Arterial revascularization with the right gastroepiploic artery and internal mammary arteries in 300 patients

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Arterial revascularization with the right gastroepiploic artery and internal mammary arteries in 300 patients

From September 1989 to September 1992, the right gastroepiploic artery in combination with one or both internal mammary arteries was used as a graft in 300 patients who underwent coronary artery bypass grafting. The gastroepiploic artery was the primary choice in preference to the saphenous vein. The study comprised 263 men and 37 women, ranging in age from 31 to 77 years (median age 59 years). Thirty-nine patients (13%) underwent previous bypass procedures with autologous vein grafts. In 17 patients (5.7%) the gastroepiploic artery was used as a single graft. In 150 patients (50%) the gastroepiploic artery in conjunction with one internal mammary artery was used (in 6 patients combined with a vein graft). In 133 patients (44.3%) the gastroepiploic artery was used with both internal mammary arteries. Revascularization in nine patients (3%) was combined with another cardiac procedure; three aortic valve replacements, two mitral valve repairs, and four resections of a left ventricular aneurysm. Ten patients died in the hospital (3.3%; 70% confidence limits 2.3% to 4.8%); two of these patients had an infarction in the area revascularized by the gastroepiploic artery. At late follow-up, 0.5 to 39 months (mean 14 months) after the operation, we found no mortality. One patient with an occluded gastroepiploic artery graft underwent reoperation with the use of the right internal mammary artery. One patient underwent percutaneous transluminal coronary angioplasty of the right coronary artery after occlusion of the gastroepiploic artery. Elective recatheterization was done in 88 patients 1 to 25 months after operation (mean 10 months). Graft patency in gastroepiploic artery grafts increased steadily from 77% in the first semester of the study to 95% in the fourth semester and then equaled the patency of the internal mammary artery grafts (97%), which was almost constant during the whole period. We conclude that patency of the gastroepiploic artery was initially related to a "learning curve" but eventually equaled that of the internal mammary artery grafts. Furthermore, the gastroepiploic artery may well be the graft of choice in conjunction with the internal mammary arteries. (J THORAC CARDIOVASC SURG 1994;107:1309-16)

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Sponsored by John W. Kirklin, MD, *Birmingham, Ala.*

Long-term patency of internal mammary artery (IMA) grafts is superior to that of saphenous vein grafts and is leading to an increasing use of this arterial bypass conduit.[1-3] However, both IMAs are usually not enough for total arterial myocardial revascularization in three-vessel coronary artery disease. Several reports[4-8] have suggested the right gastroepiploic artery (GEA) to be a promising arterial bypass conduit as an adjunct to the IMAs because of its equal size, free flow, and length[9]; its comparable pharmacologic responses[10,11]; and its low susceptibility to atherosclerosis.[9,12,13] Therefore, our hypothesis was that the patency of the GEA graft would be analogous to that of the IMA grafts. To determine the patency of the grafts we performed elective angiography in a subgroup of patients.

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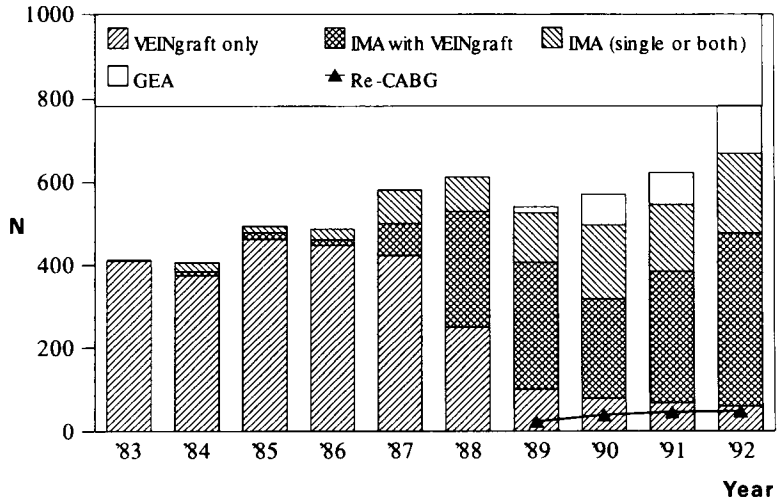


Fig. 1. Increase of arterial graft usage for primary coronary bypass operations. *VEINgraft only*, Anastomoses made with only saphenous vein grafts; *IMA with VEINgraft*, combination of IMA and saphenous vein graft; *IMA (single or both)*, operations with exclusively one or both IMAs; *GEA*, all primary bypass operations in which GEA was used; *Re-CABG*, number of repeat coronary bypass operations during that year (period 1989 to 1992).

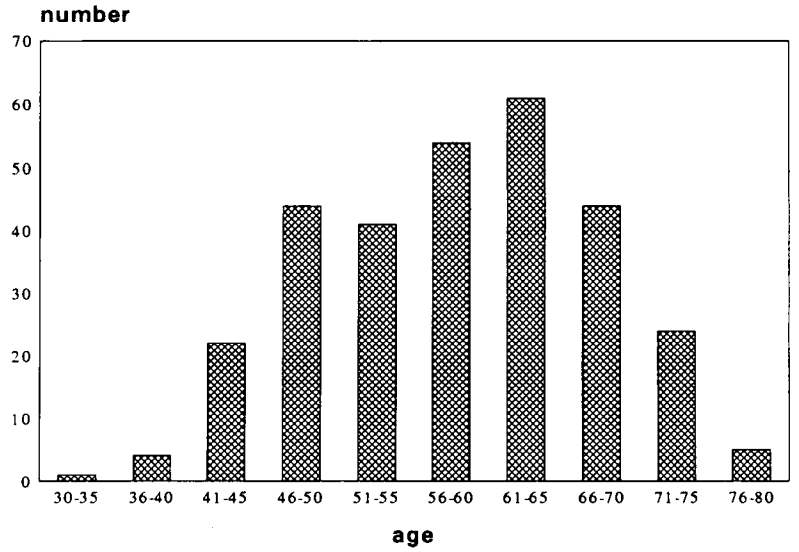


Fig. 2. Distribution of patients with GEA graft by age (in years).

Patients and methods

Patient population. During the past 10 years there was an increase in the use of arterial grafts and a strong decrease in the use of only vein grafts for myocardial revascularization at our institution. The number of reoperations was almost constant during the past 4 years (Fig. 1). Between September 1989 and September 1992, 300 patients underwent myocardial revascularization with the use of the GEA graft. The GEA graft was the primary choice in preference to an autologous saphenous vein graft. There were 263 men and 37 women with a median age of 59 years (range 31 to 77 years; Fig. 2). Preoperative patient characteristics are shown in Table I.

Chronic stable symptoms of angina were present in 194 patients (64.7%) and 106 patients (35.3%) had unstable symptoms. A previous myocardial infarction was present in 159 patients (53%) and 9 patients (6.3%) had more than one infarction. One previous coronary artery bypass grafting (CABG) operation with saphenous vein grafts had been done in 39 patients (13%), 2 patients had two previous CABG operations, and 1 patient had a previous aortic valve replacement operation. The GEA was used as a solitary bypass graft in 17 patients. The GEA in combination with one IMA (149 left IMA grafts, 1 right IMA graft, and 6 additional vein grafts) was used in 150 patients, and in 133 patients we used the GEA and both IMA

Table I. *Patient characteristics*

	No.	*%*
Hypercholesterolemia	156	52
Diabetes	23	7.7
Myocardial infarction	159	53
More than one infarction	9	6.3
PTCA	37	12
NYHA class		
II	20	7
III	174	58
IV	106	35
Reoperation	39	13

PTCA, Percutaneous transluminal coronary angioplasty; *NYHA*, New York Heart Association.

Table II. *GEA anastomoses*

Single grafts	*No.*	*Sequential grafts*	*No.*
LAD	4	RCA-Cx	11
Diagonal	1	RDP-RPL	12
Cx	18	RDP-RPL-LPL	1
RCA	54		
RDP	189		
RPL	10		

LAD, Left anterior descending; *Cx*, circumflex artery; *RCA*, right coronary artery; *RDP*, right posterior descending; *RPL*, right posterolateral; *LPL*, left posterolateral.

grafts. In 9 patients myocardial revascularization was combined with another cardiac procedure: 3 aortic valve replacements (1 aortic homograft), 2 mitral valve repairs, and 4 resections of a left ventricular aneurysm (1 combined with cryoablation for ventricular tachycardia).

A sequential arterial graft was used in 161 patients, a sequential IMA graft in 137 patients (46%), and a sequential GEA graft in 24 patients (8%). A free GEA graft was used in only 2 patients. Elective angiography was done in the 88 patients of the first 170 GEA operations who were willing to undergo this procedure and who gave written informed consent. Angiograms were done 1 to 25 months (mean 10 months) after operation.

Technique of the operation. The standard median sternotomy was extended 5 to 10 cm caudally. After one or both IMAs were harvested the peritoneal cavity was opened. The GEA was dissected with the use of two surgical clips (Hemoclip, medium, Edward Weck & Co., Inc., Research Triangle Park, N.C.) on each side branch to the stomach and omentum. The branches were divided by electrocoagulation. The GEA was dissected leftward to two thirds of the greater curvature of the stomach and proximally to the pylorus. After systemic heparinization the distal part of the GEA graft was divided and 0.5 ml of a solution of papaverine (0.1 mg/ml) was gently injected into the distal part of the graft. The routing of the GEA to the pericardial cavity was anterior to the pylorus and the left lobe of the liver. An incision in the diaphragm was made anterior to the inferior caval vein for routing the GEA to the pericardial cavity. The coronary anastomoses were made with running 8-0 polypropylene sutures. The pedicle was fixed to the epicardium by means of two sutures (6-0 polypropylene) to the epicardium to avoid kinking of the graft. The peritoneum was closed with a running resorbable suture without a drain.

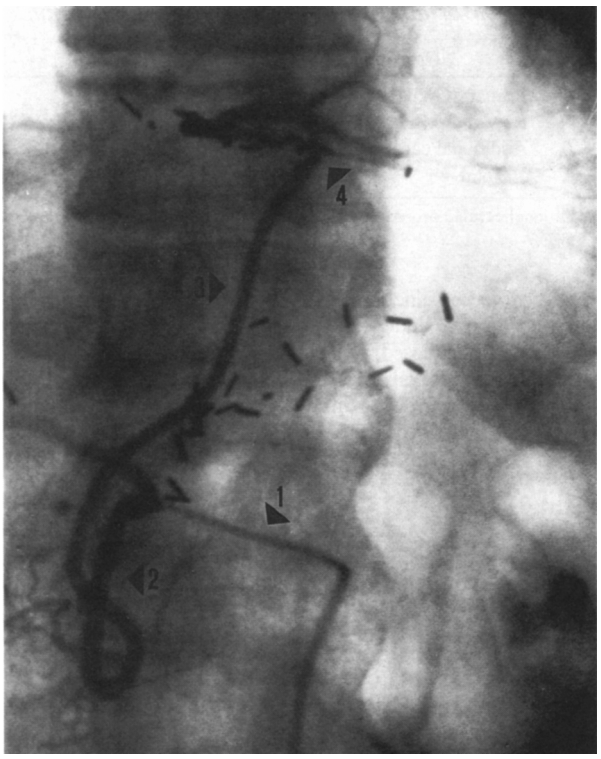


Fig. 3. Selective angiogram (posteroanterior view) of GEA. *1*, GEA catheter; *2*, gastroduodenal artery; *3*, GEA; *4*, anastomosis to right coronary artery.

A standard cardiopulmonary bypass procedure was done by a technique described elsewhere.[14] Postoperative anticoagulation treatment consisted of coumarin and dipyridamole 300 mg daily.

Technique of angiography. Elective follow-up angiography was done with the Judkins technique, by the femoral approach. Standard Judkins 7F left and right coronary artery catheters, as well as pigtail catheters, were used for the native coronary artery injections and the left ventricular angiogram. IMA catheters were used for selective angiography of the left and right IMA grafts.

A special technique was developed for angiography of the GEA graft. The celiac trunk was cannulated via a lateral projection, with either a 7F Simmons type 1 or type 2 catheter (C.R. Bard Ireland Ltd., Gallway, Ireland) or a special GEA catheter of our own design (built to specification by Cordis Europa NV, Roden, The Netherlands). With use of the posteroanterior view, a soft, steerable 0.035-inch guidewire (Terumo Corporation, Tokyo, Japan) was advanced into the common hepatic artery or subselectively into the gastroduodenal artery. The contrast catheters were advanced over these guidewires into the gastroduodenal artery or even into the origin of the GEA. This technique allowed for selective hand injections of contrast fluid and for excellent visualization of the GEA graft and its anastomoses, as well as of the native coronary artery distal to this anastomosis with multiple projections (Fig. 3). All angiograms

Table III. *Mortality by category of bypass operation*

Operation	*Total*	*No.*	*%*	*70% CL (%)*
Primary CABG	252	5	2.0	1.1-3.4
Repeat CABG	39	4	10	5-18
Additional cardiac procedure*	9	1	11	1-33
Total	300	10	3.3	2.3-4.8

*Additional cardiac procedure included aortic valve replacement in three patients; mitral valve repair in two; and left ventricular aneurysm resection in four.

were recorded on cinefilm at 12.5 to 25 frames per second and reviewed by two independent observers. Anastomoses were considered to be closed, unless proved patent.

Statistical analysis. Data were gathered in contingency tables. Logistic regression analysis was used to determine incremental risk factors for death and graft occlusion. A p value of 0.05 or less was considered to be significant.

Results

Between September 1989 and September 1992, 2025 primary CABG operations and 121 repeat CABG operations were done at our institution. In the primary CABG operations the GEA was used in 261 patients (13%) and in the repeat CABG operations the GEA was used in 39 patients (32%). The GEA was always long enough for grafting all coronary artery branches on the diaphragmatic aspect of the heart. A total of 894 anastomoses (561 IMA, 325 GEA, 8 vein) were made with the use of 716 arterial grafts and 6 vein grafts. A mean number of 2.4 grafts per patient and 3.0 anastomoses per patient were performed. One anastomosis was done with 276 GEA grafts, two anastomoses with 23 GEA grafts, and three anastomoses with 1 GEA graft, resulting in a mean of 1.1 anastomosis per GEA graft (Table II). The mean number of anastomoses of the IMA grafts was 1.3.

A total of 10 patients (3.3%) died, all in the hospital (Table III). The mortality rate was higher in the group of patients with reoperations (4 of 39 patients, 10%; CL* 5% to 18%) and in the group with combined operations (1 of 9 patients, 11%; CL 1% to 33%) than in the group with primary operations (5 of 252 patients, 2.0%; CL 1.1% to 3.4%). Mortality in the reoperation group was associated with an inferior infarction in two patients, which was the site where the GEA was used as a bypass graft. One patient died as a result of an embolizing thrombus from an old vein graft, and one patient had a rupture of an aneurysm of the abdominal aorta.

In the group of 252 primary CABG operations five patients died (2.0%; CL 1.1% to 3.4%). Three patients died of brain infarctions, one patient died of a myocardial infarction from an atheromatous aorta, and one patient died of an anterior infarction after the left anterior descending (LAD) branch was not found.

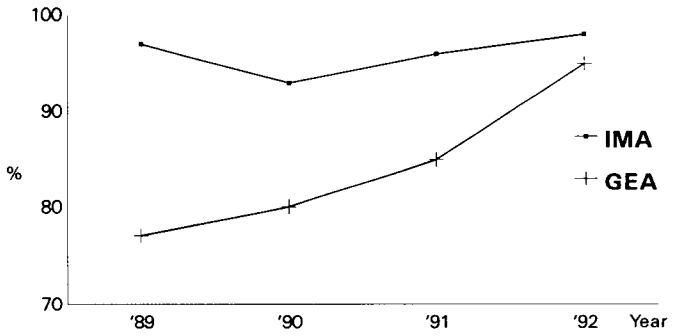
*Confidence limits.

In the nine patients who underwent a CABG operation combined with another cardiac procedure there were three aortic valve replacements, two mitral valve repairs, and four left ventricular aneurysm resections. One of these patients died (11%; CL 1% to 33%). In this patient, a 69-year-old man, we did a CABG operation with the left IMA to a diagonal branch and the LAD, the GEA graft to the posterior descending branch, and an aortic valve replacement with a homograft. One week after the operation there were signs of pneumonia and 2 days later signs of mediastinitis. The patient died of multiorgan failure after 45 days. At autopsy the grafts were patent. There was no late mortality.

Four patients underwent reoperation, twice because of graft occlusion of, respectively, the left IMA and the GEA graft, once because of a new stenosis in the LAD, and once because of mitral and tricuspid valve regurgitation after endocarditis (Table IV). A postoperative percutaneous transluminal coronary angiography (PTCA) procedure was done in three patients; one patient underwent a reoperation with a left IMA graft to the LAD and a GEA graft to the posterior descending branch. Eight months after the second operation there was a severe stenosis in the old venous jump graft to the circumflex artery treated by PTCA. A PTCA of the right coronary artery was done in a patient with an occluded GEA graft to this vessel. A PTCA of the circumflex artery was done in a patient with a sequential left IMA graft and a GEA graft to the right coronary artery, which was occluded. The circumflex branch had a new stenosis, whereas there was no longer any significant stenosis in the right coronary artery.

Mediastinitis was encountered in two patients, once in a patient who was operated on with the use of the three arterial grafts and once in the patient mentioned before, who was operated on for an aortic valve stenosis with a homograft and two arterial grafts. Gastrointestinal bleeding occurred only once and was treated conservatively. There were no late abdominal symptoms at follow-up.

Myocardial infarction was encountered in 10 patients



IMA	97	93	96	98	%
GEA	77	80	85	95	

Fig. 4. Patency as shown by angiography after 10 months (mean).

(3.3%) on the basis of clinical symptoms, electrocardiographic changes, and increased specific enzyme levels. Rethoracotomy for persistent bleeding was necessary in 24 patients (8%). In only two cases was this caused by bleeding from the pedicle of the GEA graft.

Angiography was done in 88 patients and the overall patency of the GEA anastomoses was 84.5%, whereas the patency of IMA anastomoses was 97%. One hundred three anastomoses were visualized of 88 GEA grafts. We found that the patency of the 103 GEA anastomoses of patients operated on in the first semester of the study was 77% ($n = 31$). However, the patency increased to 80% ($n = 21$) in patients operated on in the second semester, to 85% ($n = 27$) in patients of the third semester, and to 95% ($n = 24$) in patients of the fourth semester ($p = 0.037$). In contrast to the increasing patency rate of the GEA throughout the study period, we found a relatively constant patency rate in the IMA anastomoses of 93% to 98% (Fig. 4). Among the 88 angiograms, 112 IMA grafts (78 left IMAs; 34 right IMAs) and 154 IMA anastomoses were visualized.

The angiographic patency rates of IMA grafts and GEA grafts in relation to the grafted coronary vessels are shown in Table V. Both left and right IMA grafts had a very high patency rate of between 94% and 100% when anastomosed to the LAD or circumflex artery. The overall patency of the GEA graft was somewhat lower when the GEA was anastomosed to the right coronary artery (88%) and to the circumflex artery (74%).

Logistic regression analysis produced pump time and reoperation as incremental risk factors for death. Incremental risk factors for occlusion of at least one GEA anastomosis were pump time and female gender (Table VI).

Table IV. *Morbidity*

Symptoms	*No.*	*%*
Rethoracotomy	24	8
Infarction		
Total number	10	3.3
Anteroseptal	3	1.0
Anterolateral	2	0.7
Inferior	5	1.7
Gastrointestinal bleeding	1	0.3
Mediastinitis	2	0.7
Reoperation		
CABG	3	1.0
MVP/TVP	1	0.3
PTCA	3	1.0

MVP, Mitral valve plasty; *TVP*, tricuspid valve plasty.

Discussion

Long-term survival after CABG operation with the use of IMA grafts is better than that with the use of autologous saphenous vein grafts, in particular in the young patient.[2, 3] This is because of the low susceptibility for atherosclerosis and the superior patency of the IMA grafts. However, both IMA grafts are usually not enough for total arterial myocardial revascularization in three-vessel coronary artery disease.

Several authors have reported that the right GEA is a promising alternative bypass conduit for the saphenous vein.[4-8] Suma, Fukumoto, and Takeuchi[9] found that the in situ GEA has a suitable diameter for CABG and is long enough to reach coronary arteries on the inferior ventricular wall even distally. Anastomoses of the in situ GEA graft with the LAD and circumflex arteries were also made. O'Neil and associates[10] concluded from their study concerning the endothelial function of the GEA that the

Table V. *Patency rate according to grafted coronary artery*

	LAD	*Cx*	*RCA*
LIMA	98% (85)	100% (32)	
RIMA	100% (17)	94% (17)	100% (2)
GEA	100% (1)	74% (27)	88% (75)
F LIMA	100% (2)		
Vein		50% (2)	

Patency rate is distributed according to the coronary artery that was grafted. Number of studied anastomoses is given between parentheses. *LAD*, Left anterior descending; *Cx*, circumflex artery; *RCA*, right coronary artery; *LIMA*, left IMA; *RIMA*, right IMA; *F LIMA*, free left IMA; *Vein*, saphenous vein graft.

Table VI. *Logistic regression analysis*

	β	*SE*	*p Value*
Incremental risk factor for death			
Reoperation	1.5321	0.7047	0.0297
Total pump time	0.0179	0.0059	0.0026
Intercept	−5.6431	0.8295	0.0000
Incremental risk factor for GEA graft occlusion			
Female gender	0.8412	0.4642	0.0374
Total pump time	0.0172	0.0078	0.0276
Intercept	−2.5828	0.8883	0.0036

The following factors were part of regression analysis: sex, age, preoperative New York Heart Association classification, preoperative infarction, weight, year of operation, surgeon, aortic occlusion time, pump time, additional cardiac procedure, reoperation, mediastinitis, and atrial fibrillation. *β*, Risk factor coefficient; *SE*, standard error of mean; *p*, level of significance.

human GEA possesses the necessary properties to be a successful arterial bypass graft. Moreover, the GEA is pharmacologically comparable with the IMA and exhibits similar resistance against developing atherosclerosis. In a report from our institution dealing with endothelial responses of GEA and IMA to vasoactive substances, we found a resemblance of relaxations induced by methacholine and sodium nitrite in the GEA and IMA, suggesting a similar activation and behavior of the L-arginine pathway in both arteries.[11] This would indicate that the protective role of the endothelium, which contributes to the high patency rate of IMAs, is also applicable to GEAs. This prompted us to use the GEA as an alternative arterial conduit to create complete arterial revascularization in three-vessel coronary artery disease. Our hypothesis was that the patency rate of the GEA bypass conduit would be analogous to that of mammary arteries.

In this ongoing study we found that harvesting of the GEA was less tedious, easier, and of shorter duration than that of the IMA. In contrast to the experience of others[9] the dissection of the IMA and of the GEA is done in our institution by the same surgeon. However, we agree with Lytle and associates[6] that the use of the GEA increases the difficulty and complexity of the operation. Nevertheless, the use of the GEA has not led to a significant increase in our perioperative mortality for CABG operations. Overall, 10 patients (3.3%; 70% CL 2.3% to 4.8%) died in the hospital. This mortality was mainly because of a relatively high mortality rate in the reoperative cases (4 out of 39, 10%), which was also reflected in the incremental risk factors for death. Pump time reflecting the complexity of the operation was an incremental risk factor independent of reoperation. Only in two patients was mortality related to an inferior infarction, the area revascularized by the GEA; in the other patients mortality was related to anterior infarctions ($n = 2$), atheromatous aorta ($n = 1$), multiorgan failure ($n = 1$), rupture of an abdominal aorta aneurysm ($n = 1$), and brain infarction ($n = 3$). At late follow-up (0.5 to 39 months) we found no late mortality. In addition, use of the GEA did not lead to an increase in perioperative morbidity for CABG operations. Two of the 24 rethoracotomies for persistent bleeding were necessary because of bleeding of the gastroepiploic pedicle, located in the pericardial cavity.

Moreover, we encountered only one gastrointestinal bleeding episode, which could be treated conservatively. Mediastinitis, a severe complication after CABG operation, was encountered twice.

Angiograms of the GEA grafts were obtained at postoperative intervals ranging from 3 weeks to 25 months (mean 10 months). We found in patients operated on in the first semester of the study that the patency rate of the GEA (77%) was significantly lower than that of the IMA grafts. However, the patency rate of the GEA graft increased steadily to 95% in the fourth semester and virtually equaled that of the IMA (97%), indicating a "learning curve" ($p = 0.037$). This finding stresses the fact that some training by skilled surgeons is advisable. Additionally, pump time (operative complexity) and female gender were risk factors for occlusion. A specific cause for the higher occlusion rate in women is as yet unclear.

Encouraged by these results we use the GEA graft now as the first adjunct to the IMAs even in the elderly patient. Our oldest patient who received a GEA graft was 77 years old. An absolute contraindication to the use of the GEA as a graft is a previous gastric resection, whereas severe obesity, abdominal aortic operation, and previous cholecystectomy are relative contraindications. In patients with insulin-dependent diabetes the use of one IMA graft in combination with a GEA graft is probably preferable to the use of two IMA grafts, which is associated with a high risk of sternal infections.[7]

We conclude that graft failure of the GEA was initially related to a "learning curve" but eventually equaled that of the IMA grafts. Furthermore, the GEA may well be the graft of choice in conjunction with the IMAs.

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Discussion

Dr. George Cimochowski *(Wilkes-Barre, Pa.)*. Dr. Grandjean and his colleagues are to be complimented on an excellent experience that demands superb surgical judgment and technique in a large series of patients.

We have attempted at Wilkes-Barre General Hospital to do a similar thing over the past 2 years. Our experience is such that there were 907 isolated CABG operations done over 2 years. We used only veins in 2.5%. The majority of patients had either a single IMA or double IMA or a combination of artery and veins used for the grafts. In 22% of the patients we were able to use only arterial grafts, which represents 200 out of 907 patients. We attempted to do only arterial grafts in all patients less than 60 years of age, selectively from 60 to 75 years, and in patients older than 75 only when they had no other conduits.

We had pretty much the same experience as Dr. Grandjean and his group. Our patients had a mean age of 56.7 years. We did 2.82 arterial grafts per patient. Our mortality rate was 2% with a 0.5% rate of sternal wound infection. Our most common combination of conduits was bilateral IMAs and epigastric artery in about 40% of the patients.

We did mostly three-vessel grafts: three arterial grafts were done in about 40% of patients. Second most common was two-vessel grafting, and there was a smattering of other types of operations with sequential grafts.

The last point is that because we use the epigastric artery almost exclusively to the circumflex system, we attempted to put the right IMA in situ to the posterior descending coronary artery. Overall we reached the posterior descending coronary artery in about 60% of the patients, but in the past 6 months we were able to do this in 81%.

I have three questions for the authors. First, what was the percentage of arterial grafts you did over the past 3 years?

Second, do you have any results of physiologic testing, such as stress testing, to show that in fact ischemia has been relieved with this procedure?

Last, and this is a politically difficult question, in European literature and obviously in your group, arterial operation is used much more than on this continent. I wonder if you could comment as to why?

Dr. John B. Flege, Jr. *(Cincinnati, Ohio)*. In the continuing quest for other conduits for coronary artery bypass, particularly for patients who have had multiple previous operations, I turned to Sobatta's excellent illustrations. They show that the left gastric artery early in its course is adjacent to the diaphragm and only a few millimeters from the inferior surface of the heart. It would appear to be a satisfactory graft for coronary artery bypass.

A postoperative arteriogram shows the left gastric artery anastomosed to the posterior descending coronary artery. Its course is very short, and it lies out of harm's way in the event that the patient must have an upper abdominal operation.

I would like to ask the authors if any of their patients have had subsequent upper abdominal operations in which the GEA could be harmed.

Dr. Hisayoshi Suma *(Tokyo, Japan)*. When I looked at my initial 300 experiences with the GEA graft, the mean age of the patients was 59 years and the majority of patients had triple-vessel disease. The number of total distal anastomoses was 3.1 and the mean number of arterial graft anastomoses was 2.2 in combination with the IMA in 96% of the patients and the infe-

rior epigastric artery quite recently in 14 patients. There were seven early and four late deaths. A new Q wave was noted in five patients. On postoperative angiography, the patency of the GEA graft was 94% at both early and late (up to 5 years) restudy. I agree with your conclusion that the GEA is a useful conduit in CABG operations.

I have two questions. First, how did the authors handle the patent GEA graft at the time of reoperation? I had one case with this situation, with a patent GEA to the right coronary artery, and the target of the reoperation was the LAD. I approached this with a left thoracotomy very successfully.

Second, how many patients underwent abdominal operation after this kind of operation, and how did you handle this?

Dr. O. Jegaden *(Lyon, France).* I have used the GEA in 240 patients without a vein graft and without early mortality. Its use was associated with one IMA in 100 patients and with both IMAs in 140 patients.

In the first 100 patients, the graft patency rate was 96% for the GEA and 99% for the IMA. I think that this technique can be done as a normal procedure with a low mortality. In my experience this technique is actually done in 90% of patients.

However, we cannot forget that the objective of this technique is to improve long-term results in graft patency freedom from complications, and survival. I think that in some patients this technique may increase the operative risk as in patients older than 75 years and particularly in patients with severe left ventricular dysfunction and ejection fractions less than 30% percent, who need immediate and optimal flow in the graft.

My question is this: What are the limits of this technique and in which patients do you not perform this technique?

Dr. Frank C. Spencer *(New York, N.Y.).* I have one question. Your slides showed a very striking learning curve, inasmuch as the good results rose from 77% to higher than 90% over 3 years. Please tell us what you learned.

Dr. Grandjean. Dr. Cimochowski, over the past 3 years we operated on about 2000 primary CABG cases. We used the vein graft in 8% of the cases, a combination of one IMA graft and a vein graft in 55%, and in nearly 40% of the cases only arterial grafts including the GEA graft. We try to increase the use of arterial grafts in preference to the vein graft.

In nearly all the patients a stress test is done by their own cardiologist and there is a relief of ischemia in the inferior wall where a GEA graft is used, as there is a relief when the IMA grafts are used.

During our training we start with bypass operations in which the left IMA is anastomosed to the anterior wall of the heart. At the end of the training the surgeon is skilled in using IMAs and the next step is the use of other arterial grafts such as the GEA. We are rather liberal in the use of new and, we think, better operative techniques.

Dr. Flege, we have not used the left gastric artery yet, but it seems to be a promising arterial conduit. Your next question dealt with upper abdominal operations after a CABG operation in which the GEA was used. You are right when you say that this can cause some problems. All the patients who are operated on with the use of a GEA graft have to know that they have been operated on in the abdomen, and we give them a drawing with the position of the grafts. In this series of 300 patients we had one patient who underwent urgent laparotomy after rupture of an aneurysm of the abdominal aorta. We stayed "far" away from the GEA graft and its origin. Unfortunately this patient died of abdominal complications. For cholecystectomy a more lateral transverse incision is then preferable.

Dr. Suma, in this series four patients underwent reoperation. One patient with patent left IMA and GEA grafts underwent reoperation for mitral and tricuspid regurgitation after pancarditis. This operation was done with normothermic bypass and with a beating heart. There was one patient with an occluded GEA graft who underwent a reoperation with a free right IMA to the right posterior descending coronary artery. One patient who had a new stenosis in the LAD had an urgent reoperation with a vein graft to the LAD after an angioplasty procedure failed. The last patient had a occluded left IMA, and a right IMA was then anastomosed to the LAD. The GEA could easily be clamped during cardioplegic arrest.

In this series of 300 patients only one patient underwent an abdominal operation. This was the patient who was operated on for rupture of an aneurysm of the abdominal aorta.

Dr. Jegaden, as you mentioned, there will always be some contraindications for the use of so many arterial grafts. I give all my patients at least one arterial graft, even in patients with bad ventricular function. My opinion is that if you operate on these patients with vein grafts and after a few years this vein graft becomes occluded, there will be hardly a surgeon who will do a reoperation on these patients. My philosophy is to give the patients the best chance the first time, with arterial grafts.

Dr. Spencer, we did have a learning curve and in the beginning all the surgeons in our group tried to use the GEA for revascularization. After a while only two surgeons were subsequently using the GEA and they operated on 70% of the patients in this series. In the beginning anastomoses were made with the more distal part of the GEA and now we shorten the GEA until it is just long enough so that the diameters for the anastomoses are wider. We also used the GEA as a jump graft between branches of the right coronary artery and the circumflex artery, and at follow-up angiography many of the distal and thinner parts of the GEA were occluded. Now we use the GEA for the inferior part of the heart and the IMAs for the posterior and anterior parts of the heart.