

Direct myocardial revascularization

Operative mortality in the Cleveland Clinic experience

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Coronary artery operations using the aorto-coronary venous autograft have become the accepted surgical treatment for coronary atherosclerosis. Alleviation of cardiac pain has been the primary benefit, and results of a recent study¹ indicate that direct coronary artery surgery prolongs life for patients with multiple vessel disease. Statistically, this longer life-span depends on a low operative mortality, and valid criticism has been leveled at the practice of myocardial revascularization when mortality figures have reached or exceeded 10%.

Since May 1967, when the first interposed saphenous vein grafting was performed at the Cleveland Clinic, the number of direct revascularization procedures has increased annually. More than 5,000 operations consisting of saphenous vein grafts and, more recently, internal mammary artery grafts have been performed; another 750 direct revascularization procedures were combined with valve repair or replacement or ventricular aneurysmectomy. We report here the results of bypass procedures only, omitting a detailed report on the combined procedures. However, the mortality for these combined procedures is also low.

**CLEVELAND CLINIC FOUNDATION
OPERATIVE MORTALITY 1967-1973
CORONARY ARTERY BYPASS OPERATIONS**

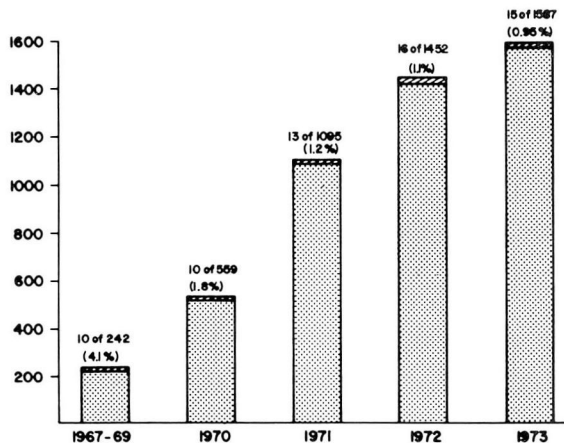


Fig. 1. Number of direct revascularization procedures increased; surgical mortality declined.

From May 1967 to December 1973, 4,935 patients underwent direct myocardial revascularization without associated procedures. In all cases, preoperative evaluation included coronary angiography and left ventriculography. Indications for surgery included the following angiographic criteria:² (1) an obstructive lesion of at least 70% in one or more major coronary vessels; (2) good distal runoff in the involved coronary artery with a lumen diameter greater than 1 mm and no further obstruction exceeding 50% in this distal portion; (3) ventriculographic evidence of normal or near normal contractility in the segment of ventricle perfused by the obstructed vessel.

As the number of direct revascularization procedures has increased, surgical mortality has declined appreciably (Fig. 1). A total of 64 patients died during operation or postoperatively for an overall mortality of 1.3% during the 7-year period. This mortality has fallen significantly from 4.1% in the first 242 patients to 0.95% in the

1,587 patients operated on during 1973. There was a slightly higher surgical risk in those patients undergoing multiple bypass procedures (Table 1). It is of interest that the improvement in overall results has continued despite the increasing proportion of multiple bypass procedures (Fig. 2).

From the cardiologist's evaluation of serum enzyme levels and electrocardiographic changes, all peri-operative myocardial infarctions have been recorded. Improvement in this infarction rate is also noted during the 7-year period. Myocardial infarction occurred in 7.2% of surgical patients during the first 3 years, but this complication has been reduced to 3.8% in the past 2 years. The reduction has been achieved despite the more complex operative combinations employed to provide more complete revascularization. A breakdown of these figures for 1972 and 1973 reveals the expected relationship between incidence of infarction and the number of bypass procedures (Table 2).

It is impossible to pinpoint any

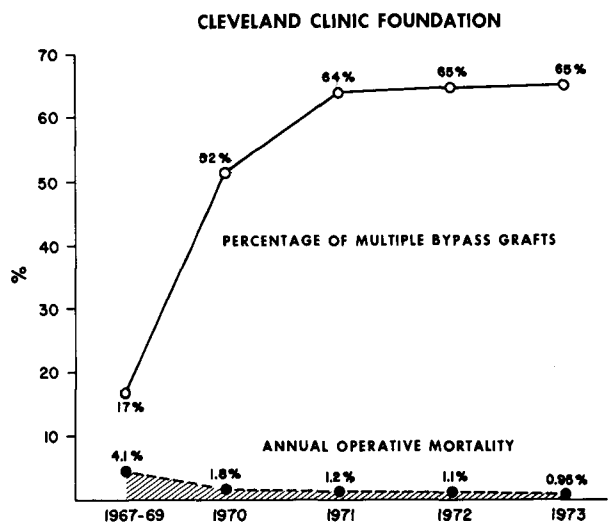


Fig. 2. Continued improvement in overall results despite increase in multiple bypass procedures.

Table 1. Annual mortality figures for single, double, and triple (or more) grafts; 1970 through 1973

Year	Single	%	Double	%	Triple or more	%
1970	4 of 270	1.5	4 of 215	1.8	2 of 74	2.7
1971	1 of 392	0.3	7 of 491	1.4	5 of 212	2.4
1972	4 of 515	0.8	6 of 703	0.9	6 of 234	2.6
1973	1 of 550	0.2	7 of 689	1.0	7 of 349	2.0
Overall	10 of 1727	0.6	24 of 2098	1.1	20 of 869	2.3

single factor which may be responsible for the continued improvement in operative results. Increasing experience has resulted in improvements in patient selection and technical proficiency and also in the recognition, prevention, and treatment of complicating factors before and after the revascularization procedure.³ Experience has shown which patients constitute prohibitive surgical risks, and the recognition that a small percentage of patients with diffuse irreversible left ventricular impairment cannot be helped by surgical intervention has contributed significantly to lower mortality. Improved anesthesia techniques and excellent postoperative nursing

Table 2. Peri-operative infarction rate for single, double, and triple (or more) grafts; 1972 and 1973

Procedure	Infarction rate	%
Single	27 of 1057	2.5
Double	55 of 1385	4.0
Triple or more	34 of 581	5.9
Overall	116 of 3023	3.8

care are additional factors that lead to lower risk.

Although the benefits of coronary artery bypass surgery are evident, this operative procedure has limitations. It is essentially a reconstructive procedure providing additional blood flow

to a compromised myocardium. However, it does not alter or reverse the basic underlying disease and cannot prevent the development of further obstructive changes in the coronary vessels. The surgeon may be limited by the extent of atherosclerotic involvement of individual vessels, making the anastomosis technically difficult in some instances. Moreover, progression of coronary disease to produce diffuse myocardial fibrosis and generalized severe impairment of left ventricular contractility constitutes a situation which cannot be reversed by surgery. Thus, a patient with coronary artery disease who has symptoms of congestive heart failure rather than angina is less likely to be improved by surgery, except in cases of acute failure secondary to myocardial ischemia or related to an associated ventricular aneurysm or defective valve.⁴

Despite these limitations, myocardial revascularization surgery obviously has an important place in the treatment of atherosclerotic heart disease. Results of these first 7 years indicate that such surgery can be accomplished with low operative mortality and a reasonable incidence of perioperative myocardial infarctions. The symptomatic improvement postoperatively has been reflected in an encouraging improvement in the quality of life of a large proportion of these patients. Preoperatively all patients undergoing revascularization surgery are in functional class II, III, or IV

(NYHA); however, our results and those of others⁵ indicate that postoperatively, almost 80% are restored to class I. Many of those previously restricted by angina are again productive individuals; two of every three having returned to their former employment. It has also been shown that life may be prolonged, particularly in those patients with double and triple vessel disease. Fully realizing the palliative nature of direct coronary artery surgery in the treatment of patients with atherosclerotic heart disease, we believe myocardial revascularization has been firmly established as an important adjunct to medical therapy provided that operative mortality can be kept within reasonable limits.

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