Gender differences in quality of distal vessels: Effect on results of coronary artery bypass grafting

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929, 932, 936, and 959.

Objective: The quality of target vessels may affect gender differences in outcome after coronary artery bypass grafting. This prospective study compares preoperative angiographic assessment of vessel quality with intraoperative visual assessment of size and presence or absence of diffuse disease. The effect of vessel quality on operative mortality and late survival is examined.

Methods: Data were prospectively collected on 1939 consecutive patients undergoing isolated coronary artery bypass grafting by a single surgeon. Quality of target vessels was assessed preoperatively (angiogram) and intraoperatively by inspection and probe calibration.

Results: Vessels were poorly visualized in 29% of female patients and 37% of male patients ($P = .004$), although all but 1.6% of target vessels were grafted. Women were no more likely than men to have small vessels (<1.5 mm) (57% vs 59%, $P = .449$) and were less likely to have distal disease (45% vs 53%, $P = .005$). Operative mortality was low, not statistically different in women versus men (1.3% vs 0.7%, $P = .237$), and increased in patients with distal disease (1.3% vs .03%, $P = .021$). Late survival was decreased in patients with poor left ventricle function, congestive heart failure, and peripheral vascular disease. Late survival was decreased in men with increased age, class IV symptoms, small size, and no left internal thoracic artery graft, and in women with recent myocardial infarction and preoperative cerebrovascular accident.

Conclusion: We conclude that in most patients with poorly visualized vessels in the preoperative angiogram, complete revascularization can be achieved if one is willing to graft small or diffusely diseased vessels. Women are no more likely than men to have vessels less than 1.5 mm in size and are less likely to have diffuse disease. Such an approach is associated with a low operative mortality and good long-term survival. Predictors of late survival were different for men and women. Neither small vessel size nor diffuse disease was an independent predictors of poor late outcome.

With recent improvements in medical therapy and angioplasty, more patients referred for bypass grafting have less than ideal distal vessels. Complete revascularization in these patients can be technically challenging, and in some centers the introduction of off-pump surgery has altered philosophy with regard to the importance of complete revascularization and the merits of grafting vessels of marginal quality.

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Studies have suggested that the size and quality of grafted vessels are important in determining operative risk, graft patency, and long-term results.¹⁻⁶ Gender differences in outcome have been attributed to small vessel size in female patients,^{3,4} yet few studies have included the size and quality of vessels in analyses of results.^{1,5} Angiographic assessment of arteries is to some extent subjective,^{6,7} and few reports have evaluated vessel size and quality as assessed at surgery.⁶ Which vessels are grafted depends on the prior experience of each surgeon. As long as morbidity and mortality are low, the tendency over time is, we believe, to attempt to graft vessels of more marginal quality.

We undertook this prospective study to examine the effect of vessel quality on the results achieved. Our objectives were to (1) report temporal trends in the quality of distal vessels in patients accepted for coronary artery bypass grafting (CABG), (2) compare angiographic appearance with intraoperative assessment of vessel quality, (3) examine gender differences in the distribution of small vessels and diffuse disease, (4) identify predictors of poor short- and long-term outcome, and (5) examine the effect of poor vessel quality on results.

Material and Methods

Between 1985 and 1997, data were prospectively collected on 1939 consecutive patients undergoing primary isolated CABG by 1 surgeon (L.M.) at the Toronto General Hospital. A trained chart reviewer used a standard data collection form to review hospital records.

Clinical Presentation

The preoperative clinical variables evaluated included sex, age, history, timing of prior myocardial infarction (MI), anginal pattern, diabetes, height, weight, body surface area (BSA), obesity (body mass index > 27), smoking status, hypertension, hyperlipidemia, family history of coronary disease, prior stroke, peripheral vascular disease, congestive heart failure, renal failure, timing of operation, mitral regurgitation, and preoperative use of an intra-aortic balloon pump (IABP).

Catheterization Data

Cardiac catheterization was performed to assess ventricular function and extent of coronary disease. Left ventricular (LV) ejection fraction (EF) was estimated by a single-plane ventriculogram and graded on a scale of 1 to 4 (1, >60%; 2, 40%-60%; 3, 20%-40%; and 4, <20%). Coronary narrowing of 50% or greater was considered significant. All angiograms were reviewed by a single observer (L.M.). If a vessel beyond the target lesion was not seen or appeared very small (≤ 1 mm) with or without evidence of diffuse disease, it was designated as poorly visualized. Factors determined from the catheterization included number of diseased vessels, LV grade, EF, and apparent quality of target vessels.

Operative Technique

Fentanyl citrate was used for the induction and maintenance of anesthesia. Myocardial protection was achieved with cold blood

cardioplegia. Myocardial temperatures were used to guide delivery of cardioplegic solution as previously described.⁸

Conduit choice included a left internal thoracic artery (LITA) for the left anterior descending artery (LAD); vein was used for all other grafts. Reasons for not using a LITA included poor quality of sternal bone, inadequate LITA flow, hemodynamic instability, and renal insufficiency. Veins were harvested by standard techniques and dilated with a dilute papaverine solution to avoid overdistention. The only change in operative technique during the course of the study was to switch from 6-0 Prolene to 7-0 Prolene sutures (Ethicon, Inc, Somerville, NJ) for the distal anastomoses.

The size and quality of target vessels were assessed intraoperatively. For each area of potentially ischemic myocardium (anterior, lateral, or inferior with coronary narrowing > 50%), we attempted to graft at least 1 vessel even if the vessel was only 1 mm in size or diffusely diseased. We did not, however, attempt multiple grafts to small or diffusely diseased side branches. Luminal diameter at each anastomosis was assessed with graduated probes (≥ 1.5 mm or <1.5 mm in size). Vessels were classified as normal or diffusely diseased (plaque at the anastomosis or palpable distal disease). When an opened artery was found to be so diseased that a suitable anastomosis could not otherwise be performed, an endarterectomy was performed.

Information from the operating room (OR) note included use of LITA, number of grafts, distal vessel quality, endarterectomy, vessels less than 1.5 mm, pump time, and cross-clamp time.

The completeness of revascularization was assessed by comparing the angiogram (number of diseased vessels) with the grafts performed. To allow for variation in arterial anatomy, the myocardium was divided into 3 areas: anterior, lateral, and inferior. If a graft was performed to a branch of a diseased circumflex or right coronary artery in the lateral or inferior distribution, this area was considered revascularized. In the anterior distribution, a graft had to be performed to the diseased LAD (not a diagonal branch) for revascularization to be complete. Patients with at least 1 graft in each diseased area were considered completely revascularized.

Postoperative Care and Outcome

Patients received intravenous nitroglycerin for 24 hours and then received a calcium channel blocking agent (Adalat XL; Thomson Micromedex, Greenwood Village, Colo) for 1 month unless hypotension precluded use of the drug. All patients were started on lipid-lowering medications before discharge.

Operative mortality was defined as death within 30 days or during hospital stay. Definitions for perioperative infarction, postoperative stroke, and sternal wound infection have been previously described.⁸ Follow-up was completed in 97.6% of cases in 1998 by telephone contact with the patient or referring physician.

Statistical Analysis

SAS 8.1 for Windows (SAS Institute Inc, Cary, NC) and SPSS 9.0 for Windows (SPSS Inc, Chicago, Ill) were used for statistical analyses. Continuous variables are reported as mean $\pm$ SD in the tables and text and as mean $\pm$ SEM in the figures.

Comparisons between groups were performed by unpaired *t* tests for continuous variables and the χ^2 test or the Fisher exact test

TABLE 1. Patient population

	Men N = 1474	Women N = 465	P value
Age (y)	60 ± 9	63 ± 9	<.001
Height (cm)	172 ± 7	159 ± 7	<.001
Weight (kg)	82 ± 13	70 ± 13	<.001
BSA (m ²)	2.0 ± .2	1.7 ± .2	<.001
Obesity BMI >27%	751 (51%)	251 (54%)	.262
Risk factors			
Diabetes	309 (21%)	116 (25%)	.067
Hypertension	663 (45%)	251 (54%)	.001
Hyperlipidemia	693 (47%)	218 (47%)	.829
Current smoker	722 (49%)	163 (35%)	<.001
Prior stroke or TIA	69 (5%)	35 (8%)	.024
Family history	914 (62%)	330 (71%)	.001
PVD	206 (14%)	79 (17%)	.114
Clinical presentation			
Prior MI	884 (60%)	274 (59%)	.623
MI within 30 d	162 (11%)	61 (13%)	.212
Canadian Cardiovascular Society angina class			
1	118 (8%)	14 (3%)	<.001
2	295 (20%)	51 (11%)	
3	498 (27%)	140 (30%)	
4	663 (45%)	265 (57%)	<.001
Urgent OR	442 (30%)	163 (35%)	.051
MR	162 (9%)	74 (14%)	.007
Preop IABP	44 (3%)	19 (4%)	.289
CHF	132 (9%)	41 (9%)	.922
Renal failure	59 (4%)	15 (3%)	.491

BSA, Body surface area; BMI, body mass index; TIA, transient ischemic attack; PVD, peripheral vascular disease; MI, myocardial infarction; OR, operation; MR, mitral regurgitation; IABP, intra-aortic balloon pump; CHF, congestive heart failure.

(when appropriate) for categorical variables. Late survival was estimated by the nonparametric Kaplan-Meier method.

Logistic regression with backward elimination was used to identify the multivariable, independent predictors of operative mortality.

All important candidate variables were entered into Cox regression analyses to determine the independent multivariable predictors of late survival. Variables included age (5-year increments), BSA, surgical priority, class IV symptoms, preoperative stroke, diabetes, peripheral vascular disease, congestive heart failure, hypertension, MI within 1 month of surgery, LV grade, mitral regurgitation, left main stenosis, poorly visualized vessels, use of LITA, small vessel size, endarterectomy, diffuse disease, and incomplete revascularization. The appropriateness of variable transformations was determined by univariate analysis. Criterion for retention of variables in the model was set at $P = .05$. The adjusted risk ratios for the sex-specific independent predictors and their 95% confidence intervals (CIs) are presented in the tables.

The Cox models were validated by bootstrap methods; 100 random data sets containing $N = 10\%$ observations each were drawn from the original data set for men and women. The Cox models were rerun in each data set. The frequency with which the variable remained in the models was considered an indicator of its importance as an independent predictor of outcome. A variable was rejected as important if it did not occur in at least 50% of the models. In addition, the risk ratios were averaged across the 100 models to indicate the validity of the magnitude of the association.

Results

Patient Population

The clinical data are shown in Table 1. There were 465 women (24%) and 1474 men (76%). Women were older, smaller, and more likely to have associated hypertension, prior stroke, and a family history for coronary disease. More men were smokers. Women were more symptomatic, had more mitral insufficiency, and more often required urgent surgery.

Angiographic criteria are listed in Table 2. Men had poorer LV function and more extensive coronary disease and were more likely to have poorly visualized distal vessels in the preoperative angiogram.

Temporal Trends in Extent of Coronary Disease

During this study, there were significant increases in the percentage of patients with small distal vessels, questionably graftable distal vessels, left main or triple vessel disease, and requiring endarterectomy (Figure 1). At the same time, the percentage of patients receiving incomplete revascularization significantly decreased.

Gender Difference in Grafting

At surgery, women had fewer grafts and were less likely to have a LITA (Table 3). Men were more likely to have

TABLE 2. Angiographic data

	Men	Women	P value
Diseased vessels			
1	64 (4%)	38 (8%)	
2	284 (19%)	111 (24%)	
3	907 (62%)	255 (55%)	
Left main	219 (15%)	61 (13%)	<.001
LVEF			
>60%	427 (29%)	117 (38%)	
40%-60%	575 (39%)	186 (40%)	
20%-40%	368 (25%)	88 (19%)	
<20%	117 (8%)	14 (3%)	<.001
Average EF (%)	46 ± 15	50 ± 13	<.001
Poorly visualized vessels	545 (37%)	135 (29%)	.004

LVEF, Left ventricular ejection fraction.

diffuse disease and require endarterectomy. Despite smaller body size, women were no more likely than men to have a grafted vessel less than 1.5 mm in size. Most vessels that were poorly visualized in the preoperative angiogram were successfully grafted (Table 4). Complete revascularization was achieved in all but 31 patients, and there was no difference between men and women with respect to completeness of revascularization (Table 3).

Operative Results

Operative mortality was 1.3% for women versus 0.7% for men ($P = .237$) (Table 3). More women required inotropic drugs than men, but the prevalence of perioperative MI and need for IABP were similar in the 2 groups. The prevalence of a perioperative central nervous system event was higher in women, but the difference did not reach statistical significance. The prevalence of reoperation for bleeding was similar in the 2 groups (Table 3).

Predictors of Operating Room Mortality

There were only 15 early deaths. Death in 8 patients was caused by perioperative MI often related to technical difficulties with poor quality distal vessels (4 endarterectomies). Death was caused by intractable congestive heart failure (present preoperatively) in 3 patients, stroke in 2 patients, aspiration pneumonia in 1 patient, renal failure in 1 patient, and respiratory failure in 1 patient. Univariate predictors of early death included increased age, decreased EF (<20%), class IV symptoms, congestive heart failure, preoperative IABP, urgent surgery, poorly visualized distal vessels, and diffuse disease with or without endarterectomy. The use of a LITA was protective for preventing early death. By multivariable logistic regression analysis, predictors of operative mortality were decreased EF (odds ratio [OR] 10.7, 95% CI 3.6-31.4, $P < .001$), failure to use a LITA (OR 0.2, 95% CI 0.1-0.5, $P < .001$), and diffuse disease with or without endarterectomy (OR 4.7, 95% CI 1.3-17.3, $P = .018$).

Long-Term Results

Actuarial survival was similar for men and women (Figure 2). During follow-up, more women reported anginal recurrence (24% vs 15%, $P = .004$), but the rate of repeat revascularization (angioplasty or redo aorta-coronary bypass) in women and men was similar (3.3% vs 2.8%, $P = .735$).

Kaplan-Meier univariate predictors of late mortality are listed in Table 5. The Cox regression predictors of late mortality in men and women are listed in Table 6.

Discussion

Trends Over Time

The current authors and other investigators have previously reported trends in patients undergoing CABG, including increased advanced age, diabetes, urgent presentation, and a decrease in EF.⁸⁻¹⁰ At the same time, OR mortality has remained the same or decreased.⁸ Improved results have been attributed to increased surgical expertise or improvements in myocardial protection.

In this study, there was also an increase over time in class IV angina (14.5%-29.2%, $P < .001$), congestive heart failure (4.2%-14.8%, $P < .001$), prior MI (3.4%-16.4%, $P = .001$), and triple vessel or left main disease (65.9%-80.1%, $P < .001$). There was an increase in poorly visualized distal vessels, small distal vessels, and vessels requiring endarterectomy for grafting. Nevertheless, the proportion of patients with incomplete revascularization decreased with time (Figure 1). These trends with increased poor vessel quality may result in part from selection of patients with good vessels for angioplasty or stent procedures.

The results of CABG depend on many factors, including graft patency, which in turn depends on the type of conduit used, conduit flow, and size and quality of distal vessels.^{6,11-14} In our practice, more patients are accepted for CABG who have less than ideal vessels. In reviewing the literature, we could find no recent study in which the size and quality of distal vessel were documented intraopera-

Figure 1. Changes over time in extent of disease and vessel quality as well as completeness of revascularization. Statistical significance by Mantel-Haenszel χ^2 test. LMS, Left main stem; TVD, triple vessel disease; ns, not significant.

tively and the impact of vessel quality on outcome was assessed.

Angiographic Poor Visualization

Assessment of vessel quality based on angiography is to some extent subjective, but a recent study by Graham and coworkers² showed that intraobserver reliability is high ($r = 0.83$). In our study, all angiograms were reviewed by a single observer, and vessel quality was determined using the

criteria of size and lumen irregularity.^{1,2,7,13} By comparing angiographic and intraoperative assessment, we found that many vessels poorly seen in the angiogram were actually of good quality and eminently graftable. In this series, all but 12 of 759 (1.6%) poorly visualized vessels were grafted.

Other investigators^{2,7} have reported increased operative mortality and decreased graft patency in patients with poorly visualized vessels.¹³ In our study, poor visualization was a univariate predictor of operative mortality and late

death, but it was not an independent predictor in multivariable analysis for either of these outcomes.

Poor visualization of distal vessels is probably related to the overall extent of coronary disease and poor collateral flow. In this series, patients with poorly visualized vessels typically were male (80% vs 74%, $P = .040$); had triple vessel disease (82% vs 68%, $P < .001$), a history of MI (70% vs 54%, $P < .001$), and poor LV function ($EF < 20\%$) (10% vs 5%, $P < .001$); and required endarterectomy (18% vs 8%, $P < .001$). Similar relationships have been reported.^{1,2,7} In some series, patients with poorly visualized vessels more often had diabetes,^{1,2} but in our series this difference did not reach statistical significance (24% vs 20%, $P = .099$). On the basis of our results, we will continue to be aggressive with revascularization in patients with poorly visualized vessels.

Use of LITA

In this series, 81% of men and 63% of women received a LITA graft to the LAD. Patients not receiving a LITA typically were smaller ($BSA < 1.8 \text{ m}^2$, 41.5% vs 24%, $P < .001$) and female (37.6% vs 19.7%, $P < .001$), and had a higher incidence of renal failure (6.9% vs 3% $P < .001$). They more often had class IV symptoms (28.7% vs 21.8%, $P = .017$) and an MI within 30 days (18.5% vs 9.4%, $P < .001$), and required urgent surgery (40.6% vs 28.4%, $P < .001$). Others have identified similar factors associated with decreased LITA use.¹⁵

Small Vessel Size

In other series, poor results in women^{3,4} have been attributed to technical difficulties related to small vessel size.^{3,4,11,12} In general, vessels 1.5 mm or greater do not present a technical challenge and have been associated with good long-term patency.¹⁵ Therefore, rather than looking at average size, we examined the distribution of patients with vessels less than 1.5 mm in size. There was no difference in the percentage of women versus men with small vessels, and hospital or long-term survival was not influenced by small vessels. Corbino and colleagues¹ reported increased OR mortality in patients with a small LAD, but vessels less than 1.5 mm were generally not grafted in that series. Although we do not have angiographic follow-up, we believe that our results support our decision to graft 1-mm vessels.

Diffuse Disease

What effect does diffuse disease have on operative mortality and long-term survival? There were only 15 early deaths in this series. Nevertheless, diffuse disease was a predictor of increased operative mortality. Not surprisingly, patients who had a perioperative MI were at increased risk (8.6% vs 0.6%, $P < .001$). As previously reported,¹⁶ OR mortality

TABLE 3. Intraoperative data and results

	Men	Women	<i>P</i> value
Pump time (min)	104 ± 27	96 ± 29	.960
Crossclamp time (min)	61 ± 18	54 ± 18	.776
Mean no. of vessels grafted	3.5 ± 0.8	3.1 ± .9	<.001
No. ACB			
1	29 (2%)	19 (4%)	
2	147 (10%)	79 (17%)	
3	1002 (34%)	200 (43%)	
4	693 (47%)	158 (34%)	
5+	103 (7%)	9 (2%)	<.001
LITA or RITA	1194 (81%)	293 (63%)	<.001
Endarterectomy	177 (12%)	37 (8%)	.011
Vessel <1.5	870 (59%)	265 (57%)	.449
Nongrafted vessel	21 (1.4%)	10 (2.2%)	.279
Diffuse disease	781 (53%)	209 (45%)	.005
Small distal distribution	368 (25%)	139 (30%)	.091
IABP	59 (4%)	23 (5%)	.164
Inotropis agents	88 (6%)	56 (12%)	<.001
OR mortality	10 (0.7%)	6 (1.3%)	.237
Periop MI	44 (3%)	18 (4%)	.119
Reop for bleeding	29 (2%)	9 (2%)	.838
Postop stroke	29 (2%)	16 (3.4%)	.077
Days in ICU	2.9 ± 2.3	3.1 ± 2.6	.126
Sternal infection	27 (1.8%)	5 (1.1%)	.305

ACB, Aorta-coronary bypass graft; LITA, left internal thoracic artery; RIMA, right internal mammary artery; ICU, intensive care unit.

TABLE 4. Fate of poorly visualized vessels in angiogram

LAD N = 250	2 nongrafted 234 grafted
OM N = 101	14 grafted with endarterectomy 6 nongrafted 93 grafted
Right N = 408	2 grafted with endarterectomy 4 nongrafted 320 grafted 84 grafted with endarterectomy

LAD, Left anterior descending; OM, obtuse marginal.

was increased in patients requiring endarterectomy, but this difference did not reach statistical significance ($P = .079$). We were surprised to find that diffusely diseased vessels and the need for endarterectomy were not independent predictors of poor late survival.

Predictors of Poor Long-Term Outcome

In the present study, 10-year survival was not different between men and women (Figure 2) and can be compared with results from other series in which 10-year survival ranges from 72% to 82%.¹⁶⁻²¹ The incidence of recurrent angina was higher in women (22% vs 15%, $P = .004$) and can be compared with the anginal recurrence of 18% at 10 years reported by Dion and colleagues.²² Repeat revascularization in men and women was similar in our series (2.8%

Figure 2. Actuarial survival curves for men and women. Numbers at the bottom indicate patients available for analysis at the time of follow-up.

TABLE 5. Factors related to late survival by univariate analysis

	Survival of men at			Survival of women at		
	5 y	10 y	P value	5 y	10 y	P value
Age						
<60	96	83	<.001	93	87	.053
>60	89	70		91	74	
Left ventricular ejection fraction						
>60%	97	87	<.001	94	83	.028
20%-60%	92	74		91	78	
<20%	75	54		85	38	
CHF	78	37	<.001	79	69	.135
None	94	81		93	79	
PVD	82	52	<.001	78	54	<.001
None	94	80		95	84	
Diabetes	89	58	<.001	87	64	.009
None	93	80		93	83	
Stroke/TIA	84	49	.001	72	54	.001
None	93	78		94	82	
MI 30 days preop	88	66	.178	83	62	.013
BSA						
<1.8 m ²	90	67	.008	92	80	.862
>1.8 m ²	93	79		91	75	
LITA	94	79	<.001	93	83	.039
None	85	64		90	70	
Ischemic MR	81	66	<.001	89	78	.232
None	93	77		93	78	
Timing						
Elective	94	79	.001	92	79	.232
Urgent	88	65		91	77	
Poorly visualized	91	73	.004	89	78	.403
Well visualized	93	78		93	79	
Left main stenosis	92	78	.330	90	72	.092
None	93	76		92	80	

MR, Mitral regurgitation.

vs 3.3%, $P = .735$) and can be compared with 3.1% from the Dion report.²²

In men and women, major predictors of poor long-term outcome were poor LV function ($EF < 20\%$), congestive heart failure, and peripheral vascular disease. Other predictors of poor late survival in men included advanced age, class IV symptoms, and small body size ($BSA < 1.8 \text{ m}^2$). Use of a LITA had a protective effect. In women, other predictors of poor late survival were recent MI and preoperative stroke. Others have reported similar predictors of poor long-term outcome including poor LV function, peripheral vascular disease, congestive heart failure, age, diabetes, and lack of a LITA.^{19-21,23}

In our study, none of the markers of poor quality distal vessels, that is, small size, diffuse disease, or need for endarterectomy, were independent predictors of poor long-term outcome.

Gender Differences

It is well documented that women presenting for CABG differ from men.⁸ In our series, women were smaller and older; had more hypertension and more severe angina; and required more urgent surgery. Conversely, they were less likely to smoke, had less extensive coronary disease, and had better preservation of LV function. Women were more likely to have diabetes, but this trend did not reach statistical significance. Women tended to receive fewer grafts and fewer LITAs. These differences agree with those reported in other series.^{3,4,7,8,24-26}

Although smaller than men, women were no more likely than men to have vessels less than 1.5 mm in size and were less likely to have distal disease.

Effect of Body Size on Results

There is a complex relationship between gender, body size, and size of distal vessels. In this series, small patients (BSA < 1.8 m²) include 16% of men and 66% of women ($P < .001$). Unlike previous reports that showed increased operative mortality in small patients,^{13,24,26,27} there was no significant increase in OR mortality for this group (1.1% vs 0.7%, $P = .387$). Small patients were, however, at increased risk for perioperative MI (4.4% vs 2.5%, $P = .037$), use of IABP (5.7% vs 3%, $P = .008$), and use of inotropic drugs (11.4% vs 6.2%, $P < .001$). Long-term survival was comparable for large and small patients (74% vs 78%, $P = .101$). By multivariable analysis, however, small body size was a predictor of poor late outcome in men.

Study Limitations

This study reports a single surgeon's experience, and the observations may not be generalizable. The percentage of women (24%) and other characteristics in this population are in keeping with the percentages reported in the Society of Thoracic Surgeons database.²⁶ Although we are confident that no selection bias against women with small vessels existed at the time of surgical assessment, it is possible that women with poor distal vessels were selected out before surgical referral.

Our use of the LITA compares with that reported in the Society of Thoracic Surgeons database²⁶ but is less than that in many contemporary series.

There were few operative deaths, and it is highly likely that multivariable analysis failed to detect important predictors of OR mortality. We do not have angiographic follow-up to document graft patency. However, survival and freedom from the need for repeat revascularization are important easily defined end points. We believe the long-term results support our aggressive approach to grafting small vessels using standard cardiopulmonary bypass techniques to achieve complete revascularization in most patients.

Conclusion

We conclude the following: (1) The quality of distal vessels in patients accepted for bypass grafting is steadily decreasing (increase in poorly visualized distal vessels, small vessels, and vessels requiring endarterectomy). (2) The quality of target vessels for grafting cannot be reliably assessed by preoperative angiography. Even in patients with poorly visualized vessels, complete revascularization can be achieved in all but a few cases. (3) Women tend to have less diffuse disease and are no more likely than men to have small vessels (<1.5 mm). (4) Operative mortality is low but increased in patients with diffuse disease. Operative mortality in women is not statistically different from that in men. (5) Predictors of decreased long-term survival include

TABLE 6. Cox regression predictors of late survival for men and women

Men				
Variable	RR (95% CI)	P	%	Bootstrap validation
				Average RR
Age/5 yr	1.13 (1.0-1.2)	.006	100	1.14
BSA M ²	0.16 (0.03-0.97)	.047	79	0.12
Class 4	1.35 (1.0-1.8)	.046	39	1.41
LV 2 or 3	2.31 (1.5-3.5)	<.001	100	2.32
LV 4	6.63 (3.8-11.4)	<.001	100	6.62
PVD	1.92 (1.4-2.7)	<.001	100	1.94
CHF	2.63 (1.8-3.9)	<.001	100	2.66
LITA	0.69 (0.5-0.96)	.03	65	0.66
Women				
Variable	RR (95% CI)	P	%	Bootstrap validation
				Average RR
Preop CVA	2.15 (1.0-4.5)	.039	49	2.31
LV 4	3.22 (1.3-7.8)	.01	97	4.53
PVD	2.78 (1.5-5.0)	<.001		
CHF	2.94 (1.3-6.6)	.009	49	3.00
MI <1 mo preop	3.14 (1.6-6.0)	<.001	100	2.94
Diabetes	NS		55	2.02
Left main stenosis	NS		21	2.05
LITA	NS		34	0.53

RR, Cox-regression risk ratio; CI, confidence interval; NS, not significant; LV, left ventricle; CVA, cerebrovascular accident.

poor LV function, congestive heart failure, and peripheral vascular disease. In men, additional predictors include advanced age, class IV symptoms, small body size, and lack of a LITA graft, whereas in women, recent MI and history of a stroke were associated with poor late outcome. (6) The quality of distal vessels was not an independent predictor of poor long-term outcome. More studies are needed to address the influence of the quality of distal vessels and completeness of revascularization on the results of CABG in both men and women.

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