Heart valve surgery in 114 patients over the age of 60

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Heart valve surgery was performed in 114 patients over the age of 60 at the National Heart Hospital between November 1964 and November 1970. This included 73 aortic, 22 mitral, and 10 multiple valve replacements, 2 mitral valve repairs, and 7 closed mitral valvotomies.

There were 21 (18%) hospital deaths, 12 (11%) late cardiac deaths, and 6 (5%) late non-cardiac deaths. The 93 patients who left hospital were followed up from 3 months to 5 years 6 months (average 20 months). Seventy-two (77%) of the survivors improved by one or more functional grades.

The mortality for aortic valve replacement was 11 (15%) hospital deaths and 7 (10%) late cardiac deaths. The respective figures for mitral valve replacement were 4 (18%) and 3 (14%) and for multiple valve replacement 6 (60%) and 0. The 2 patients who had a mitral valve repair died after they left hospital. There were no deaths among those who had a closed mitral valvotomy.

There was no difference in the average age of those who died after surgery and those who survived. Adverse factors included replacement of more than one valve, a prolonged operation as judged by the cardiopulmonary bypass time, pre-existing coronary artery disease which was present in 6 (29%) of the 21 hospital deaths and in 4 (22%) of the late deaths, also obstructive airways disease which was present in 3 (14%) of the 21 hospital deaths and in 2 (11%) of the late deaths. There were 3 thromboembolic complications in the 62 patients who received prosthetic valves and none in the 43 patients who had biological valves.

It was concluded that age alone should not be regarded as a contraindication to surgical treatment in those patients who are severely incapacitated from chronic valve disease.

The mortality of heart valve surgery has declined during recent years, mainly due to refinements in operative technique and improvements in post-operative care. The selection of patients for cardiac surgery, particularly valve replacement, has therefore become less stringent, but recently some reports quoted by Davies (1970) have been pessimistic about operations in the older age groups. We have therefore analysed 114 consecutive patients over the age of 60 who had cardiac surgery (107 open heart procedures and 7 closed mitral valvotomies) at the National Heart Hospital between November 1964 and November 1970.

The 114 patients consisted of 61 men and 53 women. Their age distribution is given in Table 1 and was from 60 to 74 years, three-quarters of the patients being between 60 and 64 years. The average duration of the postoperative follow-up period was

TABLE 1 *Age distribution*

60-64 years	65-69 years	70-74 years
85 (74.5%)	27 (23.7%)	2 (1.8%)

20 months. Seventy-one patients were followed for 1 year, 42 for 2 years, 22 for 3 years, and 9 for more than 4 years. Seventy-eight of the 93 survivors were followed up at the National Heart Hospital; information about the others was obtained from the referring physician or general practitioner.

The patients were divided into 4 groups according to the operations performed (Table 2). In group A there were 73 who had an aortic valve replacement, which included 43 prosthetic valves, 25 homografts, and 5 frame-mounted autogenous fascia lata.

TABLE 2 *Distribution of valve surgery and mortality in 114 patients*

Group	No.	Hospital deaths	Late deaths	
			Cardiac	Non-cardiac
A Aortic valve replacement				
Homograft	20	5	1	0
Homograft and mitral valvotomy or repair	5	0	0	0
Prosthesis	37	5	4	4
Prosthesis and mitral valvotomy or repair	5	0	1	0
Prosthesis and tricuspid annuloplasty	1	0	1	0
Fascia lata	5	1	0	0
	73	11 (15%)	7 (10%)	4 (5%)
B Mitral valve replacement				
Homograft	6	0	2	0
Homograft and tricuspid annuloplasty	1	0	0	0
Prosthesis	11	2	1	1
Prosthesis and tricuspid annuloplasty	1	0	0	0
Fascia lata	1	0	0	0
Fascia lata and tricuspid annuloplasty	1	1	0	0
Mitral and tricuspid homografts	1	1	0	0
	22	4 (18%)	3 (14%)	1 (4%)
C Multiple valve replacements				
Aortic and mitral homografts	1	0	0	0
Aortic and mitral homografts and tricuspid annuloplasty	1	1	0	0
Aortic and mitral prostheses	5	2	0	1
Aortic mitral and tricuspid prostheses	2	2	0	0
Aortic and mitral fascia latas	1	1	0	0
	10	6 (60%)	0 (0%)	1 (10%)
D. Mitral valve surgery				
Mitral valvotomy	7	0	0	0
Mitral valve repair	2	0	2	0
	9	0 (0%)	2 (22%)	0 (0%)
Overall	114	21 (18%)	12 (11%)	6 (5%)

Group B consisted of 22 patients who had mitral valve replacements. Prosthetic valves were used in 12, homografts in 8, and frame mounted-autogenous fascia lata in 2. In group C there were 10 patients with multiple valve replacements and in group D 9 patients who had mitral valve surgery but not replacement. Seven had a closed valvotomy and 2 a mitral valve repair. Thus, 105 of the 114 patients had 1 or more of the heart valves replaced and 9 had valvotomies or repair procedures.

Results

Functional status before operation was classified in 4 grades (1-4) according to the New York Heart Association criteria (1964): 7 per cent were in

grade 1, 43 per cent were in grade 2, 38 per cent in grade 3, and 12 per cent in grade 4. Details of individual symptoms in each surgical group are given in Fig. 1.

After operation 54 (58%) patients improved by one functional grade and 18 (19%) patients by two grades. The postoperative assessment showed that 65 per cent of the survivors were in grade 1, 27 per cent in grade 2, 8 per cent were in grade 3, and none was in grade 4. Details of the improvement of individual symptoms in the 4 surgical groups are shown in Fig. 1. As expected, the more severe the preoperative symptoms the higher the mortality.

Cardiac failure (congestive or acute pulmonary oedema) was present before operation in 46 (63%)

FIG. 1 The functional status and symptoms before and after operation in each surgical group. Group A: aortic valve replacement; group B: mitral valve replacement; group C: multiple valve replacement; group D: mitral valve operation; PND: paroxysmal nocturnal dyspnoea.

patients in group A, in 19 (87%) patients in group B, and in all 19 patients in groups C and D (Fig. 2). There was considerable improvement in all groups after operation. In group A, only 3 patients continued to have cardiac failure, one of whom had coronary heart disease (as defined by White, 1971) but was alive 4 years after operation. In group B, one patient had residual cardiac failure and died 20 months after operation. None of the 4 survivors in group C had cardiac failure after operation. In group D, 2 patients had congestive cardiac failure but were alive 4½ and 5½ years after operation (Fig. 2).

Electrocardiographic findings

In group A there were 11 (15%) patients with atrial fibrillation before operation. Of these, 4 had coronary artery disease and 4 mitral valve disease requiring mitral valvotomy in addition to aortic valve replacement. A further 2 patients had paroxysmal atrial fibrillation. Atrial fibrillation was present in 16 (73%) patients in group B, all the patients in group C, and 7 (78%) patients in group D.

After operation, the number of patients in group A with atrial fibrillation remained the same, but 3 patients reverted to sinus rhythm after operation (2 spontaneously and the third after cardioversion),

FIG. 2 The incidence of cardiac failure, left ventricular hypertrophy, and cardiomegaly before and after operation in each surgical group. Group A: aortic valve replacement; group B: mitral valve replacement; group C: multiple valve replacement; group D: mitral valve operation.

while 3 additional patients who were previously in sinus rhythm developed atrial fibrillation (2 with coronary artery disease, and 1 had a history of pulmonary embolism). In group B, 12 of the 18 survivors remained in atrial fibrillation, as did all the survivors in group C and 8 out of 9 in group D.

Left ventricular hypertrophy was assumed to be present if the sum of the S wave in V₁ and the R wave in V₅ or 6 exceeded 45 mm. Excluding patients with bundle-branch block, left ventricular hypertrophy was present before operation in 41 (58%) patients in group A, in 2 (11%) patients in group B, in 3 (30%) patients in group C, and in 1 (13%) patient in group D (Fig. 2).

Left ventricular hypertrophy was still present after operation in 15 (24%) patients in group A and in 2 out of 4 survivors in group C. None of the survivors in group B or D had left ventricular hypertrophy after operation (Fig. 2).

X-ray findings Cardiomegaly (cardiothoracic ratio of greater than 0.5) was present in 55 (75%) patients in group A. In groups B, C, and D, it was present in nearly all, i.e. 38 out of a total of 40 patients. In group A pulmonary venous congestion was present in 41 (57%) patients and was commoner among the patients who died – 14 (88%) patients compared with 27 (48%) patients who survived. In groups B, C, and D, pulmonary venous congestion occurred in all but 3 patients (Fig. 2).

Cardiomegaly was still common in all groups after operation. In group A it occurred in 39 (63%) patients, in group B, in 18 (90%) patients, in group C, in 3 (75%) patients, and in group D, in 7 (88%) patients (Fig. 2). Pulmonary venous congestion was present after operation in only 6 (6%) out of the total of 93 survivors.

Mortality

The hospital mortality in 114 patients was 18 per cent (21 patients). There were an additional 18 (16%) late deaths, 6 of which were not cardiac or related to a cardiac operation. The late deaths occurred 3 months to 2 years after operation, with an average of 8.3 months.

There was no difference in the average age of those who died and the survivors, being 63.2 and 63.1 years, respectively. The operative mortality and late deaths, both cardiac and noncardiac, for each surgical group are shown in Table 2. Of the 21 hospital deaths, there were 5 due to ventricular fibrillation at operation, and a further patient had ventricular fibrillation after complete heart block. In only 1 of these 6 cases was there a preoperative history of coronary artery disease. There were 4 deaths from circulatory failure, 2 of which were due to uncontrollable haemorrhage, and the other 2 had coronary artery disease. Cerebral damage due to air or calcific emboli was responsible for 2 of the 4 cerebral deaths. A cerebrovascular accident caused the death of another patient who had pre-existing systemic hypertension and coronary artery disease. The 3 patients who were unable to sustain an adequate circulation after coming off cardiopulmonary bypass and the 2 patients who died from cardiac tamponade had multiple valve replacements (see Table 5).

Among the 12 late cardiac deaths, the majority were severely disabled before operation and there was evidence of coronary artery disease in 4.

TABLE 3 Occurrence of preoperative complications and coexistent disease

	Overall incidence (Total 114)	Hospital deaths (Total 21)	Late deaths (Total 18)
Coronary heart disease	22 (19%)	6 (29%)	4
Chronic obstructive airways disease	8 (7%)	3 (14%)	2
Hypertension	7 (6%)	2 (10%)	1
Pulmonary embolism	6 (5%)	1 (5%)	1
Systemic embolism	5 (4%)	1 (5%)	1
Peripheral arterial disease	5 (4%)	1 (5%)	2
Diabetes	5 (4%)	2 (10%)	0
Infective endocarditis	4 (3%)	1 (5%)	1
Cerebrovascular disease	3 (3%)	0 (0%)	1

Importance of pre-existing disease

In this elderly group it was not surprising to find more pre-existing disease than in younger patients, the most important being coronary artery disease which was present in 22 (19%) of the 114 patients. Other pathology of note before operation included chronic obstructive airways disease in 8 (7%) patients, hypertension in 7 (6%) patients, and previous pulmonary emboli in 6 (5%) patients. It was difficult to be certain of the influence of pre-existing disease on the operative and late mortality, but it is probably relevant that coronary artery disease was present in 6 (29%) of the hospital deaths and in 4 (22%) of the late deaths. Similarly, chronic obstructive airways disease was present in 3 (14%) of the hospital deaths and in 2 (11%) of those who died later. Hypertension may or may not have been a contributory factor as it occurred in 2 (10%) of the hospital deaths and 1 late death. Further details are given in Table 3.

The effect of the duration of the cardiopulmonary bypass (bypass time) and the duration of cardiac arrest (ischaemic arrest time) was compared in the survivors and non-survivors who had aortic and mitral valve replacements (group A and group B). The term 'ischaemic arrest time' has been used to include all periods of operation during which either one or both coronary arteries were not perfused. The average bypass time in both groups was longer in those who died than in those who survived (Table 4). In group A it was 130 minutes in the 10 who died in hospital, compared with 104 minutes in the survivors. The respective figures for group B, 102 minutes and 71 minutes. The average ischaemic arrest time was not significantly longer in the fatal cases of either group.

Discussion

The operative results should be assessed in relation to the natural history of the valve disease without

TABLE 4 Comparison of average bypass time and ischaemic arrest time in survivors and fatal cases in groups A and B

	Survivors		Hospital deaths	
		No.		No.
<i>Group A</i>				
Bypass time	104 min	55	130 min	10
Ischaemic arrest time	25 min	53	29 min	4
<i>Group B</i>				
Bypass time	71 min	15	102 min	4
Ischaemic arrest time	40 min	14	41 min	4

TABLE 5 Cause of death

Causes of hospital deaths	No.
Ventricular fibrillation	6
Circulatory failure	4
Cerebral damage	4
Failed to come off bypass	3
Cardiac tamponade	2
Asystole	1
Died during operation	1
Total	21
<i>Causes of late deaths</i>	
Cardiac arrest	5
Acute chest infections	3
Cardiac failure	3
Bronchial carcinoma	2
<i>Esch. coli</i> endocarditis	1
Cerebral damage	1
Gastrointestinal tract haemorrhage	1
Embolus splenic rupture	1
Unknown	1
Total	18

surgical intervention. Ross and Braunwald (1968) found that in aortic valve disease, 90 per cent of those with angina and syncope died within three years of onset of symptoms, while if heart failure was present, death occurred within 1½ to 2 years. After operation, the mortality rates of survivors tended to parallel the normal mortality rates.

In this series the overall hospital mortality was 18 per cent (21 patients). There were 12 (11%) late cardiac deaths and 6 (5%) non-cardiac deaths. In group A (aortic valve replacement) the hospital mortality was 15 per cent, with 10 per cent late cardiac deaths; in group B (mitral valve replacement) the hospital mortality was 18 per cent, with 14 per cent late cardiac deaths; in group C (multiple valve replacements) the hospital mortality was 60 per cent, with no late cardiac deaths; and in Group D (mitral valve surgery) there were no hospital deaths and 22 per cent late cardiac deaths. These figures appear favourable, particularly for single valve replacement, when compared with those from other centres where patients of all age groups have been included.

For example, the earlier mortality figures for aortic Starr valve replacement were between 25 and 30 per cent (Lewis *et al.*, 1966). More recently these figures have improved to between 5 and 20 per cent (Cleland *et al.*, 1968; Hodam *et al.*, 1970; Spencer *et al.*, 1970; Shean *et al.*, 1971). Experience at the National Heart Hospital with 259 aortic homograft replacements for all age groups resulted in 16.6 per cent hospital mortality and 13.5 per cent late mortality, over a 7-year period up to 1969. The hospital mortality had, however, declined to 4.8 per cent for the 2-year period 1968 and 1969 (Gonzalez-Lavin, Al-Jabani, and Ross, 1971). Between January 1970 and December 1971, 62 more patients had aortic homograft replacements. There were 2 (3%) hospital deaths and 4 (6%) late deaths (L. Gonzalez-Lavin, D. N. Ross, and J. K. Ross, 1972, unpublished observations).

The total mortality figures for mitral prosthetic valve replacement have been between 15 and 50 per cent (Bjork and Malers, 1964; Kirklin, 1965; Morrow *et al.*, 1967; Najafi *et al.*, 1969; Schrire and Barnard, 1970; Spencer *et al.*, 1970; Starr, 1971). A lower mortality has been obtained recently for mitral homograft replacement; Angell and Shumway (1971) had a total mortality of 8 per cent, Graham *et al.* (1971) 11 per cent, and Yacoub, Towers, and Somerville (1971) 12 per cent.

In cases of double valve replacements (aortic and mitral) Spencer *et al.* (1970) had a total mortality of 28 per cent while Hodam *et al.*'s (1970) figure for multiple valve replacements with cloth covered prostheses was 41 per cent.

In patients over the age of 60 who had Starr valve replacement of one or more valves, Ahmad and Starr (1969) obtained an overall hospital mortality of 18 per cent (which is the same as ours) and a late mortality of 10 per cent. Their total mortality for aortic valve replacement was 28 per cent, for mitral valve replacement 13 per cent, and for multiple valve replacements 22 per cent. Ten out of their 23 deaths were due to thromboembolism.

In our series there was, as expected, a higher mortality in patients who were in functional grades 3 and 4 before operation, in patients who had intractable cardiac failure, and in those who had multiple valve replacements. Adverse factors also included prolonged cardiopulmonary bypass time and pre-existing coronary artery disease and, to a lesser extent, obstructive airways disease. Coronary artery disease occurred in 6 out of the 21 (29%) hospital deaths (but was the direct cause of death in only 3 patients) and in 4 out of the 18 (22%) late deaths. It was present in 16 out of the 93 (17%) of the patients who left hospital. Another feature of note was that one-third of the late deaths were not cardiac, which is consistent with the higher natural death rate in this age group. The excellent results of closed mitral valvotomy confirmed the value of this operation in elderly patients.

The relative advantage of biological valves was again demonstrated, for there were no thromboembolic complications in the 43 patients who received biological valves, i.e. homografts or frame mounted autogenous fascia lata, while in the 62 patients with prosthetic valves, all of whom were treated with long-term anticoagulants, there were 3 thromboembolic complications during the follow-up period. Two patients had cerebral emboli and 1 died after splenic infarction and rupture.

We feel, therefore, that the previous reviews reported by Davies (1970) may have been unduly pessimistic. Of the 93 patients who left hospital, 72 (77%) improved by one or more functional grade after operation. The improvement was sustained and the majority of patients were able to return to work. The hospital mortality in this group while higher than in younger patients was not prohibitive at 18 per cent.

References

- Ahmad, A., and Starr, A. (1969). Valve replacement in geriatric patients. *British Heart Journal*, **31**, 322.
- Angell, W. W., and Shumway, N. E. (1971). Late results with fresh aortic homografts and preserved heterografts. Cutter Progress Report No. 4, Jan., 1971.
- Bjork, V. O., and Malers, E. (1964). Total mitral valve replacement: late result. *Journal of Thoracic and Cardiovascular Surgery*, **48**, 625.

- Cleland, W. P., Goodwin, J. F., Bentall, H. H., Oakley, C. M., Melrose, D. G., and Hollman, A. (1968). A decade of open heart surgery. *Lancet*, **1**, 191.
- Davies, L. G. (1970). Editorial. Valve replacement. *British Heart Journal*, **32**, 723.
- Gonzalez-Lavin, L., Al-Jabani, N., and Ross, D. N. (1971). Long term results after aortic valve replacement with preserved aortic homografts. Presented at Southern Thoracic Surgical Association, Tampa, 6 November 1971.
- Graham, A. F., Schroeder, J. S., Daily, P. O., and Harrison, D. C. (1971). Clinical and haemodynamic studies in patients with homograft mitral valve replacement. *Circulation*, **44**, 334.
- Hodam, R., Starr, A., Raible, D., and Griswold, H. (1970). Totally cloth-covered prostheses. A review of 2 years' clinical experience. *Circulation*, **41** and **42**, Suppl. 2, 33.
- Kirklin, J. (1965). Surgical management of multivalvar heart disease. *New Zealand Medical Journal*, Cardiac Suppl., p. 57.
- Lewis, R. P., Herr, R. H., Starr, A., and Griswold, H. E. (1966). Aortic valve replacement with the Starr-Edwards ball-valve prosthesis. *American Heart Journal*, **71**, 549.
- Morrow, A. G., Oldham, H. N., Elkins, R. C., and Braunwald, E. (1967). Prosthetic replacement of the mitral valve. *Circulation*, **35**, 962.
- Najafi, H., Dye, W. S., Javid, H., Hunter, J. A., Ostermiller, W. E., and Julian, O. C. (1969). Mitral valve replacement. Review of 7 years' experience. *American Journal of Cardiology*, **24**, 386.
- New York Heart Association, Criteria Committee (1964). *Diseases of the Heart and Blood Vessels. Nomenclature and Criteria for Diagnosis*, 6th ed., p. 114. Little Brown, Boston; Churchill, London.
- Ross, J., and Braunwald, E. (1968). Aortic stenosis. *Circulation*, **37** and **38**, Suppl. V-61.
- Schrire, V., and Barnard, C. N. (1970). Immediate and long-term results of mitral valve replacement with University of Cape Town mitral valve prosthesis. *British Heart Journal*, **32**, 245.
- Shean, F. C., Austen, W. G., Buckley, M. J., Mundth, E. D., Scannell, J. G., and Daggett, W. M. (1971). Survival after Starr-Edwards aortic valve replacement. *Circulation*, **44**, 1.
- Spencer, F. C., Reed, G. E., Clauss, R. H., Tice, D. A., and Reppert, E. H. (1970). Cloth-covered aortic and mitral valve prostheses. Experience with 113 patients. *Journal of Thoracic and Cardiovascular Surgery*, **59**, 92.
- Starr, A. (1971). Mitral valve replacement with ball-valve prostheses. *British Heart Journal*, **33**, Suppl., 47.
- White, P. D. (1971). Perspectives. *Progress in Cardiovascular Diseases*, **14**, 250.
- Yacoub, M., Towers, M., and Somerville, W. (1971). Mitral valve replacement using fresh 'unstented' semilunar valve homografts. Communication to British Cardiac Society, November 1971.

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