

# Cardiac Surgery at Yonsei University Medical Center

— A 30-year review —

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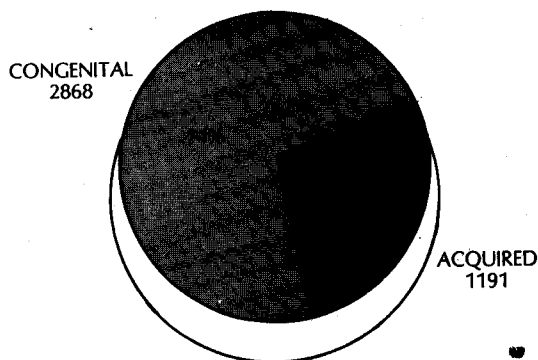
This is a 30-year review of 4,059 patients who underwent cardiac operations at Yonsei University Medical Center between September 1, 1956 and August 31, 1986. Of these, there were 1,191 patients with acquired and 2,868 with congenital cardiac lesions, constituting 29% and 71% of the group, respectively. Of 1,191 patients with acquired lesions, the number in each major category and the operative mortality were as follows: closed mitral commissurotomy, 210 and 0.95%; open mitral commissurotomy, 164 and 4.3%; mitral valve replacement, 370 and 3.5%; aortic valve replacement, 154 and 9.7%; double valve replacement, 123 and 2.4%, and coronary artery bypass grafting, 94 and 8.5%. Of 2,868 patients with congenital cardiac lesions, the number and operative mortality in the major categories were as follows: repair of tetralogy of Fallot, 593 and 9.3%, repair of ventricular septal defect, 817 and 7.1%, closure of atrial septal defect, 403 and 1.5%, and closure of patent ductus arteriosus, 550 and 1.3%.

**Key Words:** 30-year review, cardiac surgery, congenital and acquired cardiac lesions

On September 14, 1956, a closed mitral commissurotomy was successfully performed on a 20-year old man with mitral stenosis at Severance Hospital, the main teaching hospital of Yonsei University Medical Center (YUMC) in Seoul, Korea (Hong 1959). This was the first intracardiac operation ever performed at YUMC and also marks the beginning of modern cardiac surgery in Korea.

During a 30-year period from September 1, 1956 to August 31, 1986, a total of 4,059 patients underwent operative procedures for a variety of congenital and acquired cardiac lesions; 2,868 or 71% for congenital and 1,191 or 29% for acquired lesions (Fig. 1). During the initial stage of program development, closed mitral commissurotomy and shunt procedures for tetralogy of Fallot were the only cardiac procedures performed. In 1963, after a series of animal experiments (Hong *et al.* 1963), open heart surgery with the aid of extracorporeal circulation became clinically available at YUMC and cardiac operations utilizing this technique were begun to extend the scope of

surgical experience to other areas of congenital and acquired lesions (Hong *et al.* 1965). Subsequently, there was a steady increase in the number of surgical cases until the late 1970's when the patient population began to increase rapidly. This was undoubtedly set off by the introduction of the National Medical Insurance Program in Korea in 1977 which enabled many indigent patients to undergo cardiac operations which were too expensive for them in the past (Fig. 2).



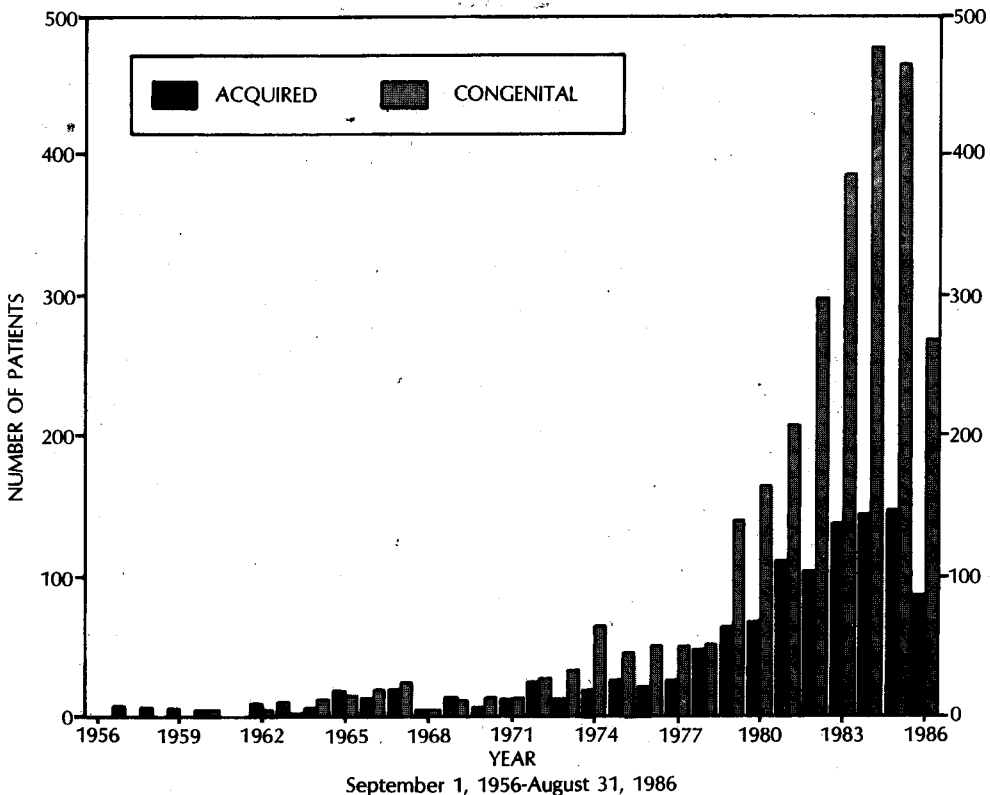
(September 1, 1956-August 31, 1986)

**Fig. 1.** Total number of patients operated on for congenital and acquired cardiac lesions (n=4,059)

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**Fig. 2.** Yearly breakdown of patients operated on for congenital and acquired cardiac lesions ( $n=4,059$ )

## MATERIAL AND METHODS

The patient materials were obtained from the medical records of Severance Hospital, Yonsei University Medical Center. The medical history and operative results of 4,059 patients who had had cardiac operations during a 30-year period from September 1, 1956 to August 31, 1986, were carefully reviewed. The number in each operative category represents the primary operations for those patients and subsequent reoperations in the same patient groups were listed separately. The operative mortality represents the number of patients dying within 30 days of the operation.

Statistical significance was determined by the chi-square method and a probability value of less than 0.05 was regarded as statistically significant.

## SURGERY FOR ACQUIRED CARDIAC LESIONS

A total of 1,191 patients underwent cardiac opera-

tions for various forms of acquired cardiac lesions (Fig. 3). Over-all, 90.0% of these were patients with valve problems and, among them, mitral valve lesions were the most common, comprising 64.6% of the total. The number of patients undergoing coronary artery bypass surgery was relatively small, reflecting the fact that coronary artery bypass grafting was not begun until 1977 and also that obstructive disease of the coronary artery, although increasing in number, is not as yet a major cardiac problem in Korea.

## MITRAL VALVE DISEASE

During the 30-year period from September, 1956, when the first closed mitral commissurotomy was performed, to August 31, 1986, a total of 769 patients had operations performed on their mitral valve. Most of the patients were relatively young and 63% of these were female (Table 1). The surgical approach to the mitral lesion evolved over the years, beginning with a closed commissurotomy using a finger fracture technique and evolving into repair and replacement of the mitral valve as facilities for open intracardiac

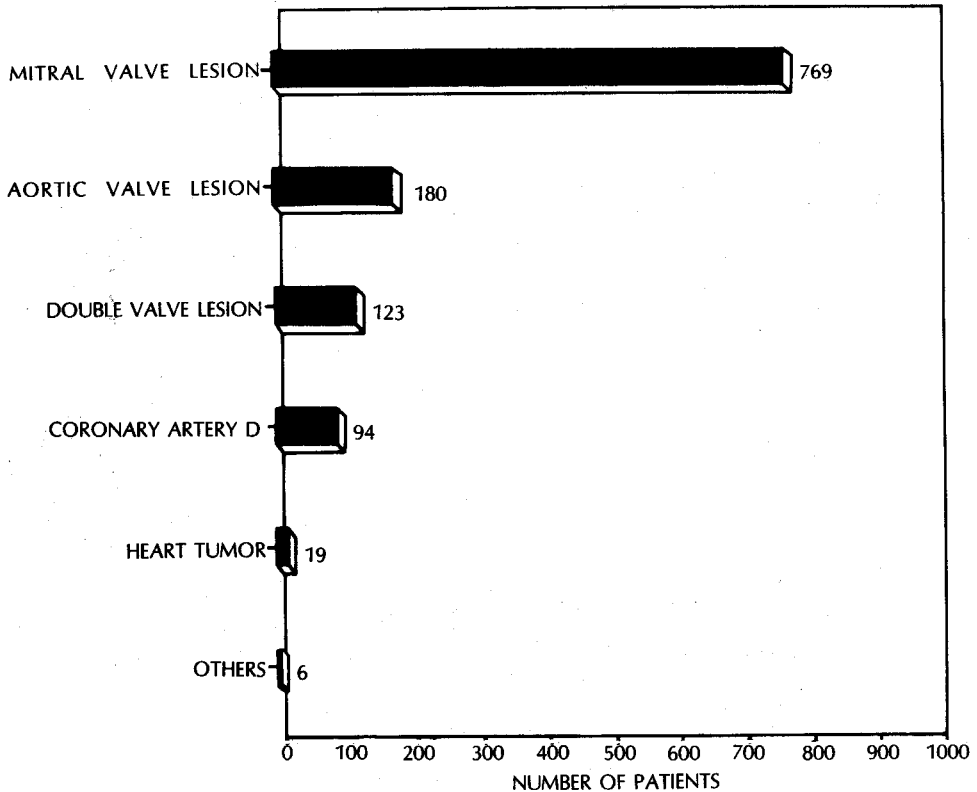


Fig. 3. Breakdown of surgically treated acquired cardiac lesions (1956-August, 1986, n=1,191)

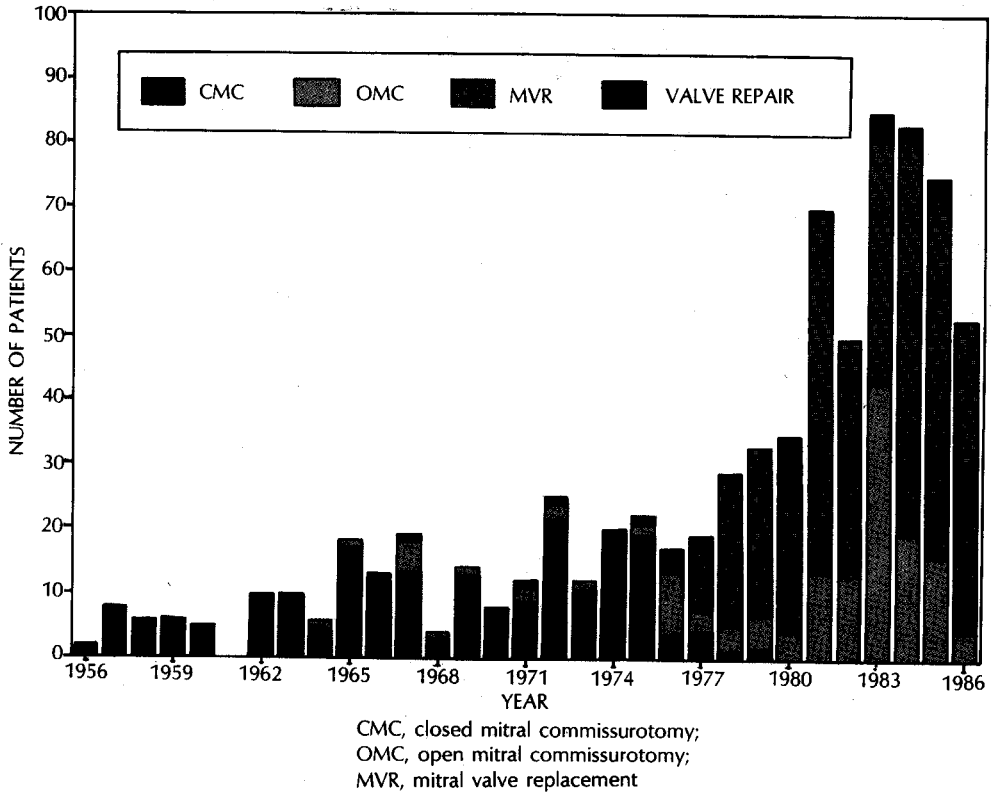
Table 1. Operations on the mitral valve (1956-August, 1986, n=769)

	n	Male %	Mean age years (range)
Closed mitral commissurotomy	210	42	30.9 (12-63)
Open mitral commissurotomy	164	33	35.5 (11-66)
Mitral valve replacement	370	34	36.3 (8-65)
Repair of mitral valve	25	48	30.3 (5-65)
MAP	17		
MVP	2		
MAP+MVP	3		
MAP+TAP	3		
Total	769	37	34.4 (5-66)

MAP, mitral annuloplasty; MVP, mitral valvuloplasty; TAP, tricuspid annuloplasty

procedures and reliable mitral prosthesis became available. Closed commissurotomy was completely phased out in 1979 and, during the last two years of this report, 79% of all surgical procedures performed on the mitral valve consisted of mitral valve replacement (Fig. 4).

**Closed mitral commissurotomy:** Initially, the closed mitral commissurotomy (CMC) consisted of a simple finger fracture technique in which the operator's index finger was forcefully inserted into the stenotic valve orifice to split the fused commissures. This was effective in providing many patients with an acceptable degree of mitral valve opening, which enabled these patients to return to a useful life-style. A minor degree of mitral regurgitation was not a contraindication of the CMC but the effectiveness of the technique was severely limited in dealing with a stenotic valve with heavy calcification and/or fibrosis and a valve with a significant degree of regurgitation. Also, it was often impossible to open the posteromedial commissures with finger pressure alone which resulted in an inadequate valve orifice. Closed com-



**Fig. 4.** Yearly breakdown of operations on the mitral valve (September, 1956-August, 1986,  $n=769$ )

missurotomies using various types of valvulotomes were next attempted with indifferent success. Subsequently, the Tubbs and the Gerbode valve dilators were used to split the commissures under controlled settings, producing a satisfactory opening in the majority of patients (Hong 1963). The degree of success with this method was such that the valve dilators were later used even in open mitral commissurotomies.

During the 23-year period between 1956 and 1979, a total of 210 patients underwent 212 closed mitral commissurotomies. Two patients had a repeat CMC done successfully 4 and 8 years after the initial commissurotomy. There were only 2 operative deaths (0.9%) in this group of patients, despite the fact that many were operated on during the early period of the authors' experience.

**Open mitral commissurotomy:** The first open mitral commissurotomy (OMC), under direct vision with the aid of a cardiopulmonary bypass, was unsuccessfully attempted on March 6, 1964 on a 23-year old female who had a mitral stenosis and aortic regurgitation. Bet-

**Table 2. Open mitral commissurotomy (1964-August, 1986,  $n=164$ )**

	Operative mortality			
	n	No.	%	p-value
Open mitral commissurotomy				
No previous surgery	155	6	3.8	0.29
Previous CMC	9	1	11.1	
	164	7	4.3	

CMC= closed mitral commissurotomy

ween 1964 and August, 1986, a total of 164 OMC were performed on 164 patients, with 7 operative deaths (4.3%). In 155 patients, in whom it was the first operation on the mitral valve, the operative mortality was 3.8%, whereas in 9, in whom it was the second operation following an initial closed mitral commissurotomy, the mortality was 11.1%. This indicates an increase in operative risk in reoperations, even

though it was not statistically significant (Table 2). In 41 patients, additional cardiac procedures were performed together with the OMC and these were: tricuspid annuloplasty, 14; mitral annuloplasty, 10; mitral valvuloplasty, 8; aortic valvuloplasty, 8 and aortic commissurotomy and tricuspid annuloplasty, 1. The operative mortality in this group of patients was 2.4%, which indicates a relatively low operative risk if these additional procedures are carried out judiciously.

**Mitral valve replacement:** The first mitral valve replacement (MVR) was performed on March 26, 1975 on a 28-year old male with stenosis and regurgitation of both the mitral and the aortic valves. The diseased mitral valve was replaced with a Starr-Edwards ball-valve prosthesis and a concomitant aortic valvuloplasty was performed. Including this patient, there were 2 operative deaths among the first 5 patients who received a Starr-Edwards valve, which probably reflects the learning curve of the surgical team at the time rather than the quality of the prosthesis itself. In 1977, the Carpentier-Edwards porcine valve became available locally and a series of valve replacements using this prosthesis was initiated in March, 1977. A total of 370 patients had their diseased

**Table 3. Mitral valve replacement  
(1975-August, 1986, n=370)**

	Operative mortality			
	n	No.	%	p-value
Mitral valve replacement				
No previous surgery	340	10	2.9	0.04
Previous surgery	30	3	10.0	
CMC	19	1	5.3	
OMC	5	1	20.0	
Valve repair	2	1	50.0	
MVR	3	0	0	
Ligation of PDA	1	0	0	
	370	13	3.5%	

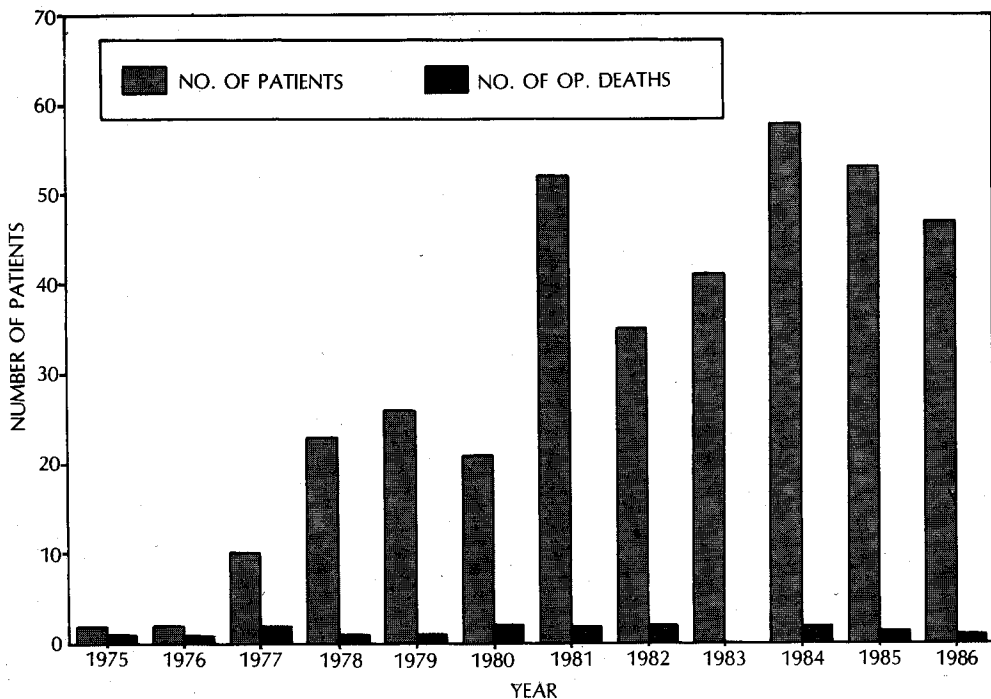
CMC, closed mitral commissurotomy;

OMC, open mitral commissurotomy;

MVR, mitral valve replacement;

PDA, patent ductus arteriosus

ed mitral valve replaced with a valve prosthesis between 1975 and 1986. There were 13 operative deaths (3.5%) in this group. In 340 patients, the MVR was the first cardiac operation, whereas in 30, it was the se-



**Fig. 5. Yearly breakdown of mitral valve replacement (1975-August, 1986, n=370)**

cond cardiac procedure, which was preceded by a previous mitral valve operation in 29. There was a statistically significant difference in the operative mortality between these two groups, which was 2.9% for the primary operation as opposed to 10.0% for the secondary procedure (Table 3). Eleven patients in this group had to have their prosthetic valve replaced with another prosthesis at a later time because of dysfunction of the original prosthesis. The results of mitral valve replacement carried out between 1975 and 1986 show a marked increase in the number of patients over the years, with a substantial decline in the operative mortality, which was only 2.8% during the last 5 years of the review (Fig. 5).

Many of these patients with mitral valve lesions had pathology in other valves as well. The most frequent was the diseased tricuspid valve, especially regurgitation, which is evidence of a failing right heart. Thus, 70 or 18.4% of these patients had a tricuspid annuloplasty for a significant degree of tricuspid incompetence, and 13 patients underwent repair of the aortic valve for functionally significant aortic lesions (Table 4). The over-all operative mortality for this group of patients was 9.8%, which is significantly greater than the 1.4% for the group without additional operative procedures on other valves. The higher mortality seen in these patients may be a reflection of the seriousness and advanced nature of the cardiac lesions which necessitated these additional procedures, rather than the problems associated with the operative procedure per se.

**Repair of the mitral valve:** In 25 patients, repair of the mitral valve was performed as the primary procedure to reconstitute the function of the diseased mitral valve.

**Table 4. Results of mitral valve replacement with and without associated procedures (1975-August, 1986, n=370)**

	n	Operative mortality			p-value
		No.	%		
MVR, isolated	278	4	1.4		0.01
MVR and other procedure	92	9	9.8		
Tricuspid annuloplasty	70	6	8.6		
Aortic valvuloplasty	13	2	15.4		
Aortic valvulotomy	2	0	0		
Others	7	1	14.2		
	370	13	3.5		

MVR= mitral valve replacement

A mitral annuloplasty was done in 17 patients, a mitral valvuloplasty in 2, a mitral annuloplasty and valvuloplasty in 3, and a mitral annuloplasty and a tricuspid annuloplasty in 3 patients.

There were 2 operative deaths in this group, both in patients following an annuloplasty of the mitral valve. The over-all mortality for the entire group was 8.0%, which is considerably higher than that of the commissurotomy or replacement of the mitral valve. Repair of the mitral valve is an acceptable and, often, a preferable method because it can restore valve function without introducing the known risks and problems of the current generation of prosthetic valves. However, it does require meticulous preoperative evaluation and planning and skillful manipulation during the operation for success; therefore, one should approach it with caution and weigh available options before making the final decision.

## AORTIC VALVE DISEASE

Except for several sporadic attempts at repair of the aortic valve which began in 1965, it was not until 1975 that a systematic effort was initiated in aortic valve surgery with availability of a clinically proven aortic valve prosthesis.

Between 1965 and 1986, 180 patients with aortic valve disease underwent various operative procedures, consisting of 8 repair procedures, 154 valve replacements and a combination of valve replacement and grafting of the ascending aorta in the remaining 18 patients with aortic annular ectasias (Table 5).

**Aortic valve replacement:** On May 6, 1975, an aortic

**Table 5. Operations on the aortic valve (1965-August, 1986, n=180)**

	n	Male %	Mean age years (range)
Repair of valve	8	75	26.4 (15-40)
AVR	154	69	36.9 (16-60)
AVR+graft of AA*	18	67	37.6 (25-55)
	180	69	36.3 (15-60)

AVR, aortic valve replacement; AA, Ascending aorta

\* Composite graft in 10, non-composite graft in 8

**Table 6. Aortic valve replacement  
(1968-August, 1986, n=154)**

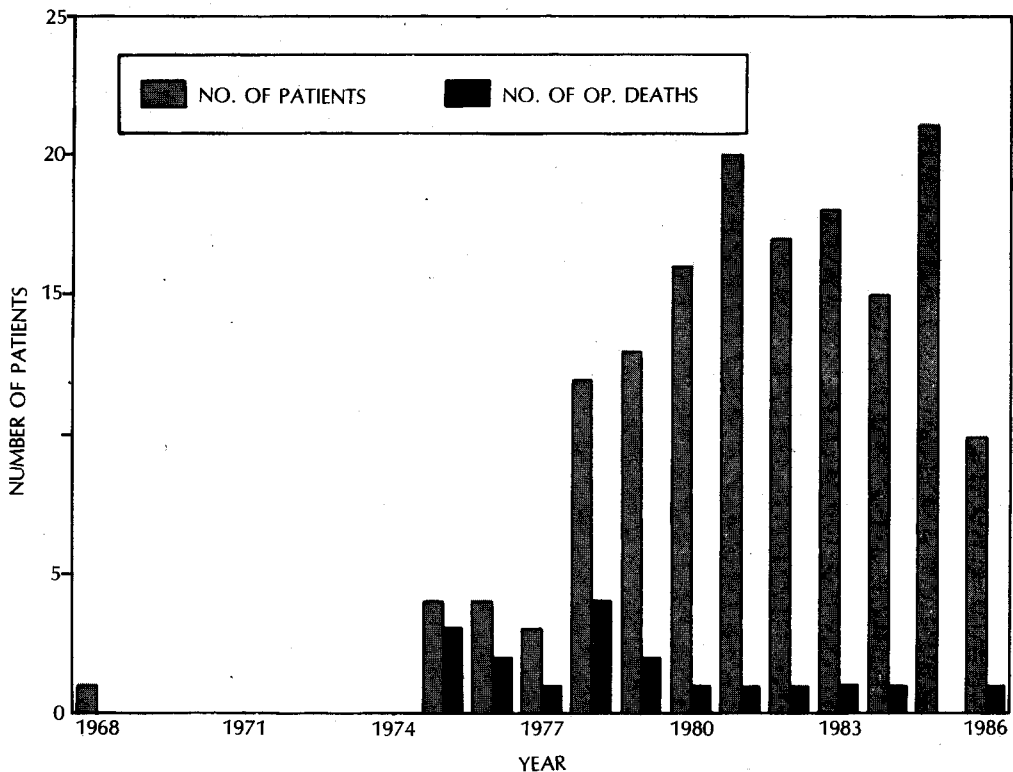
	n	Operative mortality		p-value
		No.	%	
AVR with:				
No previous surgery	150	14	9.3	0.29
Previous surgery	4	1	25.0	
CMC	2	1	50.0	
DVR	1	0	0	
AVP	1	0	0	
	154	15	9.7	

AVP, aortic valvuloplasty; AVR, aortic valve replacement; CMC, closed mitral commissurotomy; DVR, double valve replacement

valve replacement was performed successfully on a 20-year old male with aortic regurgitation. An aortic valve replacement (AVR) was carried out in 154 patients with an over-all mortality of 9.7%. In 150 patients who had not undergone a previous cardiac

operation, the mortality was 9.3% as compared with 25.0% mortality in patients who had had a previous cardiac procedure (Table 6). The AVR was the only cardiac procedure performed in 103 patients, whereas in 51 patients, additional cardiac procedures were also done (Table 7). The difference in the operative mortality between these two groups was not significant. The results of aortic valve replacement over the years again show a marked increase in the number of patients and a decline in operative mortality, it being 5.9% during the last 5 years of the study (Fig. 6). In 4 patients, the aortic valve prosthesis had to be replaced later because of failure of the original valve.

**Repair of the aortic valve:** In general, lesions of the aortic valve do not lend themselves as readily to repair procedures as those of the mitral valve. This explains why 95.5% of the surgical procedures performed on the aortic valve in this series were valve replacements, in sharp contrast to the mitral valve procedures where valve replacement constituted only 48.1% of the total. In 8 patients, repair of the valve was attempted as the primary procedure with 1 operative death (12.5%).

**Fig. 6. Yearly breakdown of aortic valve replacement (1968-August, 1986, n=154)**

**Table 7. Aortic valve replacement with and without associated procedures (1968-August, 1986, n=154)**

	n	Operative mortality		p-value
		No.	%	
AVR with:				
No associated procedure	103	11	10.7	0.57
Associated procedure	51	4	7.8	
OMC	26	3	11.5	
MAP	15	1	6.7	
OMC+MAP	3	0	0	
OMC+TAP	3	0	0	
MVP	2	0	0	
Others	2	0	0	
	154	15	9.7	

AVR, aortic valve replacement;

OMC, open mitral commissurotomy;

MAP, mitral annuloplasty;

MVP, mitral valvuloplasty;

TAP, tricuspid annuloplasty

**AVR and grafting of the ascending aorta:** Replacement of the aortic valve and concomitant grafting of the ascending aorta was performed in 18 patients with an aortic annular ectasia. A composite grafting (Bentall) was carried out in 10 patients with one operative death (10%), and a non-composite grafting was done in 8 patients without an operative death, yielding an over-all operative mortality of 5.5%.

The selection of the composite or the non-composite operative procedure was dictated by the operating surgeon's personal experience, the availability of a suitable composite grafting prosthesis and the anatomy and location of the coronary ostia relative to the aortic valve ring.

## DOUBLE VALUE REPLACEMENT

The first double valve replacement was successfully performed in 1978 on a 27-year old male with a mitral stenosis and aortic regurgitation. Both the mitral and the aortic valves were replaced with a #29 and #25 Carpentier-Edwards porcine prosthesis (Cho *et al.* 1980). Between 1978 and 1986, a double valve replacement was performed on 123 patients, the majority being a combined replacement of the mitral and the aortic valves (Table 8). There were 3 operative deaths in this group (2.4%), a relatively low mortality which may be due to the better myocar-

**Table 8. Double valve replacement (1978-1986, n=123)**

	n	Operative mortality	
		No.	%
AVR+MVR	121	3	2.5
MVR+TVR	2	0	0
	123	3	2.4

AVR, aortic valve replacement;

MVR, mitral valve replacement;

TVR, tricuspid valve replacement

dial protection provided by the cold cardioplegia used in these patients. There were only 2 patients who required a tricuspid valve replacement with the MVR because the tricuspid regurgitation secondary to mitral valve lesions was usually amenable to an annuloplasty, obviating the need for a valve replacement.

## CORONARY ARTERY BYPASS GRAFTING

The coronary artery bypass grafting (CABG) performed successfully on a 51-year old man on May 11, 1977 was the first such procedure carried out in Korea (Lee *et al.* 1979). Between 1977 and 1986, a total of 94 patients underwent CABG with 8 operative deaths (8.5%) (Table 9). The mean age was 54 years (range, 32-73) and 78.8% were male.

The number of patients who underwent CABG in this series is small. Although there has been a gradual increase in the number of patients seen with coronary artery disease, obstructive disease of the coronary artery is not as yet one of the prominent surgically

**Table 9. Coronary artery bypass grafting (1977-August, 1986, n=94)**

	n	Operative mortality		p-value
		No.	%	
CABG with:				
No associated procedure	90	8	8.9	0.53
LV aneurysmectomy*	4	0	0	
	94	8	8.5	

CABG, coronary artery bypass grafting; LV, left ventricle

\* Two of these patients also had repair of a ventricular septal defect and an aortic valve replacement



treatable cardiac problems in Korea (Cho 1985; Hong 1979).

### MISCELLANEOUS ACQUIRED CARDIAC LESIONS

There were 25 patients who underwent operations for various acquired cardiac problems (Table 10). The nineteen myxomas seen in this series were all in the

**Table 10. Operations on miscellaneous acquired cardiac lesions**  
(1966-August, 1986, n=35)

	n	Male %	Mean age years (range)	Procedure	Operative mortality %
Left atrial myxoma	19	37	40.9	Excision	0
Tricuspid valve lesion*	3	0	34.0 (33-36)	TVR 2 TAP 1	33.3
Heart trauma	3	100	33.7 (25-50)	REPAIR	0

TVR, tricuspid valve replacement;

TAP, tricuspid annuloplasty

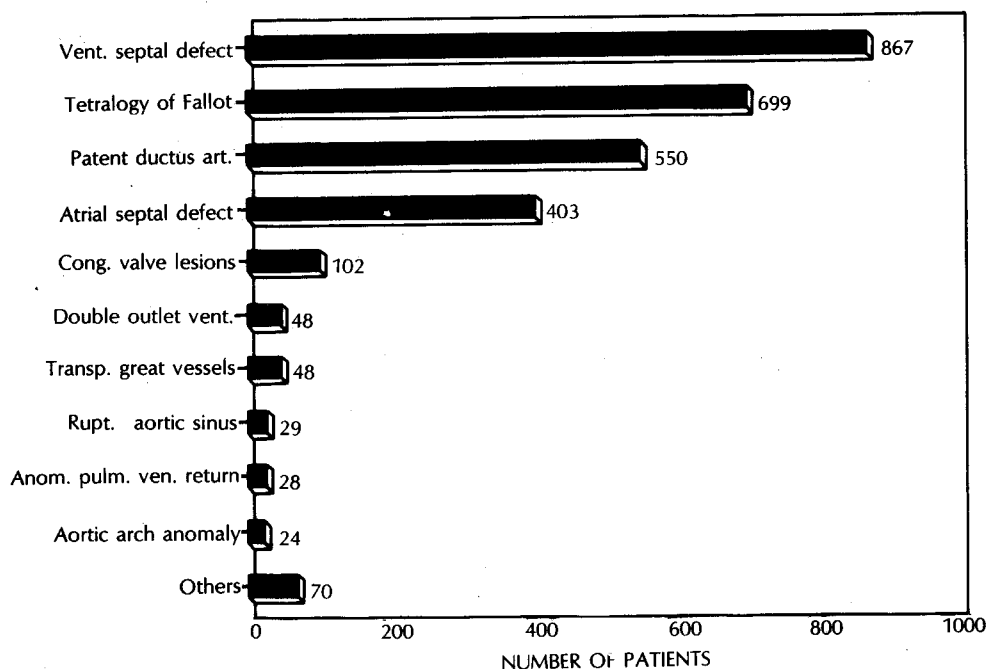
\* Excludes patients in whom tricuspid lesion was secondary in nature.

left atrium and were resected without operative mortality. The 3 patients operated on for tricuspid lesions were those in whom it was the only cardiac lesion, excluding patients in whom it was secondary to other cardiac problems. Heart trauma patients were operated on because of a stab wound of the right ventricle in 2 patients and laceration of the right atrial wall in one patient. In all 3, the wounds were repaired without operative mortality.

### SURGERY FOR CONGENITAL CARDIAC LESIONS

On April 1, 1957, a Potts-Smith aortopulmonary anastomosis was successfully performed on a 30-month girl with tetralogy of Fallot and severe cyanosis (Hong and Lim 1958). It was the beginning of a series of operations for various forms of congenital cardiac lesions at YUMC. Initially, extracardiac procedures such as shunts and closure of patent ductus arteriosus were the only operations performed. With the availability of the heart-lung bypass in 1963, intracardiac operations under direct vision were begun for more complex cardiac anomalies.

From 1957 to August, 1986, a total of 2,868 patients with various forms of congenital cardiac anomalies underwent operative procedures at this institution. In order of frequency, ventricular septal



**Fig. 7. Breakdown of surgically treated congenital cardiac lesions (1957-August, 1986, n=2,868)**

defect was the most common (30.2%) which was followed by tetralogy of Fallot (24.4%), patent ductus arteriosus (19.2%), atrial septal defect (14.0%) and others (Fig. 7).

## TETRALOGY OF FALLOT

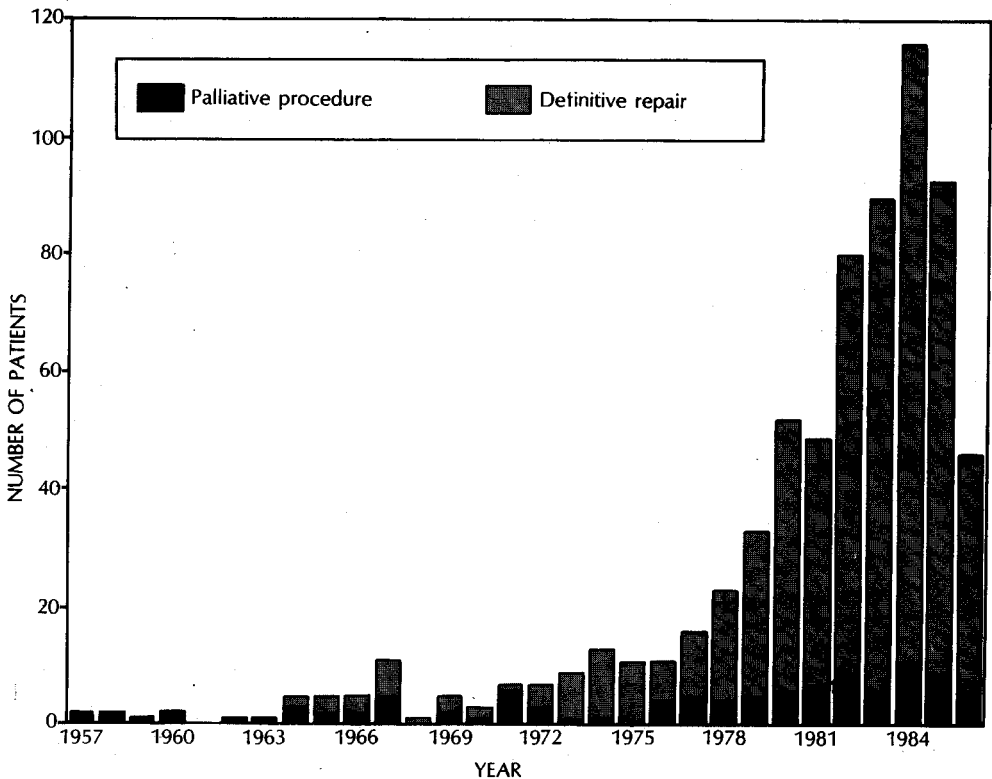
A total of 699 patients underwent operations for

**Table 11. Operations on tetralogy of Fallot (1957-August, 1986, n=699)**

	n	Male %	Mean age years (range)
Definitive repair	593	57	9.0 (3m-42yr)
Palliative procedure	106	57	5.8 (2m-31yr)
	699	57	8.5 (2m-42yr)

tetralogy of Fallot (TOF), of which 593 were corrective and 106 were palliative in nature (Table 11). There has been a gradual shift away from palliative procedures in more recent years because of the fairly high operative mortality in these operations and the improvement in the over-all results with the corrective procedures in tetralogy of Fallot (Fig. 8).

**Palliative procedures for TOF:** A total of 106 patients underwent a palliative operation for TOF with 16 postoperative deaths (15.0%), not an insignificant figure for a palliative procedure. Various shunt procedures were utilized in this series, beginning with Potts-Smith aortopulmonary side-to-side anastomosis and gradually shifting to Blalock-Taussig and Waterston anastomosis with or without the use of a Gortex bridge (Chang *et al.* 1986). It remains a valuable tool in patients with tetralogy of Fallot whose cardiac anomaly is unsuitable for a primary repair or who are too young or too ill to undergo an initial correction. In 9 patients, the shunt procedure had to be done more than once, for a total of 115 shunt operations in 106 patients.



**Fig. 8. Yearly breakdown of number of operations for tetralogy of Fallot (1957-August, 1986, n=699)**

**Definitive repair of TOF:** The first attempt at definitive repair of TOF was made unsuccessfully on May 13, 1964 on a 22-year old male who had had a Potts-Smith shunt done 6 years earlier and who was going into congestive heart failure because of the over-load of the pulmonary circuit. Between 1964 and 1986, a total of 593 patients underwent definitive repair of TOF with 55 postoperative deaths (9.3%). In patients in

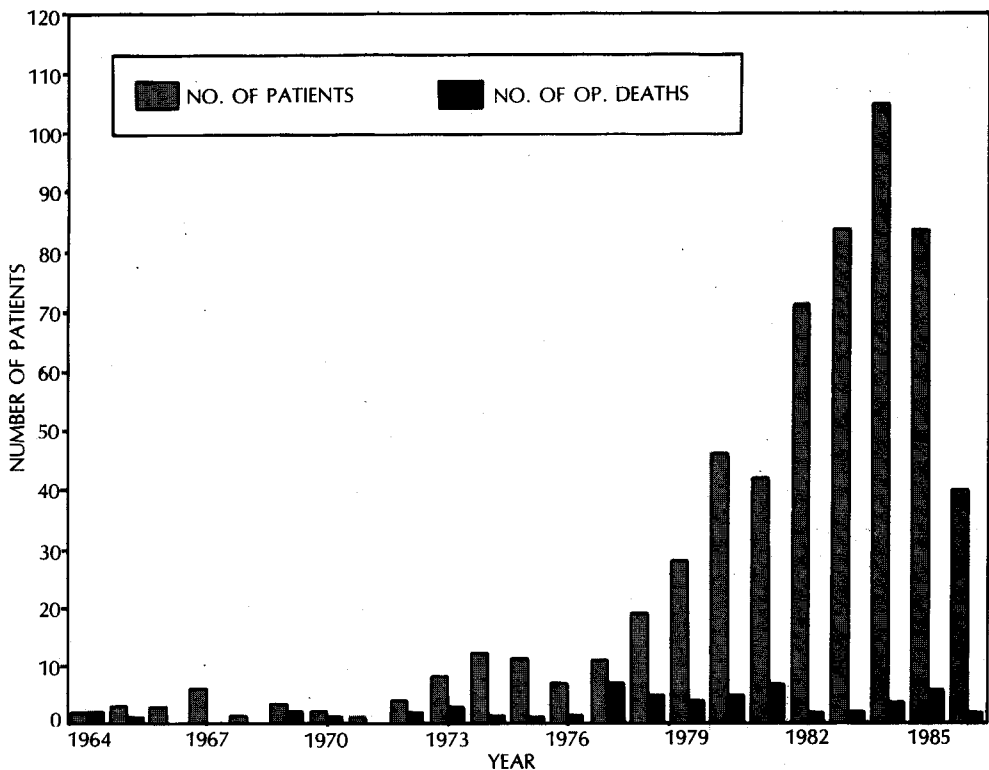
whom it was the first operation, the mortality was 8.5%, whereas in patients who had had previous shunts, the mortality was 19.0% (Table 12). The higher mortality seen in this latter group of patients reflects the severity and complexity of the cardiac anomaly which necessitated a shunt in the first place, as well as the technical problems encountered at surgery. Initially, the operative mortality was high but it gradually improved over the years, and during the last 5 years of the review period it was 4.6% (Fig. 9). A reoperation had to be performed on 14 patients at a later date; to close a residual ventricular septal defect in 12 (1 death), to repair a right ventricular aneurysm in 1 and a Rastelli operation was performed in 1 (1 death).

**Table 12. Definitive repair of tetralogy of Fallot (1964-August, 1986, n=593)**

	n	Operative mortality		p-value
		No.	%	
Definitive repair with:				
No previous surgery	550	47	8.5	0.05
Previous surgery	43	8	18.6	
Shunt	42	8	19.0	
Pulmonary valvotomy	1	0	0	
	593	55	9.3	

### VENTRICULAR SEPTAL DEFECT

Between 1964, when the first operative repair of a ventricular septal defect (VSD) was undertaken (Cho *et al.* 1978), and 1986, a total of 867 patients, the largest group in the congenital series, underwent various operative procedures. There were 817 patients



**Fig. 9. Definitive repair of tetralogy of Fallot (1964-August, 1986, n=593)**

with an isolated VSD, 44 patients with a VSD associated with a functionally significant aortic regurgitation and 6 patients who had only a pulmonary artery banding for pulmonary hypertension which accompanied the VSD. The pulmonary

artery banding was used infrequently in this series (Table 13).

**Definitive repair of VSD:** In 817 patients with isolated VSD, the defect was closed by direct suture or with a patch with 27 postoperative deaths (3.3%). The operative mortality in 813 patients without previous cardiac surgery was 3.3%, as compared to 25% seen

**Table 13. Surgical procedures for ventricular septal defect (1964-August, 1986, n=867)**

	n	Male %	Mean age years (range)
Repair of VSD	817	60	7.1 (2m-56yr)
Repair of VSD+AR	44	64	14.9 (3 -36yr)
Pulmonary artery banding	6	83	2.5 (5m-5yr)
	867	61	7.5 (2m-56yr)

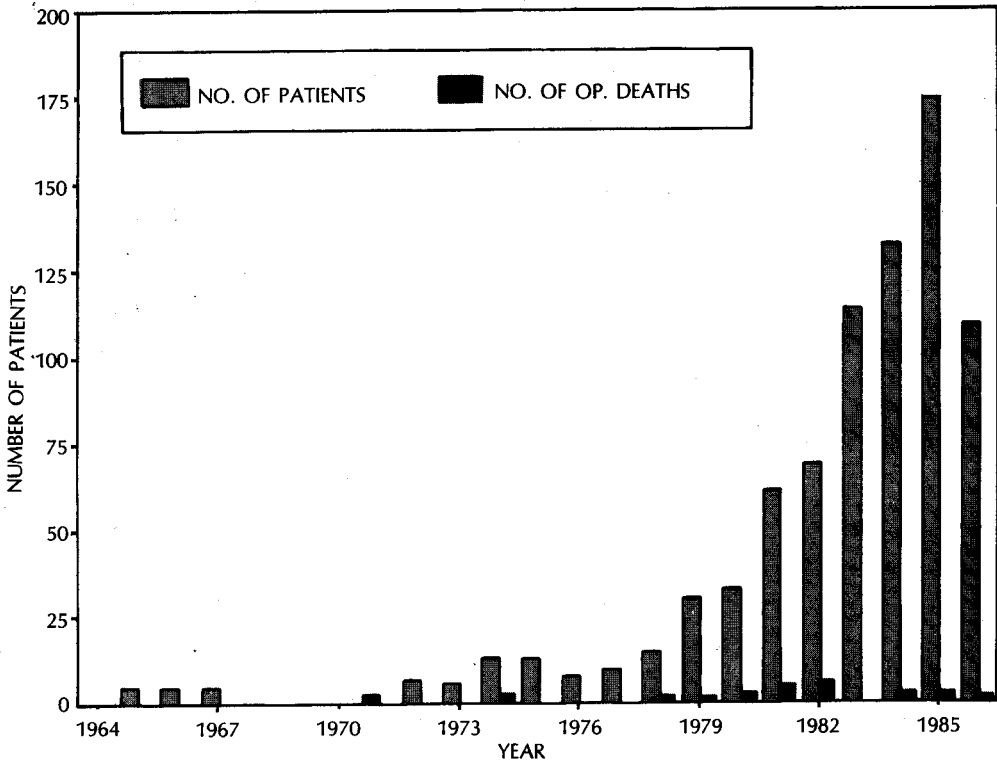
VSD, ventricular septal defect;  
AR, aortic regurgitation

**Table 14. Definitive repair of ventricular septal defect (1964-August, 1986, n=817)**

	Operative mortality		
	n	No.	%
Repair of VSD with:			
Previous surgery*	4	1	25.0
No previous surgery	813	26	3.2
	817	27	3.3%

VSD, ventricular septal defect

\* pulmonary artery banding in 2 (1 death), closure of patent ductus arteriosus in 2



**Fig. 10.** Definitive repair of ventricular septal defect (1964-August, 1986, n=87)

in 4 patients who had undergone previous cardiovascular procedures (Table 14). The operative mortality remained low throughout the review period and, during the last 5 years, it was only 2.5% (Fig. 10). In 9 patients, a reoperation was necessary to repair a residual VSD with no postoperative deaths.

**Repair of VSD with aortic regurgitation:** There were 44 patients who had a significant degree of aortic regurgitation in addition to the VSD. The overall mortality following closure of the VSD and correction of the aortic regurgitation in this group of patients was 2.3%. In 31 patients, a valvuloplastic procedure was performed; in 10, the deformed valve had to be replaced with a prosthetic device and in 3, an aortic annuloplasty was carried out (Table 15). In 2 patients, a reoperation was performed later to replace the original tissue valves with mechanical valves because of failure of the original valves. It is interesting to note that patients who required surgery for correction of the VSD and aortic regurgitation were much older than patients with simple VSD, suggesting the possibility that functionally significant aortic regurgitation developed over a period of years and that, perhaps, earlier operative closure of the VSD might lessen the chance of development of this complication.

**Table 15. Repair of ventricular septal defect with aortic regurgitation**  
(1971-August, 1986, n=44)

	n	Operative mortality	
		No.	%
Repair of VSD and aortic valve			
VSD repair + AVP	31	0	0
VSD repair + AVR	10	1	9.1
VSD repair + AAP	3	0	0
	44	1	2.3

VSD, ventricular septal defect;  
AVR, aortic valve replacement;  
AVP, aortic valvuloplasty;  
AAP, aortic annuloplasty

## ATRIAL SEPTAL DEFECT

On November 20, 1963, an atrial septal defect (ASD) of the secundum type in an 18-year old boy was closed successfully with the aid of a cardiopulmonary bypass. This was the first intracardiac surgery performed with a cardiopulmonary bypass at YUMC (Hong *et al.* 1965). Between 1963 and 1986,

a total of 403 patients underwent repair of ASD of both the ostium primum and the secundum types. There were 176 male and 227 female patients and the mean age of the group was 18.6 years (range, 8 months to 59 years). The over-all operative mortality following repair of these defects was 6 deaths or 1.5%. Four patients had to have a reoperation at a later time, one of which was due to recurrence of the defect following a direct suture. There were two deaths in this group of reoperative cases.

## PATENT DUCTUS ARTERIOSUS

A total of 550 patients underwent closure of a patent ductus arteriosus (PDA), beginning in 1960. There were 182 males and 368 females and the mean age was 8.94 years (range, 1 month to 61 years). The over-all mortality was 1.3% (Table 16). During the early period of the study, division and suture of the ductus was the procedure of choice, whereas in recent years, double or triple ligation of the ductus were done more often. The operative mortality for division was higher than that for ligation of the ductus, probably because division techniques were primarily used in patients with more difficult hemodynamic and technical problems. There were 3 patients who came for reoperation later because of recurrence of the PDA, all 3 following ligation of the ductus. There were no postoperative deaths in the reoperated cases.

**Table 16. Closure of patent ductus arteriosus**  
(1960-August, 1986, n=550)

	n	Operative mortality	
		No.	%
Primary closure of PDA			
Ligation	495	4	0.8
Division	55	3	5.4
	550	7	1.3

PDA, patent ductus arteriosus

## CONGENITAL VALVE ANOMALIES

The first open heart surgery at YUMC was performed on a 26-year old man with a congenital pulmonic stenosis on May 8, 1962. A successful valvulotomy was carried out under moderate hypothermia and inflow occlusion of venae cavae.

This group consisted of patients who had congenital deformities of the pulmonic, aortic and mitral valves. There were 57 males and 45 females and the

**Table 17. Repair of congenital valve anomalies (1962-August, 1986, n=102)**

	n	Operative mortality	
		No.	%
Primary repair of:			
Pulmonic stenosis	88	2	2.3
Aortic valve anomaly	10	1	10.0
Mitral valve anomaly	4	1	25.0
	120	4	3.9

mean age was 12.4 years (range, 2 months to 53 years). Primary repair of the pulmonic stenosis had only a 2.3% operative mortality, whereas the repair of the aortic and the mitral valve lesions carried with it much higher mortalities (Table 17). A 10-year old girl, who had had a mitral valvuloplasty for a congenital mitral insufficiency, required a mitral valve replacement 2 days later because of the continuing dysfunction of the repaired mitral valve.

#### MISCELLANEOUS CONGENITAL CARDIAC ANOMALIES

There were 247 patients who underwent 268 operative procedures for a variety of congenital cardiac problems (Table 18). As can be seen, the operative mortality in patients with more complex cardiac anomalies, such as transposition of the great vessels, double outlet right ventricle, and atresia of the pulmonary and the tricuspid valves, was high in comparison with the low operative mortality seen in patients with simpler anomalies, such as ruptured aortic sinus and aortic arch anomalies.

**Double outlet right ventricle:** Of 48 patients with a double outlet right ventricle (DORV), a corrective procedure was performed in 29 with 5 operative deaths, and a palliative procedure in 19 with 2 deaths. Three of the 4 patients who had a reoperation later died postoperatively.

**Transposition of great vessels:** A total of 48 patients underwent 51 operative procedures for transposition of great vessels (TGV). As a group, they were past the optimal age for definitive repair, with a mean age of 6.8 years (range, 1 month to 28 years). A definitive repair procedure was attempted in 28 patients with 11 postoperative deaths and a palliative procedure in 20 with 10 deaths. The high postoperative mortality seen in this group, following either a definitive or

**Table 18. Operations on miscellaneous congenital cardiac anomalies (1962-August, 1986, n=247)**

	n	Male %	Mean age years	Operative mortality
				%
Double outlet right ventricle	48	71	7.4	14.6
Transposition of great vessels	48	79	6.8	43.7
Ruptured sinus of Valsalva	29	69	23.0	0
Atrioventricular canal	28	39	1.7	10.7
Aortic arch anomalies	24	50	10.4	0
Tricuspid atresia	16	63	5.2	18.7
Pulmonary atresia	15	60	3.6	33.3
Single ventricle	15	53	4.6	13.3
Anomalous pulmonary venous return	9	89	9.5	11.1
Ebstein's anomaly	9	67	16.0	0
Truncus arteriosus	5	80	4.6	60.0%
Aorto-pulmonary window	1	100	11.0	100.0

a palliative procedure, may be due to poor candidate selection as well as to technical problems encountered during the perioperative period.

The numbers of patients in other disease categories are too small for proper analysis. It is hoped that the results in the operative management of the more complex congenital cardiac anomalies will improve as the patient selection, preoperative evaluation and management during and after the operation of these difficult patients continue to improve in future years.

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