Long-term Results of the Patients Followed over 5 Years after Mitral Valve Surgery

YASUNARU KAWASHIMA*, SUSUMU NAKANO*, KEI SAKAI*,
CHOKEN OHYAMA*, SOICHIRO KITAMURA*,
TOHRU MORI*, HIROHIDE MATSUO**

TODAY, the value of surgical intervention in the patients with symptomatic mitral valve disease has been an established fact. In order to evaluate our experiences in mitral valve surgery, this study was designed to review long-term results of the patients followed over 5 years postoperatively, who underwent closed or open mitral commissurotomy, mitral annuloplasty, and mitral valve replacement. In this review, we have attempted to clarify some factors influencing clinical and hemodynamic improvements after surgery and to formulate surgical approach to mitral valve disease.

MATERIALS

From 1952 to 1978, 867 patients underwent mitral valve surgery at Osaka University Hospital. The subject of this study is 638 patients of them, who were followed over 5 years postoperatively. They were operated upon before March 1974. The number and the type of procedures are documented in Fig. 1. The vast majority of patients underwent closed mitral commissurotomy (CMC) and 59 patients open mitral commissurotomy (OMC). Mitral annuloplasty (MAP) for pure or dominant regurgitation was performed in 17 patients. Mitral valve was replaced in 47 patients.

Key Words:

Closed mitral commissurotomy
Open mitral commissurotomy
Mitral annuloplasty
Mitral valve replacement

RESULTS

(1) Closed mitral commissurotomy

From 1952 to 1972, 550 patients underwent CMC. The actuarial survival curve of the entire patients demonstrated 15-year survival rate of 70 per cent (Fig. 2).

Clinical improvement evaluated as NYHA Functional Class I was maintained in 50 to 65 per cent of the surviving patients at 5 to 7 years postoperatively. However, it was deteriorated thereafter and only less than 25 per cent of survivors were in NYHA Class I at 15 years after CMC (Fig. 3).

The factors affecting late clinical improvements after CMC were analysed in Fig. 4. The less satisfactory results with CMC appeared largely to be due to inadequate commissurotomy, mitral regurgitation produced at the operation, pathological severity of mitral valve with or without calcification, and postoperative atrial fibrillation.

Fifty-one (9.3 per cent) of 550 patients required reoperation because of subsequent symptomatic and hemodynamic deterioration 10 years and 9 months in average following CMC. At the second operation, mitral valve was necessitated to be replaced in 26 patients (51 per cent). OMC was performed in 18 patients and CMC in 8 patients. Two patients further underwent the third operation. At reoperation, progressive pathological deteriorations of mitral valve was found. Thirty-six of 51 patients (71 per cent) showed Sellors type III (Fig. 5).

* First Department of Surgery, Osaka University, Medical School

** First Department of Medicine, Osaka University, Medical School

Procedures	Total number of patients	Patients followed over 5 years postop.
Closed commissurotomy	550	515
Open commissurotomy	164	59
Mitral annuloplasty	40	17
Mitral valve replacement	113	47
Total	867	638

Fig.1. The number and the type of procedures of mitral valve surgery.

Fig.2. Actuarial survival of the patients undergoing closed mitral commissurotomy.

(2) Open mitral commissurotomy

From 1967 to 1978, 164 patients underwent OMC. Of these patients, 59 patients were followed over 5 years after surgery. According to the pathological anatomy of mitral valve classified by Sellors, T.H., 1953¹, there were 9 patients showing Sellors type I-mobile cusp without subvalvular change; 35 patients, Sellors type II-thickened cusp with mild degree of subvalvular changes, and 15 patients, Sellors type III-rigid cusp with moderate to severe degree of subvalvular changes. Since 1972, mitral commissurotomy has been performed under direct vision by means of cardiopulmonary bypass in all patients who require operation for mitral stenosis with any pathological anatomy of mitral valve except for so-called cuspal type. Successful commissurotomy was achieved by precisely opening the fused leaflet tissue, and frequently separating and mobilizing the fused chordae and papillary muscles (chordotomy or papillotomy).

Fig.3. Serial changes of functional improvement (NYHA Functional Class) of patients followed over 5 years after closed mitral commissurotomy.

Actuarial survival rate of the entire series (164 patients) with OMC was 96 per cent at 12 years postoperatively, including 5 early operative deaths (Fig. 6).

Postoperative clinical improvements were obvious with 67 per cent of the patients followed over 5 years after OMC in NYHA Functional Class I and 33 per cent of the patients in Class II.

An analysis of the factors influencing postoperative clinical improvement is shown in Fig. 7. Thirty-six per cent of the patients with atrial fibrillation and 20 per cent of the patients with sinus rhythm were in NYHA Functional Class II. Forty-one per cent of the patients with associa-

Fig.4. An analysis of the factors affecting functional improvements of patients followed over 5 years after closed mitral commissurotomy.

Fig.5. Changes in pathological anatomy of mitral valve at reoperation following closed mitral commissurotomy.

Fig.6. Actuarial survival of the patients undergoing open mitral commissurotomy.

Fig.7. An analysis of the factors affecting functional improvements of patients followed over 5 years after open mitral commissurotomy.

ted valvular lesions were in Class II. On the other hand, only 18 per cent of the patients without them were in Class II. Only 6.3 per cent of the patients showing Sellors type I mitral valve pathologically at operation were in Class II postoperatively; 22 per cent of the patients-Sellors type III, in Class II.

In 14 of 59 patients followed over 5 years after OMC, mitral valve areas were measured by UCG. It was 2.9 cm² in average in the patients with Sellors type I; 2.3 cm², Sellors type II, and 2.0 cm², Sellors type III.

The serial determination of diastolic descent rates (DDR) revealed a progressive deterioration of this value in some patients as shown in Fig. 9, suggesting a probability of restenosis of mitral valve in a long-term period.

Late postoperative catheterization were carried out in 15 patients over 5 years postoperatively. Among these patients, 3 patients belong to Sellors type I, 8 patients to Sellors type II, and 4 patients to Sellors type III. Cardiac index increased at rest after surgery in all groups and raise up during exercise. There were no significant differences among there 3 groups. Mitral valve area (MVA) calculated from Gorlin formula was 2.5 cm² in Sellors type I, 2.1 cm² in Sellors type II, and 1.3 cm² in Sellors type III at rest after surgery. During exercise, MVA was 3.1 cm², 2.1 cm², and 1.5 cm², respectively. There were significant differences among these effective MVA

Fig.8. Mitral valve areas measured by UCG of the patients followed over 5 years after open mitral commissurotomy.

both at rest and during exercise. And, there were no significant differences in actual mitral valve area measured at operation.

(3) Mitral annuloplasty

From 1967 to 1978, 40 patients underwent MAP for pure or dominant regurgitation. 17 of these patients were followed over 5 years post-

Fig.9. Serial measurements of diastolic descent rate (DDR) after open mitral commissurotomy.

Fig.10. Cardiac index (CI) and effective mitral valve area (MVA) in patients undergoing open mitral commissurotomy, pre- and postoperatively (at rest and during exercise).

Fig.11. Actuarial survival of the patients undergoing mitral annuloplasty.

Fig.12. Changes of cardiothoracic ratio (CTR) after mitral annuloplasty – TC; torn chordae, DA; dilated annulus, MsR; fibrotic changes of valvular and subvalvular tissue.

Fig.13. Pre- and postoperative grade of mitral regurgitation (by Sellers) after mitral annuloplasty.

operatively. The patients were divided into 3 groups: Group I-ruptured chordae tendineae (3 patients); Group II-dilated annulus (8 patients); Group III-fibrotic change of valvular and subvalvular tissue (6 patients). Mitral annuloplas-

ty was performed according to J.H. Kay's procedure, with or without chordoplasty or repair of the leaflet.

Fig.14. Left ventricular endodiastolic pressure (LVEDP), left atrial mean pressure (LAm), and pulmonary arterial mean pressure (PAm) in patients undergoing mitral annuloplasty, pre- and postoperatively (at rest and during exercise).

Fig.15. PAm, LAm, and left atrial-ventricular endodiastolic pressure gradient (LAm-LVEDP) in the patients undergoing mitral valve replacement, pre- and postoperatively (at rest and during exercise).

Fig.16. Comparison of actuarial survival curves of patients undergoing CMC, OMC, MAP, MVR at Osaka University Hospital and of patients treated medically, reported by Rappaport et al..

Actuarial survival rate of all patients (40 patients) presented 97 per cent at 7 years postoperatively (Fig. 11). Seven of 17 patients followed over 5 years after MAP were in NYHA Functional Class I, 4 patients in Class II, and 3 patients in Class III. The remaining 3 patients necessitated reoperation because of recurrent symptoms and hemodynamic deterioration.

Cardiothoracic ratio of the patients in Group I (torn chordae) showed more prominent decrease from 71 per cent to 60 after surgery, compared with those of Group II and Group III (Fig. 12). Postoperative left ventriculography revealed that

no patient in Group I showed more than Grade III of residual regurgitation by Seller's classification. On the other hand, 2 patients in Group II and 6 patients in Group III had Grade III or IV regurgitation (Fig. 13).

In postoperative hemodynamic study (Fig. 14), it was evident that left ventricular endodiastolic pressure, left atrial mean pressure, and pulmonary arterial mean pressure in Group III were more adversely elevated at rest and during exercise postoperatively, in comparison with those of other groups. This fact evidently is due to residual stenosis as well as regurgitation.

(4) *Mitral valve replacement*

From 1969 to 1978, 113 patients underwent MVR. Forty-seven of these patients were followed over 5 years postoperatively. Kay-Shiley disc valve was implanted in 33 patients and Starr-Edwards disc valve in 10 patients; Beall disc valve in 2 patients, Bjork-Shiley tilting disc valve in one and Starr-Edwards ball valve in one patient.

Twenty-three of 47 patients (49 per cent) had thromboembolic episodes. Three patients required reoperation because of thrombosed valve. There were 11 late deaths for a 23 per cent of late mortality. However, 36 surviving patients were in improved conditions with 56 per cent of the patients in NYHA Functional Class I and 44 per cent in Class II. Hemodynamic studies also revealed that the changes of pulmonary arterial mean pressure, left atrial mean pressure, and left atrial-left ventricular diastolic gradient at rest and during exercise after MVR seemed to be similar to those of Sellors type III mitral stenosis undergoing OMC (Fig. 15).

COMMENTS AND CONCLUSION

It is well recognized that closed mitral commissurotomy may result inadequate enlargement of valve orifice as well as regurgitation which can be adverse factors in long-term results, as reported by Manabe et al² and Higgs et al³, previously. On the other hand, it supplies acceptable evidence that mitral commissurotomy under direct vision, frequently with additional papillotomy and chordotomy, can provide more precise and adequate enlargement of valve orifice^{4,5}. Since 1972, therefore, we have performed open mitral commissurotomy in all patients with any pathological severity of mitral valve, except for so-called cuspal type⁶.

The patients undergoing open mitral commissurotomy showed higher survival rate throughout 12-year observation and more obvious clinical improvement, in comparison with those underwent closed mitral commissurotomy. Of 59 patients followed over 5 years after OMC, no patient required reoperation so far. The low mortality and morbidity with excellent long-term results support our policy that open mitral commissurotomy is the treatment of choice for mitral stenosis.

Analysing the factors affecting clinical and hemodynamic improvements after open mitral commissurotomy, a significant number of patients in NYHA Functional Class II postoperatively were in categories of postoperative atrial

fibrillation and associated with other valvular lesions. It is also noted, as expected, that the more severe the pathological changes of mitral valve, the poorer the clinical improvement.

Hemodynamic studies revealed that effective mitral valve areas were 2.5 cm² in Sellors type I, 2.1 cm² in Sellors type II, and 1.3 cm² in Sellors type III at rest postoperatively, with no significant differences in actual mitral valve areas measured at operation. The difference in pathological anatomies of mitral stenosis appeared to be responsible for this observation⁷.

Consequently, we believe that preoperative pathological severity of mitral valve and coexisting aortic and/or tricuspid valve disease play a significant role for the late results after open mitral commissurotomy. The other causes of deterioration may be due to operatively induced mitral regurgitation, and left ventricular dysfunction which remains unclear. Restenosis of the mitral valve has been believed to be the least common cause of deterioration³. However, there are some reports^{10,11} with the finding that progressive stenosis is suggested. Further studies are needed to clarify a probability of restenosis after open commissurotomy.

Reconstructive surgery for mitral regurgitation remains controversial. By means of mitral annuloplasty according to J.H. Kay's procedure, good to excellent results were obtained in patients with mitral regurgitation due to ruptured chordae and dilated annulus. On the other hand, this procedure was less satisfactory in patients with mitral regurgitation due to fibrotic changes of valvular and subvalvular tissue. We believe that the late results with mitral annuloplasty largely depend upon pathological anatomies of incompetent valve⁹.

The late results of patients undergoing mitral valve replacement with Kay-Shiley disc valve showed poor prognosis in the majority, mainly by carrying thromboembolic complications, although the clinical and hemodynamic results of surviving patients were acceptable, compared with those of patients undergoing reconstructive mitral valve surgery. We no longer use Kay-Shiley disc valve and continue to search for improved substitute. Prosthetic mitral valves currently used clinically are still far from ideal because of higher risk of late complications such as thromboembolism, malfunction, infection, and residual gradient across the prosthesis.

An actuarial survival curves of patients who underwent open mitral commissurotomy, closed

mitral commissurotomy; mitral annuloplasty, and mitral valve replacement with Starr-Edwards disc valve, porcine xenograft and dura mater bioprosthesis introduced recently, and also of patients treated medically, reported by Rappaport et al,¹² are illustrated in Fig. 16. It is evident that the long-term results of patients undergoing mitral valve replacement and treated medically show much poorer prognosis compared with those of reconstructive surgery.

In conclusion, hereby, we confirm that reconstructive mitral valve surgery should be the treatment of choice for most of the patients with symptomatic mitral valve disease, and prosthetic replacement should be avoided or delayed when it is feasible⁸

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