Coronary Bypass Grafting With Bilateral Internal Thoracic Arteries and the Right Gastroepiploic Artery

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Now that coronary artery bypass grafting has entered its fourth decade, cardiac surgeons unanimously agree that arterial grafts yield a more satisfactory long-term clinical outcome than do autologous saphenous vein grafts. With time, venous grafts are vulnerable to accelerated atherosclerosis, which may necessitate high-risk repeat coronary bypass surgery. In contrast, arterial grafts are highly resistant to atherosclerosis. If patent immediately after surgery, they tend to remain patent indefinitely; if angina recurs, it is usually manageable with medical therapy, so repeat coronary bypass may be avoided.

Why do arteries offer superior long-term patency? Apparently, the elastic and smooth muscle elements in the arterial wall are better able to withstand pulsatile flow. An important key appears to be the integrity of the arterial endothelium, which serves as a barrier between the blood and vascular smooth muscle. After implantation as bypass conduits, arteries continue to have a basically intact endothelium; any endothelial defects that do develop are essentially nonthrombogenic. Moreover, the arterial endothelium releases vasoactive mediators that confer additional protection. These mediators include prostacyclin and nitric oxide, vasodilators that prevent atherogenesis and thrombogenesis by limiting platelet aggregation and cell adhesion. Saphenous vein grafts also produce these vasodilators but not to such a great extent.

The arterial conduit of choice is the internal thoracic artery (ITA), also known as the internal mammary artery. Use of the ITA as a bypass graft was pioneered by Green and associates in 1968. Critics doubted its ability to provide sufficient flow, and early experience yielded a high complication rate, dampening enthusiasm for the use of this artery. In 1984, however, Grondin and coworkers showed that at ≤12 years after surgery, ITA grafts had a 95% patency rate. In contrast, the patency rate for saphenous vein grafts was only ~50%. By the mid 1980s, thallium scintigraphy had confirmed that the ITA could provide enough flow to perfuse the myocardium adequately. Moreover, open heart techniques had improved to the point where use of the ITA no longer entailed excessive risk. Consequently, this artery became the conduit of choice for coronary bypass, particularly of the left anterior descending artery. Recently, Cameron and coauthors found that an ITA graft lengthens the mean survival rate by 4.4 years compared with the survival rate after venous grafting alone. These authors documented the continued beneficial influence of an ITA graft on the survival rate and clinical events at 20 years. Other investigators have shown that, in patients undergoing multiple bypasses, the addition of a second ITA graft confers a survival benefit at 15 years among hospital survivors (P = 0.05). When bilateral ITAs are used, the left one is typically used to bypass the left anterior descending artery and the right one is extended as a free graft to the next most important diseased artery.

An alternative arterial conduit is the right gastroepiploic artery (GEA), which was first implanted as a direct bypass graft in 1974 by Edwards. The GEA is generally used as a pedicled graft to avoid an aortic anastomosis. It is suitable for bypassing the right coronary artery, the circumflex artery, or the left anterior descending artery or its diagonal branch. Because the media of the GEA contains smooth muscle cells, the artery is vulnerable to spasm. Therefore, papaverine should be injected into the GEA intraluminally during bypass, and patients should take calcium antagonists on a life-long basis. Some GEA recipients also require short-term vasopressor therapy for vasoplegia. Pedicled GEA grafts offer satisfactory midterm patency: In a series of 400 patients, 376 of whom received pedicled GEA grafts, Suma and associates documented a 94% patency rate without any evidence of significant intimal hyperplasia at up to 5 years after surgery.

Other potential bypass conduits include the inferior epigastric artery and the radial artery. Rather than being used as primary bypass grafts, alternative arterial conduits (including the GEA) are generally reserved for the following groups: patients undergoing redo coronary bypass whose ITAs and saphenous veins have already been used as grafts; those whose saphenous veins have been surgically stripped or are of poor quality; those with ascending aortic disease or severe vascular disease of the lower extremity; and obese, diabetic patients at high risk for sternal wound complications associated with bilateral use of the ITA. Use of alternative arterial conduits also may be indicated for young coronary bypass patients with vein graft failure or hyperlipidemia.

To avoid using vein grafts at all, some experts recommend that arterial grafts be used exclusively, even for multivessel bypass. Among the foremost proponents of triple arterial bypass are Bergsma and associates, whose excellent results in 256 consecutive patients are reported in this issue of Circulation. Having originally described these patients in 1996, the authors are now publishing their updated results. These data are compared with the findings of other investi-
gators, who used vein grafts and/or ITA grafts in coronary bypass patients. After a maximal follow-up period of 7 years (mean, 51±15 months), Bergsma and coworkers' patients had an actuarial survival rate of 91.1%, including 4 in-hospital deaths. Considering that all of these patients had triple-vessel disease, this rate is extremely satisfactory. The cumulative probability of freedom from myocardial infarction (97.3%, including 5 in-hospital infarctions) surpassed that of vein and/or ITA graft recipients (maximal freedom, 95%). Moreover, the actuarial freedom from reintervention (95.4%) was comparable to that of other series. In addition, Bergsma’s group had 85.4% freedom from angina pectoris at 7 years, which is considerably lower than that of the control groups. No other investigator has published a longer follow-up study regarding the combined use of GEA and bilateral ITA grafts. Although the results favor the use of triple arterial bypass, further studies are needed to draw meaningful conclusions about this approach.

At the Texas Heart Institute, we use at least one arterial graft for all coronary bypass patients, regardless of age, even those with left main disease. We reserve triple arterial grafts for patients less than 55 years of age or those who lack an adequate saphenous vein. In weighing the advantages and disadvantages of triple arterial grafts, the following points should be borne in mind: (1) Most published series involving triple-artery grafts do not include elderly patients, who are not optimal candidates for this approach. (2) Because of the need for harvesting three arteries, the operative time is prolonged. (3) The loss of both ITAs may result in sternal complications, especially in diabetic and osteoporotic women. Moreover, the operative mortality rate of female coronary bypass patients is increased when the ITA is used. (4) Harvesting of the GEA necessitates an abdominal extension of the sternal incision, which may cause additional postoperative pain and may be a potential site for herniation and/or adhesion formation. Additional possible complications include post-operative ileus, pancreatitis, and intra-abdominal hemorrhage. Should abdominal surgery later become necessary in a GEA graft recipient, optimal management would be unclear. Use of the GEA is contraindicated in patients who have undergone gastric resection. Relative contraindications include severe obesity, abdominal aortic surgery, or a previous cholecystectomy.

Although triple arterial bypass may be ideal from a theoretical standpoint, caution is necessary in using this approach. Because of a steep learning curve, triple arterial bypass should be attempted only by highly skilled surgeons. As with any other operation, the surgeon must use sound judgment and must tailor the procedure to fit each individual case.

References


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