Choice of grafts—criteria for selection of coronary bypass conduit

Alexander S. Geha, M.D.

New Haven, Connecticut

The saphenous vein graft is the most commonly used bypass graft in coronary revascularization. Its main advantages are the relative ease of harvesting it, the usually large size of the vein and toughness of its wall, which make it easy to handle during construction of anastomoses, and the relative abundance of vein length which allows it to reach any site over the epicardium. However, saphenous vein grafts continue to have a somewhat unpredictable occlusion rate of about 10% at 2 weeks and 15% to 20% at 1 year postoperatively, despite refinements in the methods of preparation and handling of vein grafts. This has led us and others to investigate experimentally as well as clinically the use of internal mammary artery grafts for coronary bypass and to evaluate the results obtained with both types of grafts. This presentation will emphasize our own criteria for selection of one graft or another, the limitations of each and the results to be anticipated, based on a personal experience with coronary revascularization in 552 patients for surgical treatment of anginal syndromes and another 88 cases of revascularization in combination with other procedures (mainly valve replacement and/or myocardial resection) from January 1971 to June 1977.

The advantages of internal mammary artery grafts are (1) a single artery-to-artery anastomosis between vessels of comparable size with a natural origin of the graft from a parent major systemic artery; (2) the similarity in size of internal mammary artery graft and the recipient coronary artery tends to decrease the turbulent flow and increase the velocity of flow; (3) the internal mammary artery graft has a significantly higher early and late patency rate than the saphenous vein graft; (4) there is less difficulty with kinking and torsion of the graft or recipient artery when internal mammary artery grafts are used; (5) leg wounds are avoided or minimized and the patient with absent or unsuitable saphenous veins may be benefitted; (6) internal mammary artery grafts are significantly less susceptible to structural alterations of subintimal hyperplasia or atheromatous degeneration.

Present criteria for use of internal mammary artery graft

1. Perfect patency of the internal mammary artery: preoperative internal mammary artery visualization by angiography (painful); absence of subclavian bruits; no differential between right and left arm blood pressures; adequate internal diameter of internal mammary artery; pulsatile flow greater than 100 ml/min.

2. The size of the internal mammary artery at the site of intended transection, measured before handling the artery and causing spasm, should be equal to or greater than the lumen of the recipient artery. In our experience, the internal mammary artery graft has been suitable for the left anterior descending artery and/or diagonal in 88% of patients in whom it was attempted.

3. The internal mammary artery graft and its supporting pedicle should reach the recipient coronary vessel in as short a distance as possible and without angulation at the anastomosis. We find the left internal mammary artery particularly suitable for the left anterior descending artery and its proximal branches. If simultaneous grafts to the left anterior descending artery and a proximal diagonal are required, we prefer to use crossed double internal mammary artery grafts, since the right internal mammary artery will align better with the diagonal vessel.

4. Expected poor distal runoff.

5. Proximal left anterior descending artery lesion only moderately severe (competitive flow).

6. The patient's hemodynamic condition must be stable to allow the necessary time for dissection and preparation of the internal mammary artery graft.

Present criteria for use of saphenous vein graft

1. Grafting the right and/or left circumflex coronary arteries or distal one third of the left anterior descending artery.

2. Failure of a previous internal mammary artery graft.

3. Inadequate internal mammary artery (frequently in elderly patients, nonmuscular patients, obese women).

4. Hemodynamic instability (acute myocardial ischemia, severe left main coronary artery stenosis).

5. Bleeding dyscrasia (large raw area on chest wall associated with dissection of internal mammary artery).

6. Massive left ventricular hypertrophy with large coronary arteries.

7. Severe left ventricular dysfunction.
8. Combined valve replacement and coronary grafting.

Relative contraindications of internal mammary artery graft

1. Sequential grafting.
2. Endarterectomy for totally occluded coronary artery.
3. Training of relatively inexperienced resident staff.

Flow rates in saphenous vein grafts and internal mammary artery grafts

When these principles of selection are observed, the measured flow rates are commensurate with those predicted from angiographic estimates of the recipient coronary and its runoff. Clinically, the flow rates have been adequate to relieve angina, and the flow rates measured in internal mammary artery grafts and saphenous vein grafts in our patients were not significantly different. Our experimental studies of both types of grafts in animals and humans indicate that saphenous vein grafts and internal mammary artery grafts have similar flow rates and respond similarly to systemic administration of vasoactive drugs. Studies by Flemma and associates have shown discrepancies between flow and pressure relationships measured in each bypass, but the measurements were not obtained in the coronary arteries themselves downstream from the graft anastomosis, as required for valid comparison.

Clinical and angiographic results with saphenous vein grafts and internal mammary artery grafts

Of the 552 patients who underwent revascularization, only 349 received internal mammary artery grafts with or without saphenous vein grafts (January 1973 to June 1977) and 203 received saphenous vein grafts only (January 1971 to June 1977).

Early death and morbidity

There is no significant effect on operative mortality or perioperative infarction from the use of one type of graft or another. In the last 3 years, operative mortality has been 0.4% for patients with ejection fractions of 0.4 or higher and 2.3% for the entire group of patients with revascularization and no associated procedures. Infarction rate is 5%. The incidence of excessive postoperative mediastinal bleeding requiring reoperation is not significantly different (3.1% with saphenous vein grafts only, 3.6% with internal mammary artery grafts with or without saphenous vein grafts). Mediastinal infection occurred in three patients (0.5%), one with three saphenous vein grafts, one with crossed double internal mammary artery grafts, and one with aortic valve replacement and three saphenous vein grafts. All recovered fully with debridement, irrigation with povidone-iodine, and drainage.

Late death and functional results

These are not significantly different between the group with saphenous vein grafts only and that with internal mammary artery grafts with or without saphenous vein grafts. Actuarial survival rates are 95% at 1 year, 87% at 3 years, and 78% at 5 years. Of the surviving patients, 95% are improved by one or more functional class, and 85% are asymptomatic. Eighty-two percent of patients younger than 60 years have resumed gainful employment.

Table. Flow and patency rates of saphenous vein grafts and internal mammary artery grafts

Type of graft used for revascularization	No. of patients	No. of grafts	Mean flow rate (ml/min)		Postoperative angiographic graft patency rate (%)			
					Early (2 wk)		Late (3 mo to 6 yr)	
			SVG	IMAG	SVG	IMAG	SVG	IMAG
SVG only	118	307	67 ± 10	. . .	91	. . .	85	. . .
IMAG ± SVG	349	873	63 ± 9	56 ± 8	89	98	82	96
Total	467	1180	65 ± 10	56 ± 8	90	98	83	96

SVG = saphenous vein graft; IMAG = internal mammary artery graft.

Mean graft flows and postoperative angiographic patency are shown in the *Table* for the period January 1973 to June 1977, during which time we used both types of grafts. Early angiographic studies were done in 285 (61%) of the 467 patients and late studies in 89 (19%) of them. The majority of patients declined the late study since they were asymptomatic.

Conclusions

The addition of a 10% to 12% rate of long-term graft patency offered by the use of internal mammary artery grafts is particularly warranted in muscular young individuals with stable hemodynamics. Indiscriminate use of the internal mammary artery may lead to disappointing results.