Long-term follow-up after coronary artery bypass

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Although coronary artery bypass has been proved to relieve angina effectively and improve the quality of life, the effects upon long-term survival are still being analyzed critically.

Patient population

A series of 846 consecutive and personally observed patients from one cardiology section who underwent isolated coronary artery bypass at the Texas Heart Institute from late 1969 through June 1976 were studied and the results are presented. Calculation of all percentages was based on the total population of 846. Men comprised 88% of the series. Sixty-five percent of the men were 50 years of age or older and 35% were 60 years or older. Preoperatively, functional Classes III and IV angina (New York Heart Association) was present in 63% and 19% respectively. Sixty-one percent demonstrated a changing pattern of angina during the immediate 60 days before operation. Previous myocardial infarction had occurred in 63%. Single-vessel disease (75% or greater occlusion) was present in 114 patients (14%): the right coronary artery in 23 (3%), the left anterior descending coronary artery in 80 (10%), and the left circumflex coronary artery in 11 (1%). Double-vessel

disease was found in 290 patients (34%): the right coronary artery and left anterior descending coronary artery in 159 (19%), the right coronary artery and left circumflex coronary artery in 43 (5%), and the left anterior descending coronary artery in 88 (10%). Triple-vessel disease was present in 375 patients (44%). The main left coronary artery was involved (75% or more occlusion) in 68 patients (8%), and was associated with major two-vessel disease in 30 patients and with three-vessel disease in 37. A crude coronary artery score for all patients averaged 4.3 (75% or more narrowing = one; and more than 90% = two in each of the right coronary arteries, main left coronary artery, left anterior descending coronary artery, and left circumflex coronary artery). The ejection fraction was 0.60 or more in 52% of the patients, 0.45 to 0.59 in 30%, 0.30 to 0.44 in 13%, and less than 0.30 (average 0.25) in 5% of the patients. The average number of bypasses per patient was 2.5, with 8% of the patients having undergone one, 39% having two bypasses, 45% having three bypasses, and 8% having four or more bypasses. Several patients with single-vessel disease had more than one bypass if two branches of the same vessel, for example, the left anterior descending coronary artery and diagonal, were involved.

Factors influencing short- and long-term survival

Early mortality (30 days) was 2.96% (25 patients) and was influenced by the following: (1) sex of the patient (5.7% in women versus 2.6% in men), (2) age with the highest early mortality occurring in the youngest and oldest patients (3.3%, 39 years or younger; 2.5%, 50 to 59 years; and 5.9%, more than 70 years), (3) number of bypasses (2%, early mortality for one or two bypasses versus 3.8% for three or more bypasses), (4) functional class (angina) of the patient (2.4% in Class II, 2.7% in Class III, and 4.9% in Class IV). Mortality was influenced minimally by the ejection fraction preoperatively (3.5% in patients with a preoperative ejection fraction of 0.60 or more, 2.4% in patients with an ejection fraction between 0.45 and 0.59, 1.9% in patients with an ejection fraction between 0.30 and 0.44, and 2.2% in patients with an ejection fraction of less than 0.30). Risk factors commonly considered that unfavorably influenced early mortality included associated pulmonary disease (early mortality of 4.2%), left ventricular hypertrophy (4%), hypertriglyceridemia (3.9%), and diabetes mellitus (8%). Some combined factors that further unfavorably influenced early mortality included diabetes and age of 60 or over (12%), diabetes and pulmonary disease (22%), diabetes and hypertriglyceridemia (11.3%), and diabetes and Class IV angina (20%).

Long-term survival at 5 years of all patients, taking into consideration all cardiac and noncardiac deaths, was 88.2% (89.1% for single coronary artery bypass, 88.1% for double coronary artery bypass, 92.3% for triple coronary artery bypass, and 95.4% for quadruple coronary artery bypass), yielding a total attrition (including early mortality) of 2.3% per annum. Fatal myocardial infarctions accounted for an attrition of 0.93% per annum. Late survival (5 years) was influenced unfavorably by reduced ejection fraction at the time of surgery (for an ejection fraction of

0.30 to 0.44, the 5-year survival was 67% and for an ejection fraction of less than 0.30, the 5-year survival was 64%). Fourteen of 27 late deaths occurred in two groups of patients who had significantly impaired ventricular function and comprised only 18% of the total patient population. Perioperative myocardial infarction occurred in 11% of patients (9.7% of the men and 20% of the women), and resulted in an early mortality of 9.6% and a 5-year survival of 83.4%. Anterolateral infarction (21.5% of all infarctions) was the most devastating occurrence with an early mortality of 13.7% and a late survival of 70.5%. In patients with diabetes, the 5-year survival was 70.5%, and in patients with hypercholesterolemia the 5-year survival was 79.6%. Five-year survival was based on angina functional class: Class I, 96%; Class II, 95.1%; Class III, 86.7%; and Class IV, 87.8%.

Symptomatic improvement

At the end of 1 year, 91% of all survivors were improved compared to their preoperative status and at the end of 5 years, 90% were better (asymptomatic or fewer symptoms).

Serially graded exercise testing in functional evaluation

In a separate study done in the Clayton Noninvasive Laboratory of the St. Luke's Episcopal Hospital and the Texas Heart Institute, 302 patients underwent preoperative and serial postoperative graded treadmill exercise testing using the Bruce protocol. Average duration of exercise significantly increased 59% (317 seconds preoperatively to 503 seconds 1 year postoperatively), and the improvement was maintained through the follow-up period (5 years). Both maximum heart rate and double product showed a notable increase postoperatively (maximum heart rate from 136 preoperatively to 156, 1 year postoperatively and double product from 23.2×10^3 to 30.7×10^3). Although the improvement persisted throughout the follow-up, the maximum heart rate and double product gradually declined with time. Angina developed in 69% of patients according to preoperative graded exercise testing and in 10% after operation (at 1 year). There was a gradual, slight increase in the frequency of angina in later follow-up testing; this angina, however, occurred at consistently higher work levels than preoperatively. Symptomatic improvement persisted throughout the follow-up period. Patients who had angina preoperatively achieved a double product of 21.6×10^3, while those who developed angina postoperatively achieved a double product of 25.3×10^3 at 1 year and remained at that level during further serial follow-up. Preoperatively, ischemic electrocardiographic response (1 mm linear S-T segment depression) occurred in 81% of the patients and postoperatively in 20% (at 1 year). The frequency of ischemic responses gradually increased during the 5-year follow-up to 62%, yet occurred at significantly higher exercise levels, that is, preoperatively to postoperatively, respectively; the heart rate increased from 125 to 145 and the double product from 21.3 to 29.2×10^3, and usually was not accompanied by angina. Exercise-induced premature ventricular contractions were not predictably influenced by coronary artery bypass.

Conclusion

Coronary artery bypass can be performed with a low early risk in patients with serious symptomatic and severe angiographic coronary artery disease. Severity of disease, expressed symptomatically and angiographically, influenced early mortality. The magnitude of myocardial scarring, reflected by the ejection fraction, had a strong negative influence on long-term survival. Data derived from serially graded exercise testing best support the hypothesis that increased flow of myocardial blood is responsible for the symptomatic improvement rather than suggested alternate mechanisms. The palliative character of this improvement is evident in the mild and gradual decline with time of favorable indicators in serial follow-up over 5 years.

In this nonrandomized study of symptomatic patients with severe coronary artery disease, the long-term survival and the functional status of patients who underwent coronary artery bypass appear distinctly better than the reported medical therapy in comparable patients.