EDITORIAL

Direct Revascularization Procedure in the Management of Myocardial Ischemia

ATHEROSCLEROTIC heart disease is the greatest single cause of death among Americans today, a fact generally recognized both by physicians and the public at large. This disorder currently claims the lives of more than half a million citizens in the United States annually, and it is regarded by several knowledgeable observers to be of epidemic proportion. Of additional importance is the increasing number of young victims with complications of coronary atherosclerosis. Much effort is being directed toward a more basic understanding of this disorder, including its etiology and, particularly, its associated derangements in lipoprotein metabolism. From a clinical viewpoint, advances in the safety and reliability of coronary arteriography have delineated in a more objective manner those patients with significant disease. The need for effective therapeutic measures has again been thrust into the forefront, and in the recent past the direct approach for myocardial revascularization has surged ahead with unprecedented enthusiasm both among cardiologists and cardiovascular surgeons.

A surgical approach for the relief of anginal pain was first suggested in 1899 by Francois-Franck, a professor of physiology in Paris. It was his view that section of the cervical sympathetics might interrupt the pain fibers to the heart and, thus, ameliorate the symptoms of angina pectoris. Such a procedure was first tried in 1916 by Jonnesco and produced symptomatic relief. The subsequent recognition that angina pectoris was most often due to reduced arterial blood supply led to the development of a number of surgical procedures designed to augment myocardial blood flow. In 1935 epicardial abrasion was advocated by Beck to stimulate development of intramyocardial arterial collaterals, and in 1946 Vineberg implanted the internal mammary artery into the ventricular myocardium to produce a new source of arterial supply. Although these procedures have yielded to more direct technics, each was important in placing emphasis on the problem and upon the potential of surgical management.

The concepts upon which the direct approach is based have been greatly aided by the classic studies of Blumgart and associates; their findings have been fundamental in an understanding of the pathophysiology of myocardial ischemia. This work, together with the noteworthy studies of James and of Baroldi and Scomazzoni, has provided a firm basis for direct coronary arterial surgery. The aggregate of these observations indicates that the most advanced lesions and sites of stenosis or occlusion are most often located in the proximal third or half of the coronary arteries. Moreover, these data indicate that the frequency and severity of occlusions are greatest in the anterior descending coronary artery followed in order by the right coronary artery, the left circumflex, the left main, and least of all the right posterior descending coronary artery. It is upon these fundamental anatomic and pathologic observations that direct surgical procedures designed to augment coronary arterial flow are based.

In 1957 Bailey introduced coronary endarterectomy, a technic substantially modified by Longmire in the following year. This procedure was useful for selected patients with angina pectoris, but its application was ultimately found to be relatively restricted. Subsequent refinements in this approach were introduced, and a number of successful results are recorded. In the recent past, consider-
able enthusiasm has justifiably been given the extended treatment of severe coronary artery disease by a new surgical concept. The contributions of Johnson and associates and of Favalora and associates have led to an extensive reappraisal of the surgical approach. To these workers much credit is due for placing emphasis upon the basic principle that coronary arteries of extremely small caliber may be successfully anastomosed to a venous autograft from the aorta. These workers and others subsequently have demonstrated that coronary arteries with a diameter as small as 1 mm may be joined by suture anastomosis with prolonged patency, as confirmed by postoperative arteriography.

Although the technic of venous graft anastomosis to the coronary arteries is of recent origin, preliminary intraoperative and postoperative physiologic studies are available for analysis. In our group, Greenfield and associates (personal communication) have used an electromagnetic flowmeter to measure blood flow through the coronary venous grafts during the operation approximately 20 min after cessation of cardiopulmonary bypass. Mean flows in a single graft ranged from 20 to 80 ml/min, with an average of approximately 35 ml/min. Moreover, myocardial stimulation produced by an injection of isoproterenol into the graft resulted in an augmentation of coronary flow to double or triple the control values. After temporary occlusion of the graft, a reactive hyperemic response occurred with flows increasing to similar levels in the majority of patients. These increases in flow have occurred without changes in perfusion pressure. The data suggest the ability of the coronary circulation distal to an obstruction to function in a reasonably normal manner and document the ability of the venous bypass graft to transport a significant quantity of blood to the heart.

The results following operation are of critical importance, and reliable data are now being accumulated. The effects of the operative procedure, itself, including morbidity, mortality, and ultimate patency of the graft are of obvious importance. The mortality has continued to diminish, and in most of the leading series it is now 10% or less. The beneficial effects including the response of anginal pain, of cardiac performance under both normal and stressful situations, and ultimately the influence on the natural history of recurrent myocardial infarction are of prime importance. In an early follow-up in our series, Morris, Kong, Peter, and Behar (personal communication) have demonstrated a patency rate of greater than 90% in postoperative arteriograms. Careful review of symptoms indicates that 65% of the patients are completely free of angina, and the condition of an additional 25% are significantly improved, with the remaining patients experiencing no change.

It is apparent that routine postoperative catheterization studies, alone, may not reflect the ultimate benefit of coronary revascularization due in part to the study being performed in the resting state. A critical comparison of preoperative and postoperative stress testing may be necessary for determination of whether the performance of the heart is improved. Certainly, cardiac catheterization performed early after operation does not allow the heart to recover from the deleterious effects of a major operation with extracorporeal circulation.

Since the advent of aortic-coronary bypass grafts, several important features in the conduct of the operative procedure have become apparent. First, the need for an exacting technic is clear, with anastomoses being accomplished with very fine sutures, and some find the magnification provided by special glasses quite helpful. In addition, the heart should be quiet in order that an ideal anastomosis might be performed, and, therefore, ventricular fibrillation or asystole is preferred. While coronary arteries of minimal diameter can be anastomosed successfully, wherever possible it is important that the vessel at the site of the anastomosis be essentially normal and not involved with marked atherosclerosis. Thus far, the venous autograft appears to be the most satisfactory substitute, although the use of venous homografts...
graffs has been suggested when a suitable autograft is not available. Of interest is the fact that Green and Spencer 15 have chosen in some instances the use of an internal mammmary artery-coronary artery anastomosis in preference to a venous autograft.

The indications for operation are not firmly agreed upon, due in part to a lack of precise definition of the natural history of the disease. A primary requisite is an established diagnosis of coronary arterial occlusion by selective arteriography. Moreover, the demonstration of distal patency in one or more arterial vessels at the time of arteriography is highly desirable. At present, the chief indication is uncontrolled angina pectoris.

With an approach to the future, it is possible that not only patients with uncontrolled angina will be candidates for aortic-coronary grafts but also those with recurrent myocardial infarction, and those with acute infarction and shock ("power failure") may be helped by direct surgery. Current hemodynamic and biplane ventricular volume studies of Behar (personal communication) indicate that the presence of extensive coronary artery disease significantly alters cardiac perfomance despite clinical symptoms referable only to chest pain. If aortic-coronary grafts can be demonstrated to improve cardiac behavior in an objective assessment, this procedure might be indicated both for improvement of demonstrable abnormalities in cardiac function and as an aid in the prophylaxis of subsequent myocardial infarction. It is already recognized that varfar lesions accompanying coronary arterial insufficiency may require concomitant correction at the time of myocardial revascularization.

A critique of the current direct coronary procedures would include: (1) ultimate patency rates, (2) likelihood of involvement of the venous graft by atherosclerosis, (3) aneurysmal dilatation, (4) thrombosis and fibrosis, (5) progression of arterial disease in the presence of increased arterial flow, (6) amount of blood flowing through the graft with the passage of time, (7) effect on recurrent myocardial infarction, and (8) the relationship of the operation to extension of the life span. The answers to these critical questions are unavailable and can be made only when both time and appropriate postoperative evaluations permit. For the present, there appears to be sufficient clinical and laboratory data of an objective character to warrant continued and perhaps more widespread use of this approach in patients with myocardial ischemia.

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References
6. BLUMGART HL, SCHLESINGER MJ, DAVIS D: Studies on the relation of the clinical manifestations of angina pectoris, coronary thrombosis, and myocardial infarction to the pathologic findings with particular reference to the significance of the collateral circulation. Amer Heart J 19: 1, 1940

Circulation, Volume XLIII, February 1971


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Circulation. 1971;43:175-178
doi: 10.1161/01.CIR.43.2.175

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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