Composite arterial grafts versus conventional grafting for coronary artery bypass grafting

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Objectives: Composite arterial grafts for coronary artery bypass grafting surgery allow complete arterial revascularization but are limited by the inflow of a single internal thoracic artery supplying all the grafted vessels. We reviewed the safety of composite arterial grafts using either bilateral internal thoracic arteries or a single internal thoracic artery and radial artery.

Methods: From January 1999 to July 2002, 402 consecutive patients receiving composite grafts only were compared to a control group of patients ($n = 542$) undergoing coronary artery bypass grafting with internal thoracic artery and saphenous veins operated upon by the same surgeons. Two different statistical approaches were used to compare groups in this retrospective analysis. First, propensity score analysis with greedy matching technique was used to match patients from each group. Second, a multivariate analysis was performed looking at a combined patient outcome of death, intra-aortic balloon counterpulsation utilization, myocardial infarction, stroke, and prolonged ventilation on all patients in both groups.

Results: After matching by propensity score, the major clinical outcomes in composite arterial ($n = 249$) and control ($n = 249$) groups were found to be similar. The in-hospital mortality in the composite group was 1.2% as compared with 0.4% in matched patients ($P = .62$). However, patients in the composite group were found to have a significantly longer pump time ($P < .0001$), longer clamp time ($P < .0001$), increased incidence of prolonged mechanical ventilation (12.8% vs 4.8%; $P = .002$), and higher incidence of combined morbidity outcome (13.6% vs 6.4%; $P = .007$) as compared with matched patients. Multivariable analysis showed that composite arterial grafting was an independent predictor of the combined morbidity outcome with an odds ratio of 2.1 (1.2-3.7).

Conclusions: These findings suggest that composite arterial grafting may be associated with an increase in risk-adjusted patient morbidity when compared with a conventional coronary artery bypass grafting group, although a mortality difference was not demonstrable.

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Received for publication Jan 21, 2003; revisions received June 14, 2003; accepted for publication June 23, 2003.

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J Thorac Cardiovasc Surg 2004;127:160-6
0022-5223/\$30.00

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doi:10.1016/j.jtcvs.2003.06.016

Coronary artery bypass grafting (CABG) is a well-established therapy for patients with multivessel coronary artery disease, with excellent short- and medium-term results.¹ There are concerns, however, about long-term results of vein grafts utilized for CABG. Fitzgibbon and colleagues² in a prospective study of 1388 patients (many of whom underwent angiography early, at 1 year, 5 years, and up to 22.5 years after operation) have reported long-term vein graft patencies of 50%. Graft occlusion can result in return of disabling angina, the need for rehospitalization, reintervention, and death.³ In contrast, it is well established that patency rates for left internal thoracic artery (ITA) grafts to the left anterior descending

artery are excellent compared with saphenous vein grafts (SVGs), with patency rates at 10 years of 90%.³ Utilization of left ITA grafts has also been demonstrated to confer a survival benefit to patients having CABG.⁴

Because of the excellent results with left ITA grafts it has been hypothesized that exclusive arterial revascularization without SVGs would result in improved long-term results following CABG.⁴⁻⁶ In support of this, there are numerous published series of patients undergoing CABG with complete arterial revascularization using a variety of arterial conduits (eg, radial artery, left ITA, right ITA, gastroepiploic) demonstrating feasibility and safety.⁷⁻¹¹ This is particularly true after recent renewed interest in and demonstration of safety with radial artery conduits.⁹⁻¹²

To facilitate exclusive arterial revascularization, composite arterial grafting creating a Y or T graft from a pedicled ITA (left or right) has been proposed.⁷⁻¹¹ Although the safety of this approach is supported by single-center case series with excellent survival, a direct comparison with conventional ITA and SVG cases has yet to be made. The objective of the present study was to evaluate the safety of composite arterial grafts by comparing outcomes to a control group of patients where left ITA and SVG were utilized, using propensity score and multivariable analysis.

Materials and Methods

Patients

From January 1999 to July 2002, 402 consecutive patients undergoing coronary revascularization with exclusively composite arterial grafts (no aortic anastomoses) utilizing either 2 ITAs or 1 ITA in combination with a radial artery were identified. During the same study period 542 consecutive patients undergoing CABG that utilized the left ITA in combination with SVGs anastomosed proximally to the aorta were identified. All surgeries were performed by a group of 4 surgeons contributing to both composite and control groups. Patients with preoperative intra-aortic balloon counterpulsation (IABP) were excluded.

Indications for CABG surgery were based on a weekly peer-review process, involving cardiologist, cardiac surgeons, and cardiac radiologists. Individual patients were placed on a specific wait list according to urgency of procedure. Cardiopulmonary bypass (CPB) for coronary bypass surgery at our institution was performed in a standardized fashion. Body temperature during the procedure was allowed to drift to approximately 32°C. Intermittent cold blood cardioplegic solution was delivered antegrade via the aortic root unless otherwise indicated. The choice of conduits and/or construction of composite grafts was based on surgeon preferences rather than fixed criteria such as territory to graft, degree of target vessel stenosis, vessel size, or flow. Arterial conduits were harvested with minimal trauma (nonskeletonized ITA) and all treated with either a papaverine solution or nitroglycerine/calcium channel blocker (verapamil) solution prior to use. The composite anastomosis, in the majority of patients, was per-

formed under cardioplegic arrest after all distal anastomoses had been completed. Patients who had beating heart surgery (OPCAB) were included in this analysis and this group consisted of 97 patients (10.3%).

Postoperative Management

All patients received intravenous nitroglycerin (0.1-8 ug/kg/min) infusions for the first 24 hours unless hypotensive (systolic blood pressure < 90 mm Hg). Oral nifedipine (Adalat 10 mg by mouth 4 times a day or Adalat XL 30 mg daily; Bayer, Inc, Toronto, Ontario, Canada) was prescribed for all patients receiving a radial artery beginning on day 1 postoperatively for a period of 3 to 6 months. Other routine medications included daily aspirin and resumption of cholesterol-lowering agents and β -blockers.

Data Collection

Perioperative patient variables were collected by 3 full-time research assistants and maintained in the Maritime Heart Center Cardiac Surgery Database. This has been a standard practice at this institution for all cardiac surgical cases since 1995 with regular data validation. An elective case was defined as a patient waiting at home prior to the procedure; in-house cases were defined as hospitalized patients requiring surgery; urgent cases were defined as cases where surgery were required to be performed within 24 hours to prevent further clinical deterioration; and emergency/emergency salvage cases were those patients who required an immediate operation. Twelve-lead electrocardiogram was recorded before the operation, at 2 hours after surgery, and then when clinically indicated. Electrocardiographic diagnosis criteria for perioperative myocardial infarction (MI) were new Q-wave (0.04 ms) in at least 2 leads or electrocardiographic ST changes in association with significant creatine kinase MB enzyme release.

Data Analysis

All analyses were performed with the Statistical Analysis Systems software package (SAS, Release 8.2, Cary, NC). Descriptive statistics included continuous and discrete variables, which were analyzed accordingly with an unpaired *t* test, Wilcoxon rank sum test, chi-square test, and Fisher exact test.

A propensity analysis was performed modeling probability of receiving a composite arterial graft. Briefly, a nonparsimonious multivariable logistic regression model using clinically relevant variables was generated to compute a propensity score for each patient (Appendix). All clinically relevant variables were included into the model. The propensity score (or probability of receiving a composite graft) was then used to obtain a 1-to-1 match of composite cases with CABG controls (left ITA + SVG) by a "greedy matching" technique.¹³ Outcomes were compared between these matched groups.

Finally, a multivariable logistic regression model was used to analyze combined adverse outcomes. The fully adjusted model included 24 patient variables, as well as the type of grafting performed (composite versus control), individual surgeons, and propensity score. In an additional regression analysis we included time and experience variables as model variables. The time and experience variables included were: composite early experience, ITA + SVG early experience, composite late experience, ITA +

TABLE 1. Patient characteristics of composite arterial grafts versus LITA + SV, in 944 unmatched cases

Preoperative patient characteristic	Composite graft (n = 402), %	LITA + SV (n = 542), %	P value
Age			
<60	40.6	19.6	.0001
60–74	50.0	49.3	
≥75	9.4	31.2	
Female gender	18.2	32.7	.0001
Diabetes	36.3	40.6	.18
Renal failure	1.7	6.8	.0002
Hypertension	63.7	65.5	.56
Hypercholesterolemia	86.8	79.5	.003
PVD	12.4	18.3	.015
CVD	8.2	17.9	.0001
COPD	10.7	18.3	.001
Previous CABG	5.2	2.8	.05
EF < 40	9.0	16.0	.001
NYHA class			
I	2.0	1.1	.003
II	14.2	9.4	
III	45.3	39.5	
IV	38.6	50.0	
Status			
Elective	61.0	45.8	.0001
Inhouse	33.1	45.4	
Urgent <24 hours	5.0	7.0	
Emergency	1.0	1.8	
Distal anastomosis			
2	8.2	16.6	.0001
3	50.5	38.9	
4	32.8	31.9	
≥5	8.5	12.6	
Off-pump	9.7	10.7	.62

LITA, Left internal thoracic artery; SV, saphenous vein; PVD, peripheral vascular disease; CVD, cerebrovascular disease; COPD, chronic lung disease; CABG, coronary artery bypass grafting; EF, ejection fraction; NYHA, New York Heart Association.

SVG late experience, and time (early = first 18 months or late = last 24 months).

Results

Patient Characteristics

A total of 944 consecutive patients who underwent CABG surgery performed by 1 of the 4 surgeons experienced in composite grafts at our center and who met our graft composition criteria were identified between January 1999 to July 2002. Of these, 402 (42.6%) were composite (no saphenous vein conduits, no proximal anastomoses) and the remaining 542 were CABG controls (left ITA + SVG). Patient characteristics of the 2 groups are listed in Table 1. In summary, composite patients were significantly younger, more often of male gender, with less comorbid diseases, better New York Heart Association (NYHA) class, and less often operated upon urgently. In addition, composite graft patients received more distal anastomoses. The unadjusted

TABLE 2. Patient characteristics of composite arterial grafts versus LITA + SV, in 498 matched cases obtained by greedy matching technique using propensity scores

Preoperative patient characteristic	Composite Graft (n = 249), %	LITA + SV (n = 249), %	P value
Age			
<60	29.7	26.1	.62
60–74	55.0	56.6	
≥75	15.3	17.3	
Female gender	21.3	23.7	.52
Diabetes	37.4	39.0	.71
Renal failure	2.8	2.8	1.00
Hypertension	66.3	62.6	.40
Hypercholesterolemia	83.9	83.5	.90
PVD	15.7	11.6	.19
CVD	12.0	12.4	.89
COPD	14.9	13.2	.61
Previous CABG	4.4	4.4	1.00
EF < 40	13.2	12.0	.69
NYHA class			
I	1.2	2.0	.71
II	13.6	14.9	
III	43.4	45.8	
IV	41.8	37.4	
Status			
Elective	55.0	57.4	.75
Inhouse	38.6	34.5	
Urgent <24 hours	5.2	6.8	
Emergency	1.2	1.2	
Distal anastomosis			
2	11.6	9.2	.85
3	45.4	46.6	
4	32.1	32.5	
≥5	10.8	11.6	
Off-pump	8.0	8.8	.75

LITA, Left internal thoracic artery; SV, saphenous vein; PVD, peripheral vascular disease; CVD, cerebrovascular disease; COPD, chronic lung disease; CABG, coronary artery bypass grafting; EF, ejection fraction; NYHA, New York Heart Association.

in-hospital mortality for the composite group was 1% and for the control group was 2.8% ($P = .06$).

Comparison Using Propensity Score Analysis

The propensity score model included 24 patient variables that are listed along with their confidence intervals in Appendix. The c-statistic for this model was 0.80 (Hosmer-Lemeshow goodness-of-fit $P = .3057$). Two hundred forty-nine of 402 composite cases (62%) could be matched to controls. The 2 groups were well matched for all the patient variables (Table 2). The number of grafted vessels was 3.4 ± 0.9 grafts in the composite group compared to 3.5 ± 0.9 grafts in the matched group ($P = .28$). The conduits utilized in the composite group were the left ITA (98%), the right ITA (19%), and radial artery (89%). The conduits utilized in the matched group were the left ITA (100%) and SVGs. The CPB time (128 vs 105 minutes; $P < .0001$) and clamp time

TABLE 3. Perioperative outcomes for composite arterial grafts versus LITA + SV, in 498 matched cases obtained by greedy matching technique using propensity scores

Perioperative outcome	Composite graft (n = 249), n (%)	LITA + SV (n = 249), n (%)	P value
Combined outcome: (Mort/IABP/MI/Stroke/ LongVent)	34 (13.6)	16 (6.4)	.007
In-hospital mortality	3 (1.2)	1 (0.4)	.62
Intra-/postop IABP	9 (3.6)	2 (0.8)	.06
Periop MI	7 (2.8)	4 (1.6)	.54
Stroke	6 (2.4)	2 (0.8)	.29
Prolonged ventilation > 24 hours	32 (12.8)	12 (4.8)	.002
Deep sternal infection	3 (1.2)	2 (0.8)	<1.00
Blood products	48 (19.3)	39 (15.7)	.29
Inotropes leaving OR	53 (21.3)	49 (19.7)	.66
Return to OR for bleeding	4 (1.6)	5 (2.0)	<1.00
Return to OR for graft occlusion	4 (1.6)	0 (0.0)	.12
Number of grafts/patients (mean, SD)	3.4 ± 0.9	3.5 ± 0.9	
Pump time, minutes (median, IQR)	128 (102–160)	105 (86–133)	.0001
Clamp time, minutes (median, IQR)	102 (78–132)	74 (59–94)	.0001
Postop stay, days (median, IQR) for patients alive at discharge	6 (5–8)	6 (5–8)	.11

LITA, Left internal thoracic artery; SV, saphenous vein; Mort, mortality; MI, myocardial infarction; LongVent, prolonged ventilation; IABP, intra-aortic balloon counterpulsation; OR, operating room; IQR, interquartile range.

(102 vs 74 minutes; $P < .0001$) were significantly longer for the composite group compared with matched patients (Table 3).

The mortality was 1.2% in the composite group and 0.4% in the matched group ($P = .62$). The length of hospitalization was a median of 6 days in both groups with an interquartile range of 5 to 8 days ($P = .11$). Major morbidity was not statistically different between composite and matched groups in terms of: intra/postoperative IABP (3.6% vs 0.8%; $P = .06$), postoperative MI (2.8% vs 1.6%; $P < .54$), permanent stroke (2.4% vs 0.8%; $P = .29$), and rates of deep sternal wound infection (1.2% vs 0.8%; $P = 1.00$) (Table 3). However, significantly more patients in the composite group required prolonged mechanical ventilation compared with matched patients (12.8% vs 4.8%; $P = .002$). The combined outcome of death, IABP, MI, stroke, and prolonged ventilation was also significantly higher in the composite group compared with matched patients (13.6% vs 6.4%; $P = .007$).

TABLE 4. Patient characteristics of composite arterial grafts greedy matched (n = 249) versus failed to match (n = 153)

Preoperative patient characteristic	Composite graft greedy matched (n = 249), %	Composite graft failed to match (n = 153), %	P value
Age			
<60	29.7	58.2	.0001
60–74	55.0	41.8	
≥75	15.3	0.0	
Female gender	21.3	13.1	.04
Diabetes	37.4	34.6	.58
Renal failure	2.8	0.0	.05
Hypertension	66.3	59.5	.17
Hypercholesterolemia	83.9	91.5	.03
PVD	15.7	7.2	.01
CVD	12.0	2.0	.0003
COPD	14.9	3.9	.0006
Previous CABG	4.4	6.5	.35
EF < 40	13.2	2.0	.0001
NYHA class			
I	1.2	3.3	.22
II	13.6	15.0	
III	43.4	48.4	
IV	41.8	33.3	
Status			
Elective	55.0	70.6	.01
Inhouse	38.6	24.2	
Urgent <24 hours	5.2	4.6	
Emergency	1.2	0.6	
Distal anastomosis			
2	11.6	2.6	.0003
3	45.4	58.8	
4	32.1	34.0	
≥5	10.8	4.6	
Off-pump	8.0	12.4	.15

PVD, Peripheral vascular disease; CVD, cerebrovascular disease; COPD, chronic lung disease; CABG, coronary artery bypass grafting; EF, ejection fraction; NYHA, New York Heart Association.

The 153 composite patients that failed to match from the composite group are illustrated in Table 4. In summary, patients who failed to match were significantly younger, more often of male gender, with less comorbid diseases, normal ventricular function, and performed less urgently than the cohort that we were able to match to controls.

Comparison Using Multivariable Analysis

A multiple logistic regression analysis was performed on the entire cohort of 944 patients. The outcome evaluated was a combined outcome of mortality and morbidity because of the low event rate associated with individual variables. The combined outcome (n = 105 events) included: death, intra/post-IABP utilization, postoperative MI, permanent stroke, and prolonged mechanical ventilation (>24

TABLE 5. Multivariable preoperative predictors of combined outcome (Mortality/IABP/MI/Stroke/Prolonged Ventilation); combined outcome occurred in 105 of 944 cases

Variable	Odds ratio	Range
EF < 40	3.6	2.0–6.6
COPD	2.6	1.5–4.7
Urgent	2.5	1.2–4.9
CVD	2.3	1.3–4.4
Composite graft	2.1	1.2–3.7
PVD	2.0	1.2–3.5
NYHA class IV	1.8	1.1–3.0

EF, Ejection fraction; COPD, chronic lung disease; CVD, cerebrovascular disease; PVD, peripheral vascular disease; NYHA, New York Heart Association.

hours). A c-statistic was calculated as a measure of the sensitivity and specificity of the logistic regression model and was 0.81. In the fully adjusted model, 7 independent predictors of the combined morbidity outcome were identified (Table 5). Composite arterial grafting was found to be an independent predictor of the combined mortality/morbidity outcome with an odds ratio of 2.1 (1.2–3.7). The other independent predictors for the combined outcome were: ejection fraction less than 40%, chronic lung disease (COPD), urgent surgery, cerebrovascular disease (CVD), peripheral vascular disease (PVD) and NYHA class IV.

Because composite grafting is technically demanding and may be subject to a surgical learning curve, we created a second logistic regression model that included time and experience variables defined as: composite early experience, ITA + SVG early experience, composite late experience, ITA + SVG late experience, and time (early or late). Using this approach early composite grafting experience remained an independent predictor of the combined morbidity outcome (death, IABP, MI, stroke, and prolonged ventilation) with an odds ratio of 4.1 (2.0–8.4). The c-statistic for this model was 0.82.

Reinterventions

Four patients in the composite group had postoperative angiograms because of evidence of recurrent myocardial ischemia (day 0 to day 10). In 3 of these patients there was stenosis at the composite anastomosis, while in the fourth patient (redo CABG in the setting of a patent left ITA) angiography demonstrated an unrecognized injury to the old left ITA graft. All 4 patients were regrafted and eventually discharged home in good condition. No patients in the matched group were reoperated upon for graft failure.

Discussion

Arterial grafting has increasingly been advocated for the treatment of coronary artery disease in an attempt to im-

prove the long-term results.^{7–11} In support of the safety of arterial grafting, multiple retrospective case series have been published with excellent outcomes.^{7–11} Lytle and colleagues,⁵ in a large retrospective review of 10,124 patients comparing risk-adjusted outcomes of patients who received 2 ITA grafts with patients receiving only 1 ITA graft, reported single ITA grafting was an independent predictor of death and reintervention. Recently a case-matched study comparing saphenous vein graft (n = 956) to radial artery graft (n = 478) showed an improved freedom from reintervention up to 36 months in radial artery conduit patients.¹² Composite arterial grafting, in which a free arterial graft is anastomosed to the side of a pedicled ITA graft (usually left), is also gaining in popularity. This approach facilitates complete arterial grafting and limits manipulation of the aorta normally associated with performing proximal anastomoses.^{7–9} Recent case series attest to the safety of this approach, but to date a comparative study has not been carried out.^{7–11} In fact, variations in patient selections for total arterial grafting, choice of arterial conduit, and the use of composite arterial grafts have made comparison to established techniques of ITA grafts and SVGs problematic.

We report our experience with total arterial grafting employing composite arterial grafting using either 2 ITAs or 1 ITA and radial artery compared with control patients having CABG surgery performed with left ITA and SVGs. The overall mortality in the composite group of 1% compared favorably to other series.^{7–11} We have attempted to make meaningful comparisons between the composite group and a contemporaneous set of left ITA vein graft control cases operated upon by the same surgeons. To do this we have employed 2 statistical approaches based on propensity modeling, a technique that has been strongly advocated in several recent publications, in an effort to better evaluate treatment comparisons from nonrandomized clinical experiences.^{14,15} The propensity score is the probability of a patient receiving a given intervention (in this case composite arterial grafting) based on a nonparsimonious model derived from preoperative patient variables. The propensity model thus reduces many variables to a single balancing score, facilitating meaningful intergroup comparisons. We utilized 2 approaches, namely the creation of matched pairs based on propensity score and logistic regression analysis of outcomes in which propensity score participated as a variable.

Case matching based on propensity score is superior to conventional case matching, which typically utilizes a smaller set of variables for matching.^{13–16} Using this technique the composite arterial and control groups were remarkably well matched in terms of known risk predictors of outcomes following CABG surgery. The overall mortality and major morbidity between groups were not statistically

different. However, requirement for prolonged mechanical ventilation for more than 24 hours was significantly higher in the composite group compared with matched patients. Prolonged mechanical ventilation, defined as greater than 24 hours in this study, has previously been demonstrated to be a reliable surrogate marker for increased overall morbidity and mortality following CABG surgery.¹⁷⁻¹⁹ However, a potential explanation for this observation may be the significantly longer CPB and clamp times used in patients undergoing composite grafts.

In addition, a combined mortality and morbidity outcome was generated in an attempt to address the low event rate and the small sample size of our analysis while maintaining clinical relevance. The choice of the variables in this combined outcome was based on their clinical association with poor patient outcome following CABG surgery.¹⁷ Composite arterial grafting was shown to be significantly associated with the combined outcome compared with matched patients. It is important to note that we were unable to match 153 composite arterial cases (38%). When we examined the patient characteristics of the unmatched composite cases in comparison with the 249 composite arterial cases we were able to match, the unmatched cases were significantly lower risk than their matched counterparts (younger, more often male, fewer incidences of ejection fraction < 40%, less PVD, CVD, COPD, and less often urgent). Thus our case-matched result is likely to be more representative of the higher-risk subset of our composite arterial group, but alternatively the adverse effects of composite grafting may also be overestimated by the matching strategy.

To allow meaningful comparisons with the entire cohort of 944 patients, we utilized a multiple logistic regression analysis using the previously defined combined morbidity/mortality outcome. Using this analysis, composite arterial grafting was found to be an independent predictor of our combined morbidity/mortality outcome (mortality/IABP/MI/stroke/prolonged vent) with an odds ratio of 2.1 (95% confidence interval 1.2-3.7). Because of the technically demanding nature of composite arterial grafting, we employed a second logistic regression model to look for a learning curve effect. Additional time and experience variables were added to the model and included early composite graft (first 18 months) and late composite graft (final 24 months) experiences. In this final analysis, early composite graft experience was found to be an independent predictor of adverse outcomes as compared with other grafting strategies. This finding suggests that there is a significant learning curve effect related to technical competence impacting outcomes of composite arterial grafting. Alternatively patient selection may have improved with increasing experience with the technique.

Taken together, these data indicate that composite grafts were independently associated with increased patient mor-

bidity (prolonged ventilation) and a combined end point of mortality and major morbidity. Our observations may be the result of inadequate flow reserve in a single ITA or due to technical error resulting in compromised flow in 1 or both limbs of the composite graft. Indeed, 4 patients in the composite arterial group returned to the operating room for graft revision while none of the control group underwent graft revision. One must bear in mind that a number of case series provide evidence that the angiographic patency and flow capacity of composite grafts are good, with good short- and medium-term results.^{8-10,20,21} The outcome difference between composite arterial cases and controls may be related to longer pump and clamp times in the composite group, reflecting increased technical difficulty of exclusive arterial anastomoses. It may be advisable to alter our strategy and perform the composite anastomosis at the beginning of the operation prior to initiating CPB. This strategy could significantly shorten aortic clamp times and pump times and allow evaluation of flow in both limbs of the composite graft prior to distal anastomosis.

In summary, our findings raise some concerns about the routine use of composite arterial grafting. However, one must be cautious in interpreting our findings as our analysis was limited by its retrospective design and relatively small sample size. Another limitation of our analysis was the use of a combined outcome where 1 variable (prolonged ventilation) was already shown to be significantly different between groups, potentially disproportionally influencing the combined outcome. Nevertheless, there are several factors involved in the choice of conduits for CABG patients made by surgeons, some of which may not be included among the patient variables available for adjustment. The lack of mortality difference between the groups provides some reassurance that the differences in the incidence of prolonged ventilation and combined outcome were perhaps in part discretionary on the part of caregiver's awareness of the composite arterial technique employed and the prolonged perfusion times. Our observations support the need for a prospective, multi-institutional study to better determine both the short- and long-term outcomes of exclusive arterial grafting as alluded to by a recent small randomized trial indicating that short-term result following composite grafting resulted in improved freedom from adverse cardiac events when compared with conventional ITA and SVG grafting.²²

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APPENDIX

Logistic regression model to generate propensity scores for composite graft (n = 402) vs lima + sv graft (542): the logistic procedure, odds ratio estimates

Effect	Point estimate	95% Wald confidence limits		P value
OPCAB	0.594	0.343	1.030	.06
>4 distals	2.119	1.082	4.150	.03
4 distals	3.792	2.209	6.512	<.001
3 distals	4.580	2.737	7.666	<.001
Emergency	1.476	0.337	6.470	.61
Urgent	0.608	0.302	1.226	.16
In-house	0.636	0.450	0.900	.01
NYHA class				
IV	0.631	0.187	2.127	.46
III	0.737	0.222	2.450	.62
II	0.682	0.194	2.388	.55
Surgeon 3	0.155	0.092	0.260	<.001
Surgeon 2	0.320	0.210	0.488	<.001
Surgeon 1	0.928	0.561	1.536	.77
Age >74	0.135	0.081	0.225	<.001
Age 60-74	0.461	0.325	0.656	<.001
Sex	0.591	0.409	0.855	.005
Diabetes	0.785	0.571	1.078	.13
CRF	0.408	0.161	1.036	.06
HTN	1.162	0.842	1.604	.36
Hypercholesterolemia	1.459	0.957	2.222	.08
PVD	0.911	0.579	1.433	.69
CVD	0.454	0.279	0.740	.002
COPD	0.548	0.350	0.858	.01
PREVCAB	1.836	0.812	4.154	.14
EF 40	0.573	0.352	0.934	.03

Association of Predicted Probabilities and Observed Responses
Pairs 217884 c-statistic 0.796

LITA, Left internal thoracic artery; SV, saphenous vein; OPCAB, beating heart surgery; NYHA, New York Heart Association; CRF, renal insufficiency; HTN, hypertension; PVD, peripheral vascular disease; CVD, cerebrovascular disease; COPD, chronic lung disease; Prevcab, previous surgery; EF, ejection fraction.