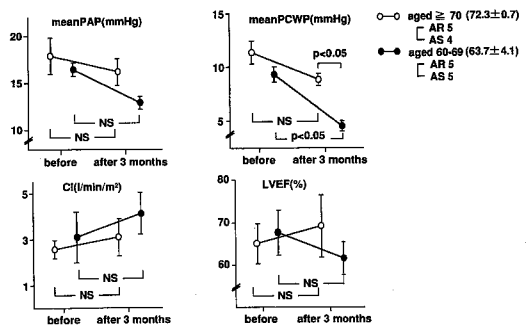

Fig. 1 Comparison of hemodynamic changes before and after AVR in 9 patients aged≧70 with 10 patients aged 60-69 years

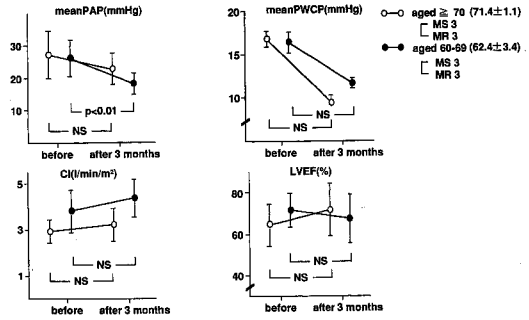

Fig. 2 Comparison of hemodynamic changes before and after MVR in 6 patients aged≧70 with 6 patients aged 60-69 years

tively. CI before surgery was 2.93±0.51 l/min/m² in the elderly group and 3.81±0.92 l/min/m² in the younger group; it also increased though not significantly, after surgery (to 3.21±0.7 l/min/m² and 4.36±0.81 l/min/m², respectively). LVEF before surgery was 64.4±10.1% in the elderly group and 71.7±8.1% in the younger group. After surgery, this increased in the elderly group (71.8±12.7%) decreased slightly (67.6±11.7%) in the younger group, but not significantly so in either case.

Postoperative clinical data and complications: There was one late death (4.5%) due to prolonged respiratory failure at 6 months after surgery. The total follow-up time in late survivors was 84.2 years and the over all survival rate at 7 years was 86.4±2.9% in the elderly group. In the younger patients there were 10 late deaths (7.4%), due to cardiac failue in 5, multiorgan failure in 3, anticoagulant related hemorrhage in one and rupture of an aneurysm in one. The overall survival rate in the younger group at 7 years was 82.7±3.9% (Table 5, Fig. 4). There were no significant differences between early and late death-patients and survival rate at 7 years between the two groups.

Careful monitering was carried out in every patient for thromboembolism, valve thrombosis, valve failure, hemolysis, anticoagulant-related hemorrhage, infective endocarditis and reoperation. There was one thromboembolic event in an elderly patient who had aortic biological valve replacement at 9

Table 5 *Postoperative mortality and mobidity: Comparison of patients aged≧70 with patients aged 60-90 years in 1987. 8-1994. 9*

Characteristic	patients aged		P value
	≧70 (72.3±1.9)	60-69 (64.2±3.1)	
• No. of patients	22	135	
• Death — Early	2 (9.0%)	4 (3.0%)	NS
• Death — Late	1 (4.5%)	10 (7.4%)	NS
• Follow-up time	84.2 years	576.7 years	
• Survival rate at 7 years	86.4±2.9%	82.7±3.9%	NS
• Morbidity			
Thromboembolism	1 (1.2% pt-y)	5 (0.9% pt-y)	NS
Valve thrombosis	0	2 (0.3% pt-y)	NS
Hemorrhage	0	2 (0.3% pt-y)	NS
Reoperation	0	2 (0.3% pt-y)	NS
Total	1 (1.2% pt-y)	11 (1.9% pt-y)	NS

months after surgery; however, there were no other complications of valve thrombosis, valve failure, hemorrhage or reoperation. In the younger group, however, thromboembolic events were observed in 5 patients (0.9% pt-y), involving valve thrombosis in 2 (0.3% pt-y) and anticoagulant related hemorrahage in 2 (0.3 pt-y); two patients (0.3% pt-y) also required reoperation for valve thrombosis and were reimplanted with St. Jude valves. They are now doing well.

The total incidences of valve related complications were one patient (1.2% pt-y) in the elderly group and 11 (1.9% pt-y) in the younger group. This represented no significant differences between the two groups (Table 5).

The actuarial freedom from all valve-related complications was calculated at 94.7±1.9% in the elderly group and 92.4±4.1% in the younger group at 7 years after surgery (Fig. 3).

All these survivors significantly improved with regards to NYHA functional class after surgery (Fig. 5). Postoperatively, 74% of the elderly group were in Class I, 21% were in Class II, and only 5% were in Class III at the time of this report; these were comparable with the results in the younger group. The cardio-thoracic ratio (CTR) before and after surgery in aortic and mitral valve diseases is shown in Fig. 5. The mean values of this ratio decreased after surgery, but not significantly so in both groups.

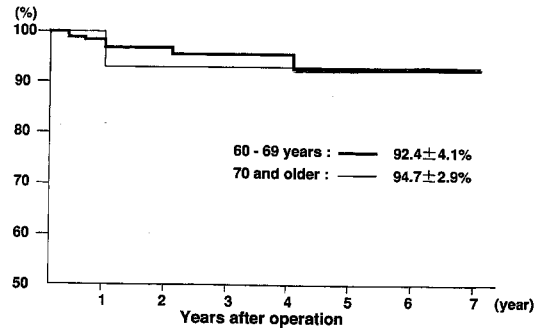

Fig. 3 The incidence of actuarial freedom from valve related complications aged≧70 years and 60-69 years old at 7 years after surgery

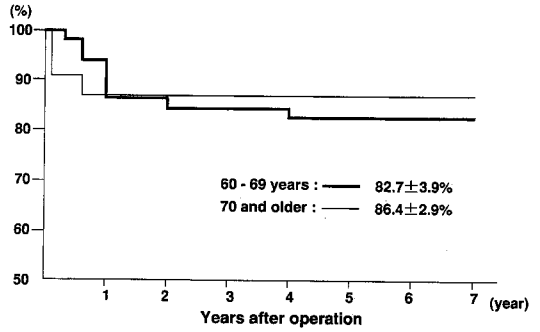

Fig. 4 Actuarial survival rate in patients aged≧70 years and 60-69 years old at 7 years after surgery

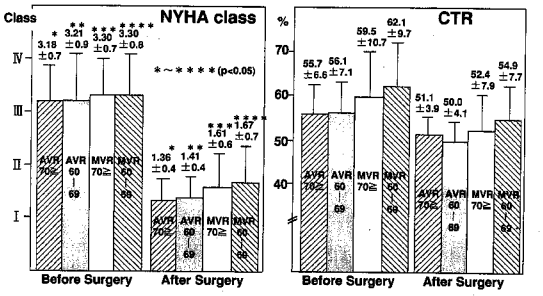

Fig. 5 NYHA class and Cardio-Thoracic-Ratio (CTR) AVR and MVR aged≧70 and aged 60-69 years

Discussion

The definition of the term "elderly patients" varies from those above a cut off age of 65[5-6] to septuagenerians[1-4),7-9] or octogenerians[12-13]. Davis *et al.*[1] reported that the term elderly is not simply a matter of chronological age; deficits in internal organs besides the heart adversely affected operative results after 70 years old. In the present study, the cut off age was set at 70 at the time of surgery. The operative mortality after valvular surgery in elderly patients was high (10 ~20%)[4),6-7),9] during the decade ending in 1984, but this rate has fallen to considerably below 10% due to improvements in myocardial protection, surgical techniques and postoperative care[1-3),5),8),11].

In our experience, the early operative mortality was two (9.1%) of 22 patients. All patients were accepted for surgery without selection and had had maximum medical treatment before surgery. Many

patients in this study had already reached the terminal stage of valvular disease at operation; 54.5% had been in NYHA Class III and 27.3% were in Class IV.

In these elderly patients with recurrent congestive heart failure, both the reserves of the major organ function and energies to recover from postoperative complications were severly deteriorated. When a patient had serious complications at or a history of multiple operation, the medical treatment and care were problematic and often failed. They showed a high incidence of preoperative major organ dysfunctions, which were diagnosed according to the criteria of the Japanese Association for Critical Care Medicine[10]. On the other hand, the only such dysfunction which actually resulted in high morbidity was respiratory. Other afflictions had low, insignificant correlations with postoperative organ failure and none compromised convalesence. Ruygrok *et al.*[3] stated that elderly patients selected for a strong will and incentive to endure the physical and mental stresses associated with major surgery have a high probability of prolonged convalesence.

Cardiac performance tends to deteriorate with advancing age[14], but in our study, the postoperative hemodynamic data are comparable to those of the younger group. Before surgery, the mean values of m-PAP, m-PCWP and CI in both the aortic and mitral positions showed lower levels than in the younger group, but these values proportionally improved after valve replacement in the two groups and ultimately there were no significant differences between the groups in aortic and mitral position, except for m-PCWP in AVR and m-PAP in MVR.

Our hemodynamic results are in agreement with those of Levinson, *et al.*[15] who found in a long-term follow-up study that valve replacement in elderly patients with poor LV function was sometimes curative by valve replacement, and that LV function could be restored to normal.

Thromboembolism and anticoagulant-related hemorrhage are major risk factors in patients with mechanical and biological prosthetic valve replacement. The incidence of thromboembolic complications was very low in our series at a linearized rate of 1.2%/patient-year; 94.7±2.9% were event free, the same as observed in 5 of 135 patients with a linearized rate of 1.9%/patient-year and 92.4±4.1% event free in the younger age group. There were no valve thrombosis or valve related hemorrhage episodes with continuous use of warfarin in our elderly patients. An additional issue regards the choice of valve prosthesis for use in elderly patients[5-6),9]. It is now agreed by most surgeons[1-4),6),9-12] that a bioprosthesis is usually preferable to a mechanical prosthesis because of the very low frequency of structural failure in elderly patients and the avoidance of chronic[6] anticoagulation. In the present study, a bioprosthetic valve was used in the aortic position in 12 of 14 patients without anticoagulation, but we needed mechanical prostheses in the mitral position in all patients in this series. The incidence of primary tissue failure in the mitral position of biological prostheses is still higher than in the aortic position even in elderly patients[4),6)]. Antunes[5] reported that mechanical prostheses in elderly patients (≧75 years) performed well and the incidences of thromboembolic and hemorrhagic episodes were similar to those observed in younger patients.

Late death occurred in one patient (4.1%) due to respiratory failure; he died of multiorgan failure at 6 months after surgery. This incidence was similar to the report by Ruygrok and *et al.*[3] Actuarial survival rate for the total survivors was 86.4±1.7% for 7 years and, which also was higher than those observed in the literature[1),3),8)].

Functional class of late survivors was significantly improved after valve surgery in both elderly and younger patients. These symptomatic and functional improvements for elderly patients seem to be very noteworthy; patients generally remain independent and have returned to normal social life and even to work.

In conclusion, the present study showed that advanced age alone is not a contraindication to surgical

treatment. Surgery is recommended in earlier stages, before major organ dysfunctions have developed. Surgical management for these elderly patients with severe valvular lesions has brought them significant symptomatic and functional improvements and excellent long-term outcomes.

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Correspondance:
Tomio Abe, M. D.
Second Department of Surgery
Sapporo Medical University School of Medicine
South1, West 17, Chuo-ku, Sapporo, 060, Japan.
Telephone: 011-611-2111
Fax: 011-613-7318

高齢者（70歳以上）弁膜症に対する外科治療成績と遠隔成績について

—70歳以上と60～69歳における臨床成績と血行動態の検討—

安倍十三夫　馬渡　徹
瓜田雷已　小松作蔵
札幌医科大学医学部外科学第二講座

今回，我々は1986年8月～1994年9月末まで，高齢者(70歳以上)弁膜症22例に対し外科治療を施行し，同時期の60～69歳(60歳代)弁膜症外科治療135例と手術成績と遠隔成績につき比較検討した．高齢者手術年齢は72.3歳であり，弁病変は大動脈弁(A弁)14例，僧帽弁（M弁）11例，連合弁5例，冠状動脈疾患合併2例であった．弁置換22例（A弁14例，M弁8例），弁形成6例(M弁3例，三尖弁3例)，冠状動脈再建2例であった．使用した人工弁は生体弁12個，機械弁10個であった．患者の術前状態はNYHA機能分類III度12例（55%），IV度6例（27%）であり，主要臓器障害合併は9～32%に認め肺機能低下例は術後に高頻度の肺合併症を認めた．術前の心機能は高齢者では60歳代に比し低下していたが，術後の心機能は良好に維持された．早期および遠隔期死亡率は高齢者（9.1%，1.5%），60歳代(3.0%，7.4%)で両者に差はなく，累積生存率と人工弁のevent-free rateも高齢者(86.4%，92.4%)と60歳代(82.7%，92.4%)で，早期死は高齢者で高いが両者に有意差は認めなかった．高齢者(70歳以上)に対する弁膜症外科治療成績は60歳代と比較し，同等の手術と遠隔期成績が得られ，症状改善と生活能力の向上が十分期待できることが示唆された．