Evolution of Surgical Treatment of Coronary Artery Occlusive Disease

ORIGINAL ABSTRACT

Aortocoronary Bypass With Saphenous Vein Graft: Seven-Year Follow-up

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A 42-year-old man had extensive occlusive disease of the coronary artery and angina pectoris. An autogenous saphenous vein bypass from the ascending aorta to the anterior descending coronary artery was performed on Nov 23, 1964. The patient suffered an asymptomatic anterior myocardial infarction during operation but made an uncomplicated recovery. Seven years after the operation, the graft functions with normal left ventricular hemodynamics, while the occlusive process has produced obstruction of the left main coronary artery and almost complete occlusion of the right coronary artery. To our knowledge, this is the first successful case of a saphenous vein-coronary artery bypass with the longest follow-up of a functioning coronary vein bypass graft.

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Commentary by George P. Noon, MD

In 1937, Ochsner and DeBakey[1] published "The Surgical Treatment of Coronary Disease" in which they reviewed indirect surgical treatment of angina pectoris consisting of 3 main approaches: the sympathetic nervous system, the thyroid, and development of collateral blood supply to the heart.

Jonnesco[2] initiated indirect surgical treatment of angina pectoris in patients in 1916, when he performed a sympathectomy that was later used by many surgeons with a variety of techniques and variable results. Subsequently, total thyroidectomy was found to relieve cardiac symptoms by decreasing the metabolic rate in patients with hyperthyroidism. In 1934, Weinstein et al,[3] however, reported marginal results treating angina with thyroidectomy in 50 consecutive patients. In 1937, Parsons and Purks[4] reported similar marginal results in 133 patients.

In 1935, Beck[5] reported a number of procedures designed to promote collateral circulation. Other physician-researchers continued to develop procedures that were used experimentally and clinically to increase collateral circulation, but with questionable results.

The concept of coronary bypass grafting for occlusive disease was originally proposed by Carrel,[6] who in 1910 reported his experimental coronary bypass operations in dogs and suggested the possible role of this procedure in the treatment of angina pectoris in humans. In 1961, DeBakey and Henley[7] published their experimental work in dogs using knitted Dacron grafts (3-5 mm) applied to the left anterior descending artery, the circumflex artery, or both. In 1957, Bailey et al[8] first reported coronary artery endarterectomy in a patient. Coronary endarterectomy was continued sporadically in selected patients.

Since the concept of direct revascularization was beginning to develop, physicians needed diagnostic testing to verify arterial coronary anatomy. In 1959, Sones et al[9] reported using radiopaque contrast in the coronary arteries. At about the same time, Crawford et al[10] reported successfully repairing opened coronary arteries in dogs with autologous vein patch grafts. In 1962, Sabiston[11] performed the first vein graft bypass from the ascending aorta to the right coronary artery, although the patient died a few days later.

Historical Significance

The classic article by Garrett et al[12] is of critical importance because 7 years after the procedure was performed, it documented the first successful coronary artery bypass graft (CABG) operation. The authors purposely waited 7 years to have a reliable follow-up outcome. Interestingly, the surgeons were not convinced that the graft was patent after the operation. The patient's electrocardiogram showed severe reversible ST-segment depres-

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sion during the operation and evidence of a perioperative myocardial infarction postoperatively. One month postoperatively, a selective coronary arteriogram and flush aortogram failed to show graft patency. It was not until selective coronary and graft arteriograms performed during a routine examination 7 years later that graft patency was confirmed. The surgeons were elated with the findings that confirmed long-term graft patency and preservation of ventricular function, despite progression of coronary artery disease. Relief of angina pectoris also continued.

This landmark article[12] was monumental in the evolution of the surgical treatment of atherosclerotic coronary artery disease. The article demonstrated a successful saphenous vein coronary bypass operation with long-term graft patency, relief of previously intractable angina, and preservation of ventricular function. This report introduced a new era of surgical treatment of coronary artery disease, rendering the previous indirect surgical procedures obsolete. Eventually CABG surgery became the most common cardiac surgical procedure performed. On many occasions, DeBakey called CABG surgery an "act of providence." This first successful procedure was not planned, but was performed as a "rescue" and the widespread application and positive effects of the treatment of atherosclerotic coronary artery occlusive disease were not realized until later.

At the time of this historic surgery,[12] heart disease was the leading cause of death in the United States[13] and the need for treatment and prevention became a medical priority. The National Institutes of Health and other sources made funding available for researching coronary heart disease. Extensive clinical studies were initiated to evaluate medical and surgical therapy, improve diagnosis, and elucidate pathogenesis and prevention.

The indications for coronary artery revascularization and medical treatment were established after review of large-scale clinical studies. As more long-term follow-up became available, comparison of graft patency of veins with that of arterial conduits demonstrated the superiority of the internal mammary artery.

Coronary artery balloon angioplasty was introduced in the 1970s by Grüntzig et al[14] and followed later by the development of coronary stents. With experience and improvements, these percutaneous devices were used more extensively than CABG surgery to establish blood flow in obstructed coronary arteries. Multiple trials compared the efficacy of balloons, stents, and bypass surgery. The success of stents in properly selected patients decreased the number of CABG procedures performed. In general, however, CABG procedures provided better long-term results.[15]

To reduce surgical trauma and morbidity, surgeons began evaluating new surgical techniques. Off-pump surgery was used to avoid such adverse effects of cardiopulmonary bypass as hemodilution and neurologic sequelae. In properly selected patients, the off-pump operation has been successful and widely accepted.

Minimally invasive procedures for CABG surgery and robotic surgery have also been developed. These operations require new methods of exposure, new operative techniques, and new surgical instruments. Coronary artery stenting is now combined with minimally invasive CABG, a hybrid procedure that usually involves bypass of the left internal mammary artery to the left anterior descending coronary artery and stenting of any other stenotic arteries.

DeBakey often spoke about the pioneering coronary bypass operation performed in 1964. Repeatedly, he pointed out that it is not enough simply to perform the operation, but also to make sure the patient does well postoperatively. He was quick to suggest that serendipity had played a role in finding a surgical alternative to treat coronary artery disease. The publication of this case report in *JAMA*[12] and the demonstration of long-term success gave high credibility to the concept of coronary revascularization.

Since this landmark procedure was performed more than 4 decades ago, treatment of coronary artery occlusive disease has undergone extensive investigation and evolution, resulting in improved diagnosis and more effective treatment. Since learning of the surgeons' successful attempt to save their patient's life, researchers have made remarkable advances in the diagnosis and treatment of coronary artery occlusive disease, and as a result, countless patient lives have been extended when disability and death might otherwise have been their fate.

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