Br Heart J 1980; **43**: 436–9

Surgery of post-myocardial infarction scars
Early and late results in 70 patients

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SUMMARY Immediate and late postoperative results in 70 patients undergoing resection of a true left ventricular aneurysm (50 patients) and of an asynergic area (20 patients) are presented. The operative mortality was 14 per cent. Predicted survival by actuarial methods was 80 per cent at one year after operation and 65 per cent at six years. Functional improvement was obvious with most of the survivors falling in NYHA class I or II. Factors influencing operative mortality were the clinical indication for operation and the anatomical lesion. Late postoperative results were better for true aneurysms than for asynergic areas.

An asynergic area was usually associated with multiple coronary vessel lesions and a diffusely ischaemic myocardium. An aneurysm was often associated with a single coronary vessel disease and with good function of the non-infarcted myocardium.

The first successful excision of a left ventricular aneurysm was performed over 20 years ago.[1] Since then many other authors have reported their experience. Most of these reports included surgical resection of asynergic areas of the left ventricular wall as well as of true ventricular aneurysms. Little attention has been directed toward the influence of the anatomical type of left ventricular abnormality on surgical results. We present early results and long-term follow-up in a group of 70 consecutive patients, emphasising the role of the anatomical lesion of the left ventricular wall.

Patients and methods

Between December 1968 and December 1976, 70 patients with left ventricular scar secondary to myocardial infarction underwent surgery. Fifty-nine patients were men and 11 women with an age range of 30 to 70 years (mean 55 years). All patients had suffered one or two documented myocardial infarctions. In 54 patients, infarction was more than three months old. In 14 patients, infarction had occurred less than three months before operation, and in two patients it had occurred less than three weeks before.

Indications for surgery are summarised in Table 1. Congestive heart failure (40%) and ventricular arrhythmia (20%) were the two main reasons. In 21 patients (30%) operation was performed for a combination of factors, most often ventricular arrhythmia complicated by congestive heart failure.

Table 1 *Myocardial resection: surgical indication in 70 patients*

Indication	*No. of patients*	*Percentage of patients*
Congestive heart failure	28	40
Ventricular arrhythmia	14	20
Angina pectoris	7	10
Mixed	21	30
Total	70	100

In earlier patients surgery was undertaken on a clinical basis alone. Subsequently, selective coronary arteriography was performed in 61 patients (87%). Significant lesions were found in three vessels in 12 (20%), in two vessels in 22 (36%), and in one major vessel in 27 patients (44%).

In 29 patients there was a contraindication to aortocoronary bypass: six had diffuse multivessel disease or one vessel disease not suitable for revascularisation, and 23 had one vessel disease corresponding to the aneurysmal or asynergic area. Operation was performed under cardiopulmonary bypass with moderate hypothermia. In 39 patients, operation was limited to left ventricular wall resection. For these cases, the aorta was not cross-

Received for publication 18 September 1979

clamped and the heart was kept beating throughout the procedure. The 31 remaining patients had a combination of left ventricular wall resection and saphenous vein aortocoronary bypass graft (22 single grafts, seven double, and two triple). For these cases, the aorta was cross-clamped for 15 minutes during peripheral anastomoses. One patient had an additional mitral valve replacement, and three underwent closure of a ventricular septal defect.

Pathology of left ventricular scar

In 50 cases, the left ventricular scar was considered as a true aneurysm, because of: (1) a discrete border between the left ventricular chamber and the bulging area on the left ventricular cineangiogram; (2) a clear-cut limit between healthy muscle and fibrous tissue at the time of operation; and (3) a transmural lesion, the entire thickness of muscle being replaced by thin, homogeneous fibrous tissue. Among these 50 aneurysms, 41 were anterior and nine were inferior.

In the remaining 20 patients, the left ventricular scar was considered as a segmental dyskinetic area because of the absence of the above criteria. There was less bulging, more diffuse fibrous scarring of the left ventricular wall, and no discrete limit between scar and healthy muscle. In those cases, coronary artery lesions were more frequently diffuse than in true ventricular aneurysm (Table 2). Among patients with only one vessel involved, 86 per cent had a true ventricular aneurysm ($p < 0.05$).

Table 2 *Main differences between 44 aneurysms and 17 asynergic areas—61 coronary angiograms*

Anatomical lesion	*Coronary disease*		*Aortocoronary bypass*	
	One major vessel	*Two or three major vessels*	*Grafted*	*Not grafted*
Aneurysm	23	21	18	26
Asynergic area	4	13	14	3
	$p < 0.05$		$p < 0.01$	

Results

EARLY POSTOPERATIVE COURSE

Ten of the 70 patients died in the perioperative period (14%). One patient died during the surgical procedure from acute myocardial failure. Six postoperative deaths were caused by a low cardiac output syndrome without evidence of recent myocardial infarction. Two deaths were the result of infection. Anticoagulant therapy caused an additional death.

Operative mortality in this group was not related to age (as an independent factor), time elapsing between myocardial infarction and operation, presence or absence of aortocoronary bypass grafts, emergency conditions, duration of cardiopulmonary bypass, or to duration of aortic cross-clamping.

Statistically significant factors influencing mortality rate were: (1) nature of indication for operation and (2) type of anatomical lesion. Among 49 patients operated on for one single complaint (congestive heart failure or ventricular arrhythmia or angina pectoris) four died, while there were six deaths in the group of 21 patients having a double or triple reason for surgery ($p < 0.001$).

Aneurysm resection accounted for five deaths among 50 patients (10%) while resection of asynergic areas led to five deaths in a group of 20 patients (25%) ($p < 0.01$, Table 3).

Table 3 *Factors influencing operative mortality*

Patients	*Indication*		*Anatomical lesion*	
	Single	*Double or triple*	*Aneurysm*	*Asynergic area*
No. of patients	49	21	50	20
No. of survivors	45	15	45	15
No. of deaths	4 (8%)	6 (30%)	5 (10%)	5 (25%)
	$p < 0.001$		$p < 0.01$	

Combined analysis allowed us to separate high- and low-risk groups. High-risk patients had at least two of the three following factors: (1) age over 50; (2) surgery decided upon for more than one complaint; and (3) a left ventricular lesion considered to be asynergic. In this group, operative mortality was 30 per cent (9/31). Low-risk patients had at least two of the following descriptors: (1) age under 50; (2) operation decided upon for one single reason; and (3) a true aneurysm. In this group, operative mortality was 2·5 per cent (1/39), a significantly lower rate ($p < 0.01$).

LATE POSTOPERATIVE COURSE

Survival was studied by the actuarial method (Fig. 1). Including the initial fall caused by operative mortality, predicted survival was 80 per cent one year after operation and 65 per cent six years after operation.

Long-term results were estimated in 46 of the 70 patients for whom postoperative follow-up was begun two years before the beginning of the study (mean 47 months, maximum eight years). Five of these patients died from cardiac causes, three from extracardiac causes between two and 18 months after operation (mean nine months), and five had dropped out. Among the 33 long-term survivors, six had been operated on for intractable ventricular arrhythmia. Only one of these patients experienced

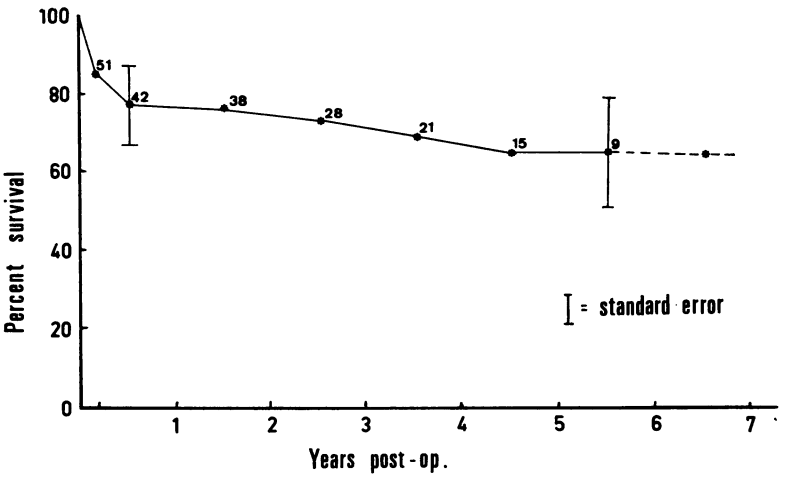

Fig. 1 *Actuarial survival curve after left ventricular resection for the entire group of 70 patients.*

recurrence of ventricular tachycardia. Left ventriculography in this patient showed the recurrence of a posterior aneurysm which was successfully resected 27 months after the first operation.

Fig. 2 shows the functional results in 27 patients operated on for cardiac failure or angina pectoris or both. Only two patients of this group were still in class III and no patient was considered to belong to class IV of the NYHA.

The only significant factor influencing long-term results in this series was the anatomical type of left ventricular wall lesion (Table 4). In all 26 patients operated on for a true ventricular aneurysm the result was satisfactory. In 12 patients operated on for an asynergic area, favourable results were observed in five patients only ($p < 0.001$).

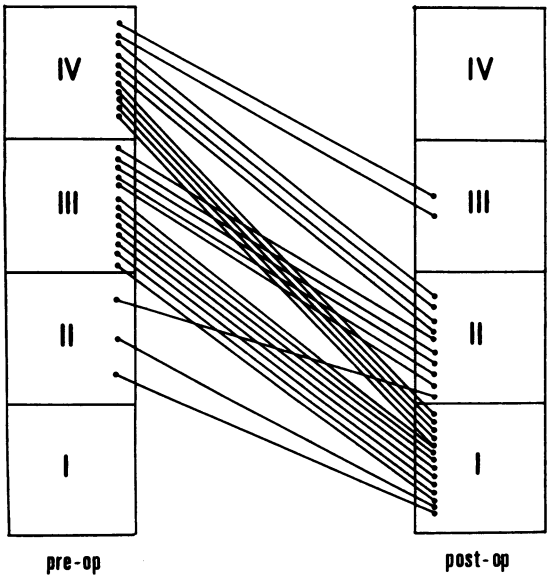

Fig. 2 *Late postoperative results (NYHA criteria). Average follow-up interval was 41 months.*

Table 4 *Late postoperative course and anatomical lesion*

Patients	*Aneurysm*	*Asynergic area*
31 class I–II	26	5
		$p < 0.001$
5 cardiac deaths and two class III	0	7

Discussion

The results of this series are primarily clinical. Postoperative catheterisation was performed only in poor surgical results. Other authors have outlined a reasonably good correlation between clinical, haemodynamic, and angiographic results.[2–4] Futhermore, contractile function is difficult to investigate in postmyocardial infarction scars. Methods such as ejection fraction and percentage of circumferential shortening of contractile segments[5 6] remain to be evaluated in preoperative prognosis.

An operative mortality of 14 per cent is comparable to other series which range from zero to 18 per cent.[4 7–10] In a previous report of our group[11] mortality was 5 per cent.

The incidence of patients operated on for ventricular arrhythmias is higher in this series (20%) than in the published reports. Efficiency of operation in these cases is obvious, since the only recurrence of ventricular tachycardia was related to the recurrence of a posterior aneurysm.

A clear-cut distinction between true ventricular aneurysms and asynergic areas is sometimes

difficult to establish, especially in the first weeks after myocardial infarction. But if angiographic and operative findings are analysed in an integrated way looking for the border area between scar and healthy muscle, then even a few days after the acute event this border can usually be precisely drawn in true ventricular aneurysms.

Several reasons explain the striking difference in the results of resection of true aneurysms versus asynergic areas. (1) In true aneurysm the entire scar can be excised, whatever its size, leaving only the few millimetres of fibrous tissue necessary for a firm suture. In asynergic areas, excision takes off the most diseased part of a diffusely scarred left ventricular wall. (2) From a haemodynamic point of view, resection of a true aneurysm is more efficient than excision of a dyskinetic zone, for the impairment of left ventricular function is probably more important in the former condition. (3) In true aneurysm, coronary artery lesions are very often limited to the vessel responsible for the myocardial infarction. In asynergic areas, coronary artery disease is usually more diffuse. Though aorto-coronary bypass grafts are beneficial in patients with angina pectoris, their efficiency in improving myocardial contraction is questionable.[12 13]

We thank Dr Mark Perlroth, Department of Medicine, Stanford University School of Medicine, for reviewing and criticising the manuscript.

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