Left ventricular aneurysm

The Wessex experience

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SUMMARY One hundred patients with left ventricular aneurysms were operated on between February 1973 and January 1983. The principal indications for operation were left ventricular failure in 58, angina in 23, both in 17, with arrhythmia and systemic emboli accounting for one case each. Eighty five had had anterior infarction causing 82 anteroapical and three lateral aneurysms, while the remainder had had inferior infarcts resulting in 14 inferior aneurysms and one lateral aneurysm. Coronary angiography detected a single coronary lesion in 46%. Three patients had aneurysmal plication and the remainder had aneurysmectomy. Eleven mitral valve replacements were performed. Forty patients underwent coronary artery bypass grafting with a mean number of grafts per patient of 1.4. The early mortality was 7% with no early deaths since 1978. The actuarial five year survival was 68%, and 82% of survivors are in New York Heart Association class I or II (mean follow up three years). Left ventricular aneurysmectomy may be performed with a low operative mortality and good long term results.

Since 1958 when Cooley *et al* first excised a left ventricular aneurysm using temporary cardiopulmonary bypass,¹ excision of the aneurysm and removal of all thrombus has become a standard procedure.² An acquired ventricular septal defect may be closed and mitral valve surgery may be performed at the same time. Coronary artery bypass grafting is now performed on all significantly stenosed arteries that will not be excised with the aneurysm. Operative mortality has varied between 0% and 18%³⁻⁵ and is generally considered to be related primarily to the function of the residual myocardium.⁶ We reported our results in the first 20 patients in 1976,⁷ and we now analyse our experience in 100 patients.

Patients and methods

Between February 1973 and January 1983, 100 patients (83 men, 17 women; mean age 56 years) underwent repair of a left ventricular aneurysm, which was defined as a non-contractile left ventricular segment that protrudes beyond the normal end systolic and end diastolic outline of the left ventricle as

determined by left ventriculography.⁵ Myocardial infarction (83 anterolateral, two lateral, 15 inferior) had occurred a mean of 14 (SD 18) months before operation, and 11 patients had had multiple previous infarcts. The principal indications for operation were left ventricular failure alone (58), angina alone (23), and the combination of dyspnoea and angina (17). Ventricular arrhythmias were present in 10 patients, although this was the principal indication for operation in only one. Recurrent systemic embolism was present in six, but was the sole indication for operation in only one. Sixty six of those with dyspnoea were in New York Heart Association class IV with 43 of these receiving maximal medical treatment (at least 250 mg frusemide daily, digoxin, and afterload reduction).

All were investigated by left ventriculography in two planes and coronary angiography. Left ventricular end diastolic pressure was routinely measured and had a mean of 19.5 (SD 9.6) mm Hg. At angiography, 82 of the aneurysms were anteroapical, 14 were inferior, and four were lateral. Residual ventricular function was graded by examination of the left ventriculogram into good (42), moderate (44), or poor (14). Patients with globally poor left ventricular function are not included in this series.

The results of coronary angiography were available for analysis in 96 patients (Fig. 1). Eighty four had

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Fig. 1 Results of coronary angiography in 96 patients. LAD, left anterior descending coronary artery.

occlusion or a major stenosis of the left anterior descending coronary artery. In 39 of these patients there were no other lesions, but in the other 45 patients there were significant stenoses in other coronary arteries. In the remaining 12 patients who did not have lesions of the left anterior descending coronary artery the right and circumflex coronary arteries were equally involved. Patients were not excluded if their coronary artery lesions could not be revascularised.

Mitral regurgitation was assessed both clinically and angiographically and it was present in 37 (39%) of the 94 patients for whom data were available. It was graded as severe (6%), moderate (15%), and mild (18%). Fourteen patients had an acquired ventricular septal defect associated with the aneurysm, which was anterior in seven and inferior in seven. These were all repaired at aneurysmectomy. Aneurysmectomy had to be performed within one month of infarction on 10 occasions, and in eight of these there was an acquired ventricular septal defect. Two of these eight accounted for the only deaths in this group of very ill patients.

Operative details

Anaesthetic and cardiopulmonary bypass technique with a bloodless prime⁸ was similar in all cases. Operations performed since January 1978 have been done with cardioplegia and hypothermic perfusion.⁹ Intermittent cross clamping had been used before 1978. Three patients operated on early in the series had plication of the aneurysm whereas the remainder had an aneurysmectomy. This involved excision of aneurysmal tissue that left only a rim of fibrous tissue. The defect was repaired with two layers of a non-absorbable suture over large strips of Teflon felt. If a coronary artery bypass graft was to be performed, this

was done after excision of the aneurysm but before closure of the left ventricle. In this series a total of 56 coronary artery grafts was performed on 40 patients (Fig. 2). It was our policy to graft any stenosed major artery supplying an area not to be excised. Eleven mitral valves were replaced with Björk Shiley prostheses, most (9) replacements were performed through the ventriculotomy—which avoided opening the left atrium. It was not possible to repair the mitral valve in any of our patients. Five patients required tricuspid annuloplasty and the left atrium was opened in a further patient to achieve a complete evacuation of clot from the heart. Acquired ventricular septal defects were repaired with a Dacron patch or Teflon felt.

Fig. 2 Temporal relation of operations performed. (Number on top of box is number of grafts performed per patient. Average number of grafts per patient was 1.4.)

Results

Seven patients died within 30 days of operation. In one cardiac output became low at operation and this patient could not be weaned off cardiopulmonary bypass. Four died in the early postoperative period of congestive cardiac failure. At necropsy two cases showed evidence of a perioperative myocardial infarct and the remaining two deaths were caused by sudden arrhythmias. All of those who died within this period had moderate or poor left ventricular function and most had been shown to have multiple vessel coronary artery disease.

Inotropic support was required in 46 patients for at least 24 hours and the intra-aortic balloon pump was used postoperatively in nine. Five patients had prolonged left heart failure which responded to medical treatment and one required a permanent pacemaker because of complete heart block. Ventricular arrhythmias occurred postoperatively in 11 patients including the two who died of this cause. Twenty one had supraventricular tachycardia during this time. In

eight patients there was postoperative neurological impairment. This was transient in six. There was one instance of acute renal failure, which responded to conservative measures.

Late mortality was studied by the actuarial method¹⁰ (Fig. 3). Sixty eight per cent of patients were alive at five years and 57% at seven. Actuarial survival was analysed for the different main presenting symptoms. These were dyspnoea alone, angina alone, and dyspnoea with angina (Fig. 3b). Long term survival was much better in those presenting with angina alone. Analysis based on preoperative left ventricular function (Fig. 3c) showed that those with good function had an improved chance of survival, with 79% alive at five years compared with only 50% of those with poor function.

At five years 70% of those with single vessel disease were alive compared with 65% of those with multiple vessel disease (Fig. 3d). At five years 69% of those with coronary artery bypass grafts were alive compared with 66% of those without. Neither of these differences is statistically significant. Most late deaths were caused by progressive ischaemic heart disease; in many patients this was heart failure and in some there was good clinical evidence of further myocardial infarction. At review 1-11 years postoperatively

(mean three years) 82% of the survivors were in New York Heart Association classes I and II (Table). In sharp contrast to the survival statistics, there was no significant association between poor preoperative residual ventricular function and poor postoperative functional result. Six patients had postoperative cardiac catheterisation, most for persistent angina. In all of these the suture line in the ventricle was represented by an akinetic area. In two patients false aneurysms developed at the site of the suture line as a late complication and these required reoperation.

New York Heart Association classification at review, on average 36 months postoperatively.

	New York Association classification			
	I	II	III	IV
No (%) of patients	27 (36)	34 (46)	11 (15)	2 (3)

Discussion

Left ventricular aneurysms may be expected to develop in at least 10% of those who survive large myocardial infarcts. The symptoms they give rise to vary according to size of the aneurysm and to the

Fig. 3 Actuarial analysis of survival (a) showing influence of coronary artery bypass grafting (CABG), (b) according to preoperative symptoms, (c) according to preoperative residual left ventricular function, and (d) according to extent of coronary artery disease.

presence or absence of other major mechanical consequences of infarction (mitral regurgitation, ventricular septal defect), but the common presentation is one of congestive cardiac failure and this was so in our series. In these circumstances congestive heart failure suggests the possibility of aneurysm, and the diagnosis may be confirmed by echocardiography and left ventricular angiography. The plain chest radiograph is often misleading but can on occasion be diagnostic. Left ventricular aneurysms without symptoms have a good prognosis¹¹ and potentially a survival rate as good as 90% at five years. The outlook in patients with symptoms who are not surgically treated is poor ($\leq 50\%$ survival at five years¹¹), but with surgery life expectancy in this group is significantly improved, as others have reported.^{2,5,12} Successful surgery also results in important symptomatic improvement (Table). The selection of patients for surgery is based on the functional state of the left ventricle and the potential ventricular cavity size once the aneurysm has been resected. Both may be very difficult to judge and the argument that a ventricle able to sustain life with an aneurysm should be able to do so better without it is not necessarily valid. In our series all seven patients who died soon after operation did so because their residual left ventricular function was inadequate, and we believe that the fact that there has been no early postoperative death in the past six years reflects careful case selection as much as improvement in technique and management. This low operative mortality (7%) is in keeping with the results from other recently reported series.^{2,5,13}

Because left ventricular aneurysm is commonly caused by proximal occlusion of a single major coronary artery attention is naturally directed to the state of the other coronary arteries, which, all workers agree, should be assessed by angiography. It has been our policy, in all except the earlier cases reported in this series, to graft all arteries with significant stenoses that supply areas of myocardium not affected by the aneurysmectomy and the subsequent suture line. This practice has not increased the operative risk; our experience is the same as that reported by the Texas Heart Institute² and the Cleveland Clinic⁶ and we intend to continue this policy. The effect of bypass grafting on longer survival after aneurysmectomy is difficult to assess. Actuarial survival curves for those with single and those with multiple vessel disease in our series are similar (Fig. 3d). Also, there is no difference in actuarial survival between those who had and those who did not have coronary artery grafts (Fig. 3a). Here, one possible interpretation is that grafting converted those in whom the prognosis was worse because of multiple vessel disease into the same risk category as those in whom a single artery only was blocked. The suggestion that an aggressive approach to coronary grafting at aneurysmectomy is rewarded by longer survival¹⁴ has yet to be proved conclusively. Although only half our patients had multiple vessel

disease compared with a much higher proportion (75%) in recent series reported from the United States,^{2,5} throughout our own series the number of patients having coronary artery grafts and the number of grafts in the individual patient have tended to increase. It remains to be seen whether this trend continues.

In conclusion, despite the fact that haemodynamic measurements may show little improvement post-operatively, we believe that left ventricular aneurysmectomy should be recommended in patients with symptoms, provided that remaining left ventricular function is judged to be adequate. Coronary artery bypass grafting should be carried out at the same time for all seriously narrowed vessels supplying viable muscle. These conclusions are based on the demonstrable symptomatic improvement and improved life expectancy which have been observed after surgery for this type of coronary heart disease.

References

- 1 Cooley DA, Collins HA, Morris GC Jr, Chapman DW. Ventricular aneurysm after myocardial infarction: surgical excision with use of temporary cardiopulmonary bypass. *JAMA* 1958; 167: 557-60.
- 2 Cooley DA, Walker WE. Surgical treatment of postinfarction ventricular aneurysm: evolution of technique and results in 1533 patients. In: Moran JM, Michaelis LL, eds. *Surgery for the complications of myocardial infarction*. New York: Grune and Stratton, 1980: 273-87.
- 3 Rao G, Zikria EA, Miller WH, Samadani SR, Ford WB. Experience with 60 consecutive ventricular aneurysm resections. *Circulation* 1974; 50 (suppl II): 149-53.
- 4 Hutchinson JE, Green GG, Mekhjian HA, et al. Combined left ventricular aneurysm and coronary artery bypass surgery: long-term results of 100 consecutive patients. *Arch Surg* 1978; 113: 1236-40.
- 5 Burton NA, Stinson EB, Oyer PE, Shumway NE. Left ventricular aneurysm: pre-operative risk factors and long-term post-operative results. *J Thorac Cardiovasc Surg* 1979; 77: 65-75.
- 6 Cosgrove DM, Loop FD. Long-term results and life expectancy after ventricular aneurysmectomy. In: Moran JM, Michaelis LL, eds. *Surgery for the complications of myocardial infarction*. New York: Grune and Stratton, 1980: 289-302.
- 7 Sbokos CG, Monro JL, Ross JK. Elective operations for postinfarction left ventricular aneurysms. *Thorax* 1976; 31: 55-62.
- 8 Manners JM. Anaesthesia for cardiac surgery. In: Normal J, Whitwam JG, eds. *Topical reviews in anaesthesia*. Bristol: John Wright, 1980: 179-260.
- 9 Hearse DJ, Stewart DA, Braimbridge MV. Hypothermic arrest and potassium arrest. Metabolic and myocardial protection during elective cardiac arrest. *Circ Res* 1975; 36: 481-9.
- 10 Anderson RP, Bonchek LI, Grunkemeier GL, Lambert LE, Starr A. The analysis and presentation of surgical results by actuarial methods. *J Surg Res* 1974; 16: 224-30.
- 11 Grondin P, Kretz JG, Bical O, Donzeau-Gouge P, Petitclerc R, Campeau L. Natural history of saccular aneurysms of the left ventricle. *J Thorac Cardiovasc Surg* 1979; 77: 57-64.
- 12 Halim M, Mustafa I, Towers M, Yacoub M. Late results of resection of left ventricular aneurysm [Abstract]. *Br Heart J* 1980; 43: 121.
- 13 Rivera R, Delcan JL. Factors influencing better results in operation for postinfarction ventricular aneurysms. *Ann Thorac Surg* 1979; 27: 445-50.
- 14 Barratt-Boyes BG, White HD, Agnew TM, Pemberton JR, Wild CJ. The results of surgical treatment of left ventricular aneurysms. *J Thorac Cardiovasc Surg* 1984; 87: 87-98.