Results of Aortocoronary Bypass Surgery for Angina Pectoris

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To determine the relative risks and benefits of coronary bypass surgery for angina pectoris, we examined the results in our first consecutive 360 patients operated upon between May 1970 and December 1975. The age range was 27 to 75 years; there were 309 males and 51 females. The patients were classified clinically as having stable angina in 119 cases (33%), unstable angina in 205 cases (57%) and preinfarction angina in 36 cases (10%). Unstable angina was defined as a definite recent increase in severity or frequency of chest pain, angina at rest or nocturnal angina. Preinfarction angina was defined as a syndrome of prolonged angina, poorly controlled by nitrites, occurring at rest with typical ECG changes of ischemia. Such patients underwent observation in the Coronary Intensive Care Unit followed by emergency arteriography and surgery, usually within 24 hours.

All patients had preoperative coronary arteriography and left ventriculography. Significant lesions were defined as 50% or more narrowing of the left main coronary artery and 75% or greater narrowing of the other vessels. Abnormal left ventricular function was defined as an ejection fraction of less than 40% and was considered severe if the ejection fraction was less than 25% or if a large left ventricular aneurysm was present. Forty-three patients (12%) had left main-vessel disease, 83 (23%) had single-vessel, 115 (32%) double-vessel, and 119 (33%) triple-vessel disease. One hundred and ninety-four patients (54%) had abnormal ventricular function and in 84 (23%) it was considered severe. Eighty-four (23%) patients had single bypass surgery, 135 (38%) patients had double bypass, and 140 (39%) patients had three or more grafts. One patient died in the operating room before bypass could be carried out. (See below.) Twenty-two patients (6%) had concomitant left ventricular aneurysm resection and are included in the analysis. Patients with angina pectoris were excluded from surgical therapy only if the left ventricular ejection fraction was less than 15% in the absence of a large left ventricular aneurysm or if there were no suitable vessels for grafting.

The operation (Fig 1) generally involved the use of the saphenous vein as the bypass conduit. When the greater saphenous vein was unavailable or inadequate, alternative choices included the internal mammary artery, lesser saphenous vein, and in two instances, Gortex synthetic grafts. Operation was carried out under hemodilution and moderate systemic hypothermia of 28 C to 30 C, using intentional ventricular fibrillation and intermittent aortic occlusion for periods not exceeding 20 minutes, or alternatively, cardioplegia with cold hyperkalemic

This paper reports the clinical results of a five-year study of bypass surgery patients at the Medical College of Virginia.

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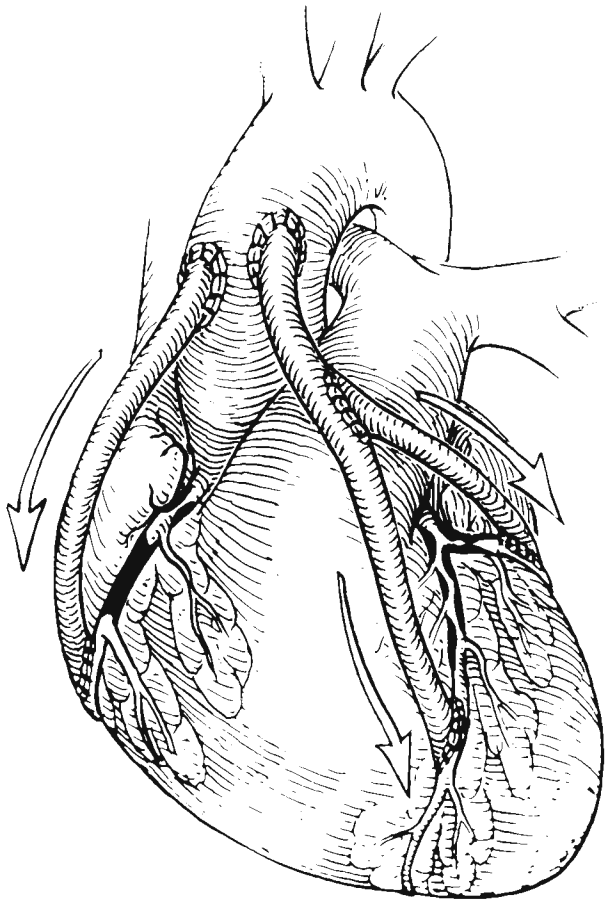

Fig 1—Technique usually employed for aortocoronary bypass, utilizing saphenous vein to revascularize the distal right, marginal circumflex, and left anterior descending branches.

solution for longer periods of arrest. When considered appropriate, coronary artery endarterectomy was carried out in addition to bypass grafting, most frequently involving the distal right coronary artery and occasionally the left anterior descending or circumflex branches. Aneurysm resection was performed in a standard fashion only when there was a full thickness scar with thinning of the ventricular wall;

TABLE 1

Estimated survival proportions for patients undergoing coronary bypass surgery at MCV from 1970 through May 31, 1976

Months after bypass surgery	Alive at beginning of interval	Died during interval	Withdrawn alive during interval	Estimated proportion surviving to end of interval (cumulative)
0-6	360	9	27	0.974
6-12	324	1	46	0.971
12-18	277	1	43	0.967
18-24	233	0	35	0.967
24-30	198	3	47	0.950
30-36	148	3	28	0.929
36-42	117	1	42	0.919
42-48	74	1	24	0.905
48-54	49	0	21	0.905
54-60	28	0	14	0.905*

*Standard error of the five year survival proportion is 0.0248.

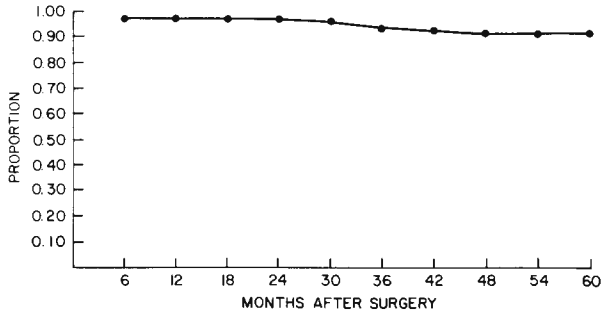

Fig 2—Proportion of patients surviving following coronary graft surgery at the Medical College of Virginia from 1970 through May 31, 1976.

frequently, an intraventricular thrombus was removed during aneurysm resection.

Results

There were two operative deaths and four postoperative deaths within the first month for a total operative mortality of 1.7%. One operative death in a 54-year-old female with stable angina and two-vessel disease resulted from an iatrogenic intraoperative aortic dissection, with death occurring before extracorporeal circulation could be established. This was the only operative or postoperative death in the group of patients with stable angina. The second operative death was in the only patient who could not be weaned from cardiopulmonary bypass. Postmortem examination of the 62-year-old male revealed extensive three-vessel disease, an old anterior wall infarction, and a posterior wall infarction (unsuspected preoperatively) estimated to be of two to three days' duration. No other patient required intraoperative or postoperative intra-aortic balloon assist. The operative mortality in the last four years of the study was 0.7%. There were four early postoperative deaths within one month: one from acute myocardial infarction occurring in a nonrevascularized area one week after operation, one from acute renal failure in a patient with chronic renal disease, one from an unsuspected, ruptured abdominal aneurysm in an obese patient, and one from a dissecting aneurysm in a patient with severe myxedema.

During this same period of study, 33 patients had operations for valve disease and concomitant coronary bypass grafting with no operative or hospital deaths in this group. However, these patients were not included in the analysis of surgery for angina pectoris and are not further considered in this report.

TABLE 2

Estimated proportions reporting angina free status following coronary bypass surgery at MCV from 1970 through May 31, 1976

Years after graft	Angina free at beginning of interval	Symptoms returned during interval	Withdrawn angina free during interval	Cumulative proportion angina free at end of interval
0-1	264	78	0	0.706
1-2	187	22	46	0.611
2-3	119	6	37	0.575
3-4	75	1	43	0.564
4-5	54	1	20	0.552*

***Standard error for proportion angina free five years after surgery is 0.035.**

Within the series of patients operated upon for angina pectoris, the perioperative infarction rate was studied in 100 consecutive patients with serial ECGs, vectorcardiography, and serum enzymes. A new perioperative infarction, one of which was fatal, was diagnosed in four patients.

There were 13 late postoperative deaths (3.4%) occurring two months to four years after operation; all were in patients who were classified preoperatively as unstable or having preinfarction angina. In each case there was abnormal ventricular function demonstrated preoperatively and in six patients it was considered severe. Two patients had aneurysmectomy in addition to bypass. Twelve of the 13 patients had documented myocardial infarction preoperatively. Ten of the patients had three-vessel disease and three of the patients two-vessel disease. Three of the deaths were non-cardiac in origin; one of disseminated malignancy and two from stroke. There have been no operative or postoperative deaths in patients with single-vessel disease. No late deaths have occurred during the period of this study in patients with a preoperative classification of stable angina pectoris. There were no operative or early postoperative deaths in patients with left main-vessel disease, and two late postoperative deaths have occurred in this group. Statistical analysis of all patients by life table methods (Table 1 and Fig 2), including the operative deaths, revealed a five-year expected survival rate of approximately 91%.

To evaluate the degree of palliation and its duration, follow-up evaluation was carried out in all surviving patients who had survived more than one year after operation at the time of the study. Evaluation consisted of personal examination, mail questionnaire, or telephone interview, with 100% follow-up. On the basis of the interviews, patients were classified as 1) asymptomatic, 2) improved, though with some angina, or 3) unimproved. An attempt was made to define when in the postoperative course angina

TABLE 3

Estimated proportions reporting improvement following coronary bypass surgery at MCV from 1970 through May 31, 1976

Years after graft	Improved at beginning of interval	Failed during interval	Withdrawn improved during interval	Cumulative proportion improved at end of interval
0-1	265	12	0	0.955
1-2	253	2	75	0.946
2-3	176	1	71	0.939
3-4	104	0	60	0.939
4-5	44	0	34	0.939*

* Standard Error for proportion improved five years after surgery is 0.016.

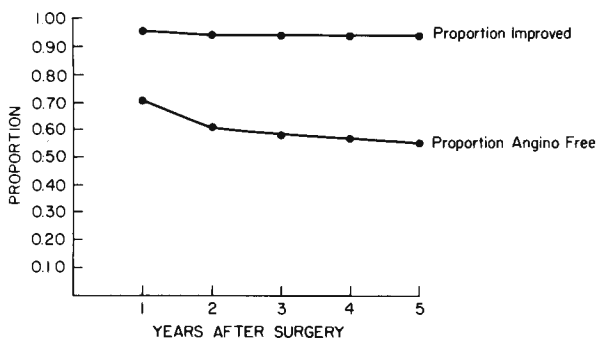

Fig 3—Proportion of patients reporting improved status and proportion reporting angina-free status following coronary vein graft surgery from 1970 through May 31, 1976 at the Medical College of Virginia.

had reappeared or when therapeutic failure had occurred. Similar life table analysis of the duration of palliation (Tables 2 and 3, Fig 3) revealed that at five years 55% of the patients were anticipated to be pain-free and 93% asymptomatic or improved, with 7% either unimproved or worse.

Conclusions

These results appear to show that aortocoronary bypass grafting for angina pectoris can be carried out with relative safety and effectiveness in the majority of properly selected patients. The risk appears particularly low in patients with single-vessel disease, those with stable angina, and those with good left ventricular function. The operative risk also appears appropriately low for all patients with left ventricular ejection fraction above 15% so long as suitable graftable vessels are present even if concomitant ventricular aneurysm resection is required. Determination of the ultimate value of aortocoronary bypass grafting in terms of prolongation of life and duration of palliation will require several more years of analysis in view of the generally progressive nature of the disease both in the native circulation and in the bypass grafts. However, the analysis of this group of patients from one to five years after operation strongly suggests that operation has provided improved longevity as well as effective palliation.