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(Review)

A Twenty Seven Year Experience of Open Heart Surgery at Seoul National University Hospital†

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=Abstract=For twenty seven years from 1959 to 1985, 4,115 cases of open heart surgery utilizing cardiopulmonary bypass were done in the Department of Cardiothoracic Surgery, Seoul National University Hospital. Among 4,115 cases operated, congenital heart disease comprised 72.5% (2,982 cases), and acquired heart disease comprised 17.5% (1,133 cases). The operative mortality rate on congenital heart disease was 8.9% and the rate on acquired heart disease was 8.0%. Among cases operated due to congenital anomalies, 1,963 cases were acyanotic and 1,019 cases were cyanotic varieties; the operative mortality rate of the former was 3.7% and that of the latter was 18.9%. Valvular heart disease was the major cause of open heart surgery in acquired heart disease with the operative mortality rate of 7.8%. During the burgeoning period, mortality rate was high and the number of operated cases was small. But as the experiences accumulated year by year, the mortality rate decreased rapidly and markedly and plummeted to less than 5% in recent years. But many problems associated with high operative mortality rate in cyanotic patients should be solved and it is expected that coronary artery bypass surgery will increase rapidly in a few years.

Key words: ***Open heart surgery, Operative mortality rate***

INTRODUCTION

Open heart surgery utilizing cardiopulmonary bypass is a difficult clinical field, especially in developing countries. It is not only because it requires a specially orgnized team including excellent anesthesiologists and nurses and a large amount of investment in equipment and facilities leading to high medical cost, but also because it would always be accompanied by high operative risk, were it not for good techniques. And so it reflects the general level of medical achievement whether open heart surgery can be done or not.

Annual number of open heart surgery

Since the first case of ventricular septal defect was operated in August 1959, 4,115 open heart operations has been done by the end of December 1985. During the burgeoning period, mortality rates were high and the number of operated cases was small, but as the operated cases increased year by year, mortality rate decreased rapidly and markedly.

As shown in Table 1, 100 cases were operated in 1977 for the first time in Korea. Thereafter the rate of increase in the number of operations was rapid. In 1980, 416 operations were done in one year and in recent years as many as 600 cases were done yearly. Moreover the operative mortality rate decreased more markedly. At the early period of 60's, it ranged from 30% to 100%, but in the 70's, it abated to 10 to 25%. Although patients with complex anomalies were treated more frequently in recent years, it plummeted to less than 5%. This decrease can be attributed to several factors.

First, as experience accumulated in related

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Table 1. Annual open heart surgery at SNUH (1959-1985)

Year	Congenital		Acquired		Total	
	Case	Death	Case	Death	Case	Death(%)
1959	1	1	0	0	1	1(100.0)
1961	5	5	1	1	6	6(100.0)
1963	5	4	6	2	11	6(54.5)
1964	1	1	3	3	4	4(100.0)
1968	8	4	5	1	13	5(38.5)
1969	4	1	11	3	15	4(26.7)
1971	4	0	8	5	12	5(41.7)
1972	12	3	5	1	17	4(23.5)
1973	15	3	4	2	19	5(26.3)
1974	49	8	10	3	59	11(18.6)
1975	39	6	14	3	53	9(17.0)
1976	39	10	15	4	54	14(25.9)
1977	65	8	35	7	100	15(15.0)
1978	130	11	76	6	206	17(8.3)
1979	220	27	100	7	320	34(10.6)
1980	288	41	128	9	416	50(12.0)
1981	369	29	150	3	519	32(6.2)
1982	446	33	154	7	600	40(6.7)
1983	424	25	119	10	543	35(6.4)
1984	427	21	142	4	569	25(4.4)
1985	423	20	139	6	562	26(4.6)
Total	2,982	266	1,133	91	4,115	357(8.7)

fields, the knowledge to cardiac physiology and new surgical techniques increased, not to mention the better cooperation with those involved in nursing and ventilator cares. Secondly, better equipment such as 5 head roller pump, monitoring systems became available and new cardiotonic drugs were introduced.

Third, the skill of myocardial protection improved with the introduction of such cardioplegic solution as Bretschenider's or MGH solution, hypothermia and hemodilution techniques in extracorporeal circulation.

In summary, among 4,115 cases operated, congenital heart disease comprised 72.5% (2,982 cases) and acquired heart disease comprised 27.5% (1,133 cases).

Surgery on congenital heart diseases

The number of total cases was 2,982, among which 1,963 cases were acyanotic heart diseases and 1,019 cases were cyanotic heart diseases. Operative mortality rate of acyanotic lesions and cyanotic lesions were 3.7% and 18.9% respectively (Table 2).

Table 2. Summary of open heart surgery cases at SNUH (1959-1985)

Diseases		Cases	Death	Mortality(%)
Congental	Acyanotic	1,963	73	3.7
	Cyanotic	1,019	193	18.9
	Total	2,982	266	8.9
Acquired	Non-Valve	88	9	10.2
	Valve	1,045	82	7.8
	Total	1,133	91	8.0
Grand Total		4,115	357	8.7

1) Acyanotic congenital diseases

The most frequent anomalies were ventricular septal defect (1,163 cases, 50.2%), atrial septal defect (480 cases, 24.5%), pulmonic stenosis (105 cases, 5.3%) and endocardial cushion defect (68 cases, 3.5%) in decreasing frequency (Table 3). Ventricular septal defect accompained other cardiac anomalies in 22.4% as shown in Table 4. Patent ductus arteriosus and atiral septal defect were present in 4.6%, 4.6% respec-

Table 3. Acyanotic congenital anomalies (1959-1985)

Category	Cases	Death	Mortality(%)
VSD	1,163	43	3.7
ASD	480	4	0.8
PS	105	1	1.0
ECD	68	10	14.7
DCRV	13	0	0
LV-RA canal	10	0	0
Cong. MS	4	1	25.0
Cong. MR	5	1	20.0
Cong. ASR	2	0	0
Sinus Valsalva	6	1	16.7
AP Window	2	0	0
Others	105	12	11.4
Total	1,963	73	3.7

Table 4. Associated anomalies in ventricular septal defect (1959-1985)

Category	Cases	%
Isolated VSD	902	77.6
PDA	54	4.6
ASD	53	4.6
AR	48	4.1
MR	30	2.6
PS	29	2.5
DCRV	24	2.1
TR	10	0.9
ASD+PS	2	0.2
Others	11	0.9
Total	1,163	100

tively. Especially important was aortic regurgitation accompanying 4.1% which was frequently associated with subpulmonic ventricular septal defects (type 1 VSD after Kirklin-Becu classification) that were reported to be more prevalent in Korea and other oriental countries. Other associated anomalies were mitral regurgitation due to congenitally or secondarily dilated mitral annuli (2.6%), pulmonic stenosis (2.5%), double chambered right ventricle (2.1%) and tricuspid regurgitation (0.9%). The operative mortality was 3.7%. Atrial septal defect accompanied other anomalies in 24% as shown in Table 5. Among them, 6.7% (31 cases out of 480) had moderate to severe mitral regurgitation and 6.3% (30 cases) accompanied pulmonic stenosis with left to right shunt.

Table 5. Associated anomalies in atrial septal defect (1959-1985)

Category	Cases	%
Isolated ASD	392	81.7
MR	31	6.7
PS	30	6.3
PAPVR	16	3.3
TR	5	1.0
Others	6	1.3
Total	480	100

Table 6. Cyanotic congenital anomalies (1959-1985)

Category	Cases	Deaths	Mortality(%)
TOF	753	108	14.3
DORV+PS	61	19	31.1
TGA	42	22	52.4
Ebstein's anomaly	18	3	16.7
UVH	23	13	56.5
TAPVR	15	1	6.7
TA	16	5	31.3
PA	11	8	72.7
C-TGA+VSD+PS	6	2	33.3
Others	74	12	16.2
Total	1,019	193	18.9

2) Cyanotic congenital disease

Table 6 shows a variety of cyanotic lesion operated in SNUH. There were tetralogy of Fallot (753 cases, 73.9%), double outlet right ventricle (61 cases, 5.9%), transposition of great arteries (42 cases, 4.1%), univentricular heart (23 cases, 2.2%), Ebstein's anomaly (18 cases, 1.8%), tricuspid atresia (16 cases, 1.6%), total anomalous pulmonary venous return (15 cases, 1.5%) in decreasing frequency. As noted above, 18.9% died in the hospital after surgery. The reason for such a high mortality rate was due to the fact that young infants with severe cyanosis had a large proportion of this group. The surgical techiques for these patients involve many unsolved problems difficult to overcome, but for these patients to be rescued, more intensive and somewhat aggressive measures should be taken with more knowledge to detailed pathophysiology. It is hoped that the mortality rate would be lessened in near future. Tetralogy of Fallot was the most frequent cyanotic cardiac anomaly, and clinical spectrum varied from

Table 7. Associated anomalies of tetralogy of Fallot (1959-1985)

Category	Cases	%
Isolated TF	648	86.0
ASD	90	12.0
PDA	11	1.5
C-ECD	2	0.3
Coronary artery anomaly	1	0.1
Others	1	0.1
Total	753	0.1

Table 8. Acquired diseases (1959-1985)

Category	Cases	Deaths	Mortality(%)
Valve disease	1,045	82	7.8
Cardiac myxoma	29	0	0
Great vessel	16	4	25.0
CABG	9	0	0
Others	34	5	14.7
Total	1,133	91	8.0

so-called pink TOF to severe ones with small pulmonary artery or with unilateral pulmonary artery agenesis. Other cardiac anomalies were also present in 14% (105 cases out of 753) i.e. atrial septal defect in 90 (12.0%: pentalogy of Fallot), Patent ductus arteriosus in 11 (1.5%), complete endocardial cushion defect in 2 (0.3%) and coronary artery anomaly in 1 (0.1%) as shown in Table 7. The operative mortality rate was 14.3%. Double outlet right ventricle was differentiated from tetralogy of Fallot by the use of the "fifty percent rule". Operative mortality rate was 31.1%. Transposition of great arteries was difficult to operate with high mortality rate of 52.4%. Mustard and Senning operation were used in the main, but in a few cases, arterial switch operation (Jatene operation) were done.

Surgery on acquired heart disease

As shown in Table 8, cases with valvular heart disease comprised a majority (1,045 out of 1,133 cases). The second largest group was cardiac myxomas (29 cases) which were located in left atrium in 22 cases, in right atrium in 3 cases, right ventricle in 3 cases, left ventricle in 1 case. Surgical mortality was nil in cardiac myxomas. Among 16 cases of aortic diseases operated utilizing cardiopulmonary bypass, there were some cases of Marfan syndrome, annuloectasia and aortic aneurysm. Coronary artery bypass graft surgery was done only in 9 cases. It seems to be not only due to lower incidence of coronary disease in Korea, but also because this type of operation was started recently in this department.

Table 9. Valve diseases at SNUH (1959-1985)

Category	Cases	Deaths	Mortality(%)
Single valve	629	49	7.8
Double valve	370	25	6.8
Triple valve	46	8	17.4
Total	1,045	82	7.8

Table 10. Single valve diseases (1959-1985)

Category	Cases	Deaths	Mortality(%)
MS	196	14	7.1
MR	237	14	5.9
AS	6	0	0
AR	66	9	13.0
MSR	110	11	10.0
ASR	14	1	7.1
Total	629	49	7.8

1) Valvular heart disease

Among 1,045 cases with valvular heart disease, 629 had single valve disease, 370 had double valve disease and 46 had triple valve disease (Table 9). Mitral valve was more frequently involved than aortic valve. Mitral regurgitation (237 cases) was the commonest lesion followed by mitral stenosis (196 cases), mitral stenoinsufficiency (110 cases) and aortic regurgitation (66 cases). It was interesting that aortic stenosis was rare (6 cases) (Table 10). Double valve disease was combined aortic and mitral valve disease or mitral and tricuspid valve disease. The incidence of a variety of combinations is shown in Table 11.

Overall operative mortality of valve surgery including valve replacement, commissurotomy and annuloplasty was 7.8%. The triple valve disease had a high mortality rate of 17.4%, whereas operative mortality rates of single and double valve disease were 7.8%, 6.8% respectively. As was known, aortic valve disease showed higher mortality rate compared to mitral valve disease, that is 11.6% vs 6.1%.

2) Valve replacement surgery

The number of implanted artificial valve was

Table 11. Double valve diseases (1959-1985)

Category	Cases	Deaths	Mortality(%)
MS+TR	46	3	6.5
MR+TR	57	5	8.8
MSR+TR	31	2	6.5
MSR+ASR	75	3	4.0
MSR+AR	40	3	7.5
MS+AR	49	2	4.1
MR+AR	72	7	9.7
Total	370	25	6.8

Table 12. Valve replacement surgery at SNUH (1959-1985)

Category	Cases	Deaths	Mortality(%)
Single M	635	43	6.8
A	122	12	9.8
T	12	2	16.7
Subtotal	769	57	7.4
Double M+A	166	15	9.0
M+T	33	5	15.2
Subtotal	199	20	10.0
Triple M+A+T	8	1	12.5
Total	976	78	8.0

1,191 in 976 patients which included some cases of congenital anomalies requiring valve replacement (i.e. congenital mitral stenosis, congential mitral regurgitation, congenital aortic stenosis, endocardial cushion defect, aortic regurgitation associated with VSD, Ebstein anomaly etc.). A variety of prosthetic valves (Beall, Björk-Shiley, Wada-Cutter, Starr-Edwards, Magovern-Cromie, Smeloff-Cutter and St. Jude Valve and Ionescu-Shiley valve) were implanted. Due to the difficulty of postoperative anticoagulation in Korea, bioprostetic valves (Ionescu-Shiley bovine pericaridal xenograft) has been used recently in most cases. Single valve replacement was the most common procedure followed by double and triple valve replacement. Among single valve replacement, mitral valve replacement was performed most frequently (635 cases) followed by aortic replacement (122 cases) and tricuspid replacement (12 cases). The operative mortality rate was higher in tricuspid valve replacement (16.7%) compared to those of aortic and mitral valve replacement (9.8%, 6.8% respectively).

This seems to be related to concomitant hepatic dysfunction present in tricuspid regurgitation. As the number of replaced valves increased, the operative mortality rate was higher i.e. 7.4% in single valve replacement, 12.5% in triple valve replacement (Table 12).

Overall results are summarized as follows:

(1) Since the first open heart surgery was performed in 1959, a total 4,115 consecutive open heart operation were done until 1985.

(2) The overall mortality was 8.7%. Since 1981, when over 500 open heart surgery cases in a year were marked, it has been stabilized around 5%.

(3) Among 4,115 cases, 2,982 were congenital and 1,133 acquired heart diseases with mortality rate of 8.9% and 8.0% respectively.

(4) The congenital anomalies consisted of 1,963 acyanotic and 1,019 cyanotic varieties with mortality rate of 3.7% and 18.9% respectively.

(5) The main acyanotic congenital anomalies were ventricular septal defect, atrial septal defect, pulmonic stenosis and endocardial cushion defect with 1,163, 480, 105 and 68 cases respectively.

(6) The main cyanotic congenital anomalies were tetralogy of Fallot, double outlet right ventricle plus pulmonic stenosis, transposition of great arteries and univentricular heart and the number of each anomaly were 753, 61, 42 and 23 respectively.

(7) The acquired heart diseases consisted of 1,045 valvular heart diseases, 29 cardiac myxomas, 16 great vessel dieases, 9 coronary artery diseases and 34 other lesion with mortality rate of 7.8%, 0%, 25%, 0%, and 14.7% respectively.

(8) Among 1,045 valvular heart diseases, there were 629 single, 370 double and 46 triple-valve diseases with operative mortality 7.8%, 6.8% and 17.4% respectively.

(9) The mitral valve diseases were most frequently presented in 543 out of 629 patients.

(10) A total of 1,191 artificial cardiac valves were implanted in 976 patients.

(11) The single, double and triple valve replacements were done in 769,199 and 8 patients with mortality rates of 7.4% 10.0% and 12.5% respectively.

(12) Due to the difficulties of long-term postoperative anticoagulation in Korea, bioprosthetic valves have mainly been utilized in recent years.

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= 국문초록 =

서울대학교병원에서의 개심술 치험

서울대학교 의과대학 흉부외과학교실

이영균

1959년부터 1985년까지 과거 27년간, 서울대학교 의과대학 흉부외과학교실에서는 심폐기를 이용한 개심술을 총 4,115예 실시하였다. 그중 선천성심장기형에 대한 수술예가 2,982예 였고 후천성심장병은 1,133예였으며 수술사망율은 전자가 8.9%, 후자가 8.0%였으며 총사망율은 8.7%였다.

선천성심장기형에는 비청색군이 1,963예, 청색군이 1,019예였고 수술사망율은 각각 3.7%의 18.9%였다.

후천성심장질환중에는 판막질환이 1,045예로 대다수를 점하였고, 심장점액종이 29예, 대혈관질환이 16예, 관상동맥질환이 9예, 그리고 기타질환이 34예 포함되었다. 또한 수술사망율은 각각 7.8%, 0%, 2.5%, 14.7%였다.

초창기에는 수술증례도 매우적었고 수술사망율도 매우 높았으나 점차로 증례가 증가하여 최근에는 년 600회 내외로 되었으며 사망율도 5%미만으로 격감하였다.

이러한 현저한 진보에도 불구하고, 아직 몇몇 복잡기형에 대한 수술사망율이 높은데, 향후 수년내 극복되리라 생각되며, 또한 관상동맥에 대한 수술예도 급격히 증가되리라 생각된다.