Results of Coronary Artery Endarterectomy and Coronary Artery Bypass Grafting for Diffuse Coronary Artery Disease

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Background. Coronary artery endarterectomy with coronary artery bypass grafting for diffuse coronary artery disease has been associated with increased morbidity and mortality. We evaluated our institutional experience to redefine the role of coronary endarterectomy for diffuse coronary artery disease.

Methods. From 1985 to 2002 isolated coronary artery endarterectomy with coronary artery bypass grafting was performed in 1,478 consecutive patients. The short-term outcomes were compared with concurrent series of conventional coronary artery bypass graft surgery, and risk factors for adverse outcomes after coronary endarterectomy were identified.

Results. Patients in the coronary endarterectomy group were of higher risk with increased incidence of comorbidities and three-vessel coronary disease. The operative mortality (3.2% versus control 2.2%; \( p = 0.03 \)) and the incidence of major postoperative morbidity (not significant) were comparable between the groups. Prolonged cardiopulmonary bypass time, recent acute myocardial infarction, redo surgery, and poor ventricular function were important predictors of in-hospital mortality. Vessel endarterectomized, technique of endarterectomy, and cardiopulmonary bypass versus off-pump technique did not alter results. At long-term follow-up, 5-year and 10-year survivals were 83% \( \pm \) 5%, and 74% \( \pm \) 3%, respectively, and freedom from angina at 5 and 10 years was 75% \( \pm \) 5%, and 69% \( \pm \) 4%, respectively, with 96% of survivors in New York Heart Association class II.

Conclusions. In selected patients with diffuse coronary artery disease, coronary endarterectomy can be used as a tool for myocardial revascularization. The operative mortality and major morbidity were comparable or similar to coronary artery bypass grafting, and short-term and long-term results were favorable.

Accepted for publication March 23, 2005.

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Material and Methods

The spectrum of patients referred for coronary artery bypass graft (CABG) surgery is fast changing in recent decades. Patients are older and more often than not are afflicted with other morbidities such as hypertension, diabetes mellitus, cerebral and peripheral vascular disease, renal dysfunction, and chronic pulmonary disease. In addition, many patients referred for CABG have advanced and diffuse coronary disease, and one or more catheter-based interventions or surgical revascularization procedures were already performed. Because of the diffuse disease, vessels may not be graftable, and complete revascularization using conventional CABG may not be feasible. Incomplete myocardial revascularization procedure was shown to adversely affect short-term and long-term outcomes after coronary surgery [1–5]. Coronary endarterectomy (CE) was used as an adjunct to CABG in this select group of patients to afford complete revascularization.

Many surgeons are reluctant to perform CE because of reports of poor long-term clinical outcomes as compared with conventional CABG, increased postoperative mortality (3.2% to 10%), and myocardial infarction (MI) rates (4% to 15%) [6, 7]. Many patients with diffuse disease may have been denied the chance of complete revascularization. Transmyocardial laser revascularization and angiogenesis or tissue growth factor therapy are evolving as treatment modalities in diffuse disease. These therapies may either supplement or replace CE in diffuse coronary disease [8, 9]. We conducted this study to redefine the role of CE in diffuse coronary artery disease. Short-term clinical outcomes of patients undergoing CE were compared with isolated CABG, and were analyzed to identify the predictors of adverse clinical outcomes.

Operative Details

At Newark Beth Israel Medical Center between July 1985 and July 2002, 8,874 patients underwent isolated myocardial revascularization procedures, of which 1,478 consecutive patients had undergone CE with CABG for diffuse coronary artery disease. During the same period CABG without CE was performed in 7,396 patients, who served as a control group. Patients having combined valve and CABG or CE or other concomitant procedures were excluded.
open technique. In rare instances in which removal of the plaque, converting the endarterectomy to an aortotomy was extended as necessary to allow complete removal of residual plaque was left in the distal vessel, the arteriotomy (10 to 12 mm in length) was performed at the site. In selected cases, an additional arteriotomy (1.5 to 2 cm proximal to the anastomotic site) was performed to improve the perfusion area, especially in cases of diffuse disease involving two or more neighboring major branches. If the diseased vessel supplied a myocardial territory that was fibrotic, akinetic, and with a fixed perfusion defect on perfusion scan, the endarterectomy was not attempted. A limited incision and “traction” technique was used in most cases. A limited arteriotomy (10 to 12 mm in length) was performed at the usual site for distal coronary anastomosis; the plaque was dissected proximally and distally and removed from the vessel. In the left anterior descending (LAD) territory, the proximal extent of the endarterectomy was limited not to jeopardize the septal perforators. It was divided 1.5 to 2 cm proximal to the anastomotic site. In the right main coronary artery (RCA), if the vessel was totally occluded, the plaque was endarterectomized as proximally as possible.

If the distal end of the plaque was irregular, or a residual plaque was left in the distal vessel, the arteriotomy was extended as necessary to allow complete removal of the plaque, converting the endarterectomy to an “open” technique. In rare instances in which diffuse disease involved two or more neighboring major branches (eg, the obtuse marginal branches of the CX), a counterincision on the branch vessels or a main trunk facilitated a complete removal of plaque. In most cases, the bypass conduit (arterial or venous) was directly anastomosed to the endarterectomy site. In selected cases, with a very long open segment, a transfemoral cardiopulmonary bypass was used for more than 24 hours, or a newly placed intraaortic balloon pump either to wean off cardiopulmonary bypass or as a postoperative insertion to maintain a cardiac index greater than 2.2 L · min⁻¹ · m⁻² [estimated by thermodilution method]), sternal dehiscence with mediastinal infection, transient ischemic attack or cerebrovascular accident, new-onset renal failure, bleeding and transfusion requirements, and other major morbidity. Duration of intensive care unit stay and total hospital stay in days was noted. Operative mortality was defined as a death occurring within 30 days of operation or during the same hospitalization if longer.

**Long-Term Follow-Up**

Long-term follow-up was complete in 97% of patients with a cutoff date set on June 30, 2002. Patients’ in-hospital and outpatient charts were reviewed. Further, a direct communication with a family physician or a cardiologist and a telephonic contact with either the patient or a family member assisted in completing the long-term follow-up. Patient clinical condition, Canadian Cardiovascular Society angina class, New York Heart Association functional class, operative complications, follow-up echocardiograms, radionuclide perfusion multigated imaging, and angina status were recorded.

**Data Collection and Postoperative Care**

All patient data were prospectively collected and reviewed. The institutional review board and ethics committee of Newark Beth Israel Medical Center approved this study and waived the patients’ consent. Data included demographics, associated morbidities, operative details, and postoperative complications. Demographics, cardiac profile, and associated morbidities are depicted in Table 1. Age, sex, body surface area, left ventricular ejection fraction, and ratio of elective versus nonelective procedures were similar in both groups. The CE group had a higher incidence of hypertension (82% versus 72%; p < 0.0001), diabetes mellitus (44% versus 33%; p < 0.0001), prior MI (69% versus 61%; p = 0.0001), peripheral vascular disease (37% versus 21%; p < 0.0001), chronic renal failure (14% versus 4%; p < 0.0001), three-vessel coronary disease (83% versus 70%; p = 0.0001), and left main stenosis (30% versus 27%; p = 0.02). On preoperative risk stratification of the entire cohort, the CE group had a higher risk score (13 ± 4 versus 6 ± 2) as compared with the control group by using the methods described by Parsonnet. The estimated operative risk for the CE group was 10% (lower 95% confidence limits).

Significant postoperative morbidity was defined as reoperation for bleeding, pulmonary complications such as lobar pneumonia or major pleural effusions, ventilator dependency for more than 24 hours, MI (new Q wave, elevation of creatine kinase-MB fraction or cardiac troponin, new wall motion abnormality in echocardiogram), low cardiac output state (ie, the use of inotropic support for more than 24 hours, or a newly placed intraaortic balloon pump either to wean off cardiopulmonary bypass or as a postoperative insertion to maintain a cardiac index greater than 2.2 L · min⁻¹ · m⁻² [estimated by thermodilution method]), sternal dehiscence with mediastinal infection, transient ischemic attack or cerebrovascular accident, new-onset renal failure, bleeding and transfusion requirements, and other major morbidity. Duration of intensive care unit stay and total hospital stay in days was noted. Operative mortality was defined as a death occurring within 30 days of operation or during the same hospitalization if longer.

**Abbreviations and Acronyms**

- CABG = coronary artery bypass grafting
- CE = coronary endarterectomy
- CPB = cardiopulmonary bypass
- CX = circumflex coronary
- LAD = left anterior descending coronary
- MI = myocardial infarction
- OR = odds ratio
- RCA = right coronary artery

32°C) and standard systemic anticoagulation. Intermit-tent aortic cross-clamping with fibrillatory arrest (1985 to 1986), cold antegrade blood cardioplegia (1987 to 1989), and combined antegrade and retrograde blood cardio-plegia (1990 to 2002) were used for myocardial protection. The off-pump CABG procedures were done in 52 cases (from 2000), because the diffuse disease was limited but not as extensive at the operating table.

Coronary artery endarterectomy was chosen selec-tively for all diffusely diseased major coronary arteries or their major branches with an outer diameter of at least 1.5 mm, if the vessels perfused a viable myocardial segment or a myocardial segment of doubtful viability (includes hypokinetic, severely hypokinetic, and akinetic segments). If the diseased vessel supplied a myocardial territory that was fibrotic, akinetic, and with a fixed perfusion defect on perfusion scan, the endarterectomy was not attempted. A limited incision and “traction” technique was used in most cases. A limited arteriotomy (10 to 12 mm in length) was performed at the usual site for distal coronary anastomosis; the plaque was dissected proximally and distally and removed from the vessel. In the left anterior descending (LAD) territory, the proximal extent of the endarterectomy was limited not to jeopardize the septal perforators. It was divided 1.5 to 2 cm proximal to the anastomotic site. In the right main coronary artery (RCA), if the vessel was totally occluded, the plaque was endarterectomized as proximally as possible.

If the distal end of the plaque was irregular, or a residual plaque was left in the distal vessel, the arteri-otomy was extended as necessary to allow complete removal of the plaque, converting the endarterectomy to an “open” technique. In rare instances in which diffuse disease involved two or more neighboring major branches (eg, the obtuse marginal branches of the circumflex artery [CX]), a counterincision on the branch vessels or a main trunk facilitated a complete removal of plaque. In most cases, the bypass conduit (arterial or venous) was directly anastomosed to the endarterectomy site. In selected cases, with a very long open segment, a vein patch was used to close the endarterectomy site, and the distal anastomosis was constructed between the conduit and the patch. If long arteriotomy was made in the LAD, the internal mammary artery patch graft was done if the latter was of good size. If two are more adjacent major branches of were opened (eg, the obtuse marginal
scans, medical management, hospital readmissions, and surgical or catheter-based reinterventions were noted.

Statistical Analysis
Data were expressed as mean ± standard deviation. Median and range values were added for selected variables. Two-tailed Student's t test was used to analyze continuous variables. Categorical data were analyzed using the χ² test or Fisher's exact test when appropriate. A p value of less than 0.05 was considered significant. Univariate and multivariate analyses were performed to identify predictors of in-hospital mortality, postoperative MI, and major postoperative morbidity. A stepwise backward selection method was used to select the univariate variables with a significance level of 0.2 for entry, and a significance level of 0.05 for staying in the model. Selected univariate variables were further analyzed by multiple logistic regression analysis, and the results are expressed as odds ratios (OR) with associated 95% confidence limits. Propensity score analysis (saturated one) was performed for the entire cohort, and the score was used in the multivariate models for risk adjustment. The receiver-operating characteristic scores were calculated for predictors of adverse outcomes in CE. The Kaplan-Meier method was used to analyze actuarial survival and long-term postoperative events of both the cohorts of CE and matched isolated CABG. All statistical analysis was performed using SPSS 9 software (SPSS Inc, Chicago, IL).

Results
The internal mammary graft was used in more than 92% of patients in both groups (Table 2). In CE patients, owing to extensive disease, more bypass grafts per patients were performed than in conventional CABG (3.9 ± 1 versus 3.1 ± 0.8; p = 0.003). The complexity of the
procedure in the CE group was associated with longer CPB time (109 ± 29 versus 82 ± 24 minutes; p < 0.001) and aortic cross-clamp times (82 ± 21 versus 43 ± 17 minutes; p < 0.001).

Endarterectomy was performed in 2,201 vessels; the LAD, 714; diagonal branch, 140; distal branch of main CX, 60; obtuse marginal branch, 244; RCA, 758; posterior descending coronary artery (ie, required a separate arteriotomy to remove a plaque either in conjunction with or without an RCA plaque), 203; and posterolateral branch (ie, required a separate arteriotomy to remove a plaque either in conjunction with or without an RCA plaque), 82. In 52 patients using off-pump CABG, the endarterectomy of LAD (25 vessels), RCA (29 vessels), main CX (2 vessels), and posterior descending (6 vessels) was performed. Overall 63% of patients underwent a single-vessel and 37% of patients, a multi-vessel endarterectomy. Twelve percent had undergone three-vessel endarterectomy. Single-vessel endarterectomy of LAD was performed in 324 patients (22%), single RCA in 420 patients (28%), single CX in 187 patients (13%). Twenty-eight percent of the endarterectomized vessels were totally or near-totally occluded as demonstrated on preoperative coronary angiogram. The limited incision and traction technique was used in 85% vessels and the open technique, in 15%.

Among the conduits for grafting to the endarterectomy site, the saphenous vein graft was used in 55.5%, the internal mammary artery (left or right) in 41.5% of vessels, and the radial artery in 3% of vessels. In a rare few (10 patients, 0.7%), the endarterectomy was technically unsatisfactory because of persistence of soft atheromatous debris in the vessels or lack of a proper plane for dissection (17 vessels) preventing placement of a bypass conduit, and such vessels were ligated.

Hospital outcomes are shown in Table 3. The incidence of major postoperative complications in the CE group versus conventional CABG group (postoperative MI, 4.2% versus 3.4%; p = 0.15; cerebrovascular accident, 1.7% versus 0.9%; p = 0.08; respiratory complications, 7.5% versus 5%; p = 0.33; and reexplorations for bleeding, 1.3% versus 1.7%; p = 0.89) was similar.

Of the 62 patients with postoperative MI in the CE group, 37 were localized to the territory supplied by the endarterectomized vessel and 25 were localized to a different territory. The difference between MI rate in occluded (20) and nonoccluded vessels (17) was not statistically significant. The incidence of postoperative MI for patients in whom the vessels were ligated as a result of technically unsatisfactory endarterectomy was 40% (4 of 10 patients), and 75% of MIs were localized to the territory supplied by endarterectomized vessel.

The operative mortality for single-vessel endarterectomy was 1.8% and 5.5% for multi-vessel endarterectomy (p = 0.0003). The mortality for endarterectomy of LAD was 1.2%, and for RCA and CX, 1.4% and 2.1%, respectively (LAD versus RCA; p = 0.93; LAD versus CX; p = 0.47; CX versus RCA; p = 0.51). The operative mortality was comparable between the groups (CE, 3.2% versus CABG, 2.2%; p = 0.03) with a low level of significance. Causes of mortality in the endarterectomy group included low cardiac output (22 patients), multiorgan failure (8 patients), respiratory insufficiency (6 patients), stroke (6 patients), and pulmonary embolism (5 patients). Of 30 patients with low cardiac output and multiorgan failure, 22 had perioperative MI and the infarction was localized to the endarterectomized vessel in only 10. Among all postoperative MIs localized to the endarterectomized vessel (37 patients), 10 resulted in low cardiac output and multiorgan failure leading to death.

In the CE group several variables were analyzed univariately and multivariately (Table 4) to identify predic-
tors of operative mortality, adverse postoperative outcomes (significant postoperative MI, and postoperative morbidity. On univariate analysis, the operative mortality (risk) was similar for diffuse and extensive disease in LAD versus no disease in LAD (3.2% versus 3.1%; OR = 1.01; p = 0.92); left main disease versus no left main disease (2.7% versus 3.3%; OR = 1.25; p = 0.62); emergency versus elective surgery (3.01% versus 3.22%; OR = 1.04; p = 0.98); aortic cross-clamp time (>90 minutes; 3.08% versus 3.21%; OR = 1.04; p = 0.96); techniques of myocardial protection used (ie, intermittent clamp technique versus cardioplegic arrest; 2.9% versus 3.2%; OR = 1.07; p = 0.94); combined retrograde and antegrade cardioplegia versus other types of myocardial protection (ie, intermittent ischemia or antegrade cardioplegia; 3.18% versus 3.16%; OR = 1.0; p = 0.88); off-pump versus on-pump surgery (1.9% versus 3.2%; OR = 1.56; p = 0.99); the endarterectomy technique used (ie, limited incision and traction versus open technique; 3.18% versus 3.15%; OR = 1.0; p = 0.85); and vessel endarterectomized (ie, LAD versus non-LAD vessels; 3.1% versus 3.2%; OR = 1.06; p = 0.96; CX and obtuse marginal versus non-obtuse marginal vessels; 3.2% versus 3.15%; OR = 0.96; p = 0.95; RCA versus non-RCA vessels; 3.29% versus 3.05%; OR = 0.93; p = 0.91).

Predictors of in-hospital mortality in endarterectomy group included postoperative cerebrovascular accident, poor left ventricular function (ejection fraction less than 0.30), recent acute MI, redo surgery, prolonged CPB time (≥180 minutes), chronic obstructive pulmonary disease, and end-stage renal disease requiring dialysis (Table 4). Prolonged CPB time, redo surgery, and extensive three-vessel disease with inadequate revascularization were the only independent predictors of postoperative MI (Table 4). Independent predictors of overall postoperative morbidity in the multiple logistic regression analysis included prior cerebrovascular accident, prior MI, preoperative cardiac arrhythmia, advanced age, chronic obstructive pulmonary disease, and end-stage renal disease requiring dialysis (Table 4). In the CE group the length of stay in intensive care (2.8 ± 4 versus 1.2 ± 1 days; p < 0.001) and total hospital stay (7.9 ± 7 versus 6.2 ± 3 days; p = 0.005) were increased with increased use of blood component therapy (7.2 ± 8 versus 2.9 ± 6 units; p < 0.0001) attributable to increased postoperative morbidity.

The long-term follow-up for 1,418 patients (97%) was a mean of 96 ± 29 months (range, 2 months to 17.5 years). Two hundred sixty-two patients died during the follow-up period. Causes of deaths were cardiac in 89 patients (congestive heart failure, 49; MI, 29; arrhythmia, 11); cancer, 57; neurologic stroke, 32; multiorgan failure, 19; pulmonary embolism, 11; respiratory failure, 12; pneumonia, 12; infectious complications and sepsis, 9; and unknown, 21. Actuarial survival (including hospital mortality) at 1, 5, and 10 years was 92% ± 2%, 83% ± 5%, and 74% ± 3%, respectively, as compared with actuarial survival for the conventional CABG group, which was
97% ± 3% at 1 year, 86% ± 3% at 5 years, and 78% ± 4% at 10 years (Fig 1). The freedom from angina (Canadian Cardiovascular Society) for the CE cohort at 1, 5, and 10 years was 87% ± 2%, 75% ± 5%, and 69% ± 4%, respectively, as compared with 96% ± 2% at 1 year, 86% ± 4% at 5 years, and 83% ± 3% at 10 years for isolated CABG. For the CE group the event-free survival at 1, 5, and 10 years was 85% ± 3%, 72% ± 6%, and 66% ± 3%, respectively. At a late follow-up 96% of survivors (1,122 of 1,169) were in New York Heart Association class II with the presence of a variable degree of symptoms in 337 patients. Echocardiograms or radionuclide perfusion mulitigated scans were performed in 187 patients for Canadian Cardiovascular Society class III or New York Heart Association class III symptoms. New changes in wall motion or perfusion abnormalities were detected in 132 patients requiring repeat coronary angiogram. Ninety-three patients (8% of survivors) underwent angioplasty, 31 (2.7% of survivors) repeat surgery, and in 8 no new lesions were detected. Among patients who had interventions (124), in 18 patients the grafts were occluded to the previously endarterectomized vessels with long-term patency rate of 85%.

Comment

Coronary artery endarterectomy has been used as an adjunct to myocardial revascularization for 40 years but has not been used as often as conventional CABG. The decreased postoperative morbidity and operative mortality reported in the literature dissuaded many surgeons from performing this procedure [4–7]. In this institute 16.6% of patients scheduled for an isolated CABG required CE to accomplish complete myocardial revascularization. Although this figure approximates 20% to 50% frequency reported in many series [6, 7, 13–17], our study represents a highly selective group with diffuse coronary disease in which CABG was not feasible without an endarterectomy. The high incidence at this institute reflects the high-risk profile of the patients with various comorbidities referred for surgical revascularization. At least one or more prior surgical or catheter-based interventions were performed in 46% of the patients. The operative mortality of 3.2% in this study is similar to the operative mortality of 2% to 6% reported by others, and the incidence of postoperative MI of 4.2% in this study is similar to 2% to 12% in prior reports [13–20].

Although CE of the LAD was reported by some to carry an increased operative risk compared with RCA endarterectomy [5, 13], this study showed no differences in MI rate or operative risk between the endarterectomy of the partially occluded and totally occluded vessels or endarterectomy of the different major vessels and is consistent with results reported by other series [7, 14, 15]. The increase in operative mortality for multivessel endarterectomy as compared with a single vessel in this study is consistent with other studies [18].

The technique of endarterectomy did not influence results in this study, although the open technique was recommended in most cases by some [14]. Requirement for more grafts per patient and the endarterectomy itself resulted in longer CPB and aortic cross-clamp times. In this study as well as in some others the prolonged CPB time was an independent predictor of postoperative MI, operative morbidity, and in-hospital mortality although aortic cross-clamp time was not [7, 16]. There were no differences in types of myocardial protection used on clinical outcomes in our study, although in high-risk patients use of combined antegrade and retrograde cardioplegia is of benefit [1, 21]. Similarly, off-pump CABG yielded the same results as conventional CPB technique.

In some patients, diffuse and extensive disease may hinder complete removal of the plaque, if the plaque is not mature enough, preventing complete revascularization. Redo coronary surgery and extensive three-vessel disease with inadequate revascularization, in which endarterectomy was technically unsatisfactory in both, and prolonged CPB time were found to be independent predictors of postoperative MI in this study. The technique of endarterectomy should be used with caution in all such patients, or strategies such as transmyocardial revascularization or angiogenic growth factor therapy may be chosen as an alternative [8, 9].

An early graft closure with the lower long-term graft patency rates is the common concern after CE, as the endarterectomized vessels tend to become thrombosed. Despite the concerns for size mismatch and integrity of the arterial conduit, several series reported reduction in perioperative MI rates, improved early graft patency rates, and improved long-term survivals when the internal mammary graft is used to reconstruct endarterectomized LAD coronary artery [13, 19, 20]. Beretta and colleagues [19] reported a reduction in perioperative MI rate from 10% to 2%, with an improved early graft patency from 85% to 93% and improved 5-year survivals from 70% to 87% for internal thoracic artery grafts as compared with use of saphenous vein conduit.
In our study the patency of the grafts to the endarterectomized vessels was not routinely assessed by follow-up coronary angiographic studies. Cardiac wall motion studies by radionucleotide ventriculography or perfusion imaging techniques, which may assess graft patency indirectly, were either inconsistent or showed either improvement or deterioration of function [7, 20]. In our symptomatic patients, on a long-term follow-up cardiac function and graft patency were studied by wall motion abnormalities, nuclear imaging, and repeat coronary angiography, which were consistent with favorable long-term graft patency rates (ie, 85%), although some studies showed no correlation between patient symptoms and graft patency [17, 19, 20].

The long-term results after CE are comparable to primary CABG. The freedom from angina at 5 and 10 years of 75% ± 5%, and 69% ± 4%, respectively, in this study is consistent with other studies [18], although it was in excess of the recurrent angina of 18% reported after primary conventional CABG [22]. The long-term survivals of 92% at 1 year and 83% at 5 years in our study is comparable to other series that reported 5-year actuarial survivals of 71% and 90% [13, 15]. These differences may be attributable to the high-risk profile of our patients with existing comorbidities, severity of the diffuse disease, and patient selection. At long-term follow-up, a New York Heart Association functional class II of 96% survivors with a few symptoms and an angina-free rate of 70% (Canadian Cardiovascular Society classification) after 10 years is an acceptable clinical outcome and is comparable to conventional CABG.

In summary, patients with extensive and diffuse coronary artery disease are high-risk candidates with coexisting morbidities. Myocardial revascularization procedure in such a group is challenging without CE. This study indicated that despite higher risk profile, both short-term and long-term outcomes after isolated CE with CABG are either comparable or were similar to conventional CABG. In selected individuals with diffuse coronary artery disease CE still remains a surgical tool for complete myocardial revascularization with an acceptable outcome, which may further be improved by either eliminating or modifying several risk factors that result in adverse postoperative outcomes.

References

INVITED COMMENTARY

Coronary endarterectomy (CE) is an important tool for the cardiac surgeon, because the number of patients with severe coronary artery disease continues to increase. To identify risk factors for adverse outcome after CE, Sirivella and colleagues [1] retrospectively compared a group of CE patients with a group of patients operated on with conventional coronary artery bypass graft surgery.