Long-Term Outcomes of Endoscopic Vein Harvesting After Coronary Artery Bypass Grafting

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Background—Use of endoscopic saphenous vein harvesting has developed into a routine surgical approach at many cardiothoracic surgical centers. The association between this technique and long-term morbidity and mortality has recently been called into question. The present report describes the use of open versus endoscopic vein harvesting and risk of mortality and repeat revascularization in northern New England during a time period (2001 to 2004) in which both techniques were being performed.

Methods and Results—From 2001 to 2004, 8542 patients underwent isolated coronary artery bypass grafting procedures, 52.5% with endoscopic vein harvesting. Surgical discretion dictated the vein harvest approach. The main outcomes were death and repeat revascularization (percutaneous coronary intervention or coronary artery bypass grafting) within 4 years of the index admission. The use of endoscopic vein harvesting increased from 34% in 2001 to 75% in 2004. In general, patients undergoing endoscopic vein harvesting had greater disease burden. Endoscopic vein harvesting was associated with an increased adjusted risk of bleeding requiring a return to the operating room (2.4 versus 1.7; \( P=0.03 \)) but a decreased risk of leg wound infections (0.2 versus 1.1; \( P<0.001 \)). Use of endoscopic vein harvesting was associated with a significant reduction in long-term mortality (adjusted hazard ratio, 0.74; 95% confidence interval, 0.60 to 0.92) but a nonsignificant increased risk of repeat revascularization (adjusted hazard ratio, 1.29; 95% confidence interval, 0.96 to 1.74). Similar results were obtained in propensity-stratified analysis.

Conclusions—During 2001 to 2004 in northern New England, the use of endoscopic vein harvesting was not associated with harm. There was a nonsignificant increase in repeat revascularization, and survival was not decreased. (Circulation. 2011; 123:147-153.)

Key Words: cardiopulmonary bypass ■ heart surgery ■ survival

Coronary artery bypass grafting (CABG) surgery is a commonly performed procedure, with nearly 450 000 performed during 2006 in the United States.\(^1\) CABG is one of the most intensely studied of surgical procedures, with special focus on outcomes such as mortality, stroke, and infection rates. The choice of conduit, whether arterial or venous, is one of the many factors that have been shown to influence patient outcomes in both the short- and long-term settings.\(^2\)

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Of necessity, saphenous vein grafts continue to be a frequent choice of conduit during CABG. Traditionally, vein harvesting required a lengthy incision in the leg, open vein harvesting (OVH). More recently, endoscopic vein harvesting (EVH) has grown in popularity in an effort to reduce the pain and risk of infection associated with the procedure. The
Society of Thoracic Surgeons’ National Cardiac Database reported that 70% of CABG procedures performed in 2008 used this vein harvesting method.³ Lopes et al⁴ recently challenged the use of EVH as a routine surgical approach and called into question whether its use may expose patients to the risk of vein-graft failure, death, myocardial infarction, and repeat revascularization. The Lopes et al study was a posthoc analysis of patients enrolled within a larger randomized trial that assessed the efficacy of pretreating vein grafts to decrease neointimal hyperplasia. It is unclear whether these findings are generalizable to everyday clinical practice. Thus, an analysis of prospectively collected data was undertaken to explore the use of EVH and its influence on perioperative and long-term outcomes at 8 medical centers in northern New England.

Methods

Study Population
Consecutive patients were enrolled in the present cohort study if they underwent a first-time isolated CABG surgery at any of the 8 medical centers in Maine, Vermont, and New Hampshire providing this service. Data were analyzed for procedures conducted between 2001 and 2004, a time frame in which both methods of vein harvesting were reasonably represented (Figure 1). Patients were excluded if they were <30 years of age, had a life-threatening malignancy, required emergency surgery, had only arterial conduits, or had a radial artery harvested.

Data Collection
Data were obtained from the CABG and percutaneous coronary intervention registries of the Northern New England Cardiovascular Disease Study Group (NNECDSG). The NNECDSG is a voluntary regional consortium of clinicians, allied health professionals, administrators, and clinical scientists who seek to foster continuous improvement in the quality, safety, and effectiveness of cardiovascular care in the region.⁵⁻⁷ Participating centers collect data on consecutive CABG and percutaneous coronary intervention procedures and submit those data to the regional database. Registry data are validated for case counts and in-hospital mortality through the use of administrative data from each center. Information is collected on patient demographics, comorbid conditions, cardiac history, cardiac anatomy, cardiac function, procedural indication and priority, procedural process, and outcomes. Definitions of these variables have previously been published.⁸ For analytic purposes, data across registries are maintained as a relational database. The CABG data collection specifically asks whether saphenous vein conduit was obtained via EVH or OVH.

Institutional review board approval was obtained at each participating medical center. Institutional review boards from 7 of the 8 NNECDSG member centers have designated the NNECDSG as a Quality Improvement Registry; therefore, patient consent was not required. Written patient consent was obtained for the 1 remaining center.

Study Outcomes
In-hospital mortality was obtained from validated registry data. Long-term mortality out to 4 years was obtained through linkage of registry data to the Social Security Administration’s Death Master File, US Department of Commerce Technology Administration. Linkage was made through the use of a combination of first name, last name, date of birth, date last known alive, and Social Security number. The sensitivity of the Social Security Administration’s Death Master File (92.2%) is comparable to that of the National Death Index among American-born individuals (87% to 98%).⁹ Repeat revascularization, defined as repeat CABG or crossover to percutaneous coronary intervention, out to 4 years was identified through the linked validated registry data in the relational database.

Statistical Analysis
Patients were stratified by use of endoscopy for saphenous vein harvesting. Patient and disease characteristics were summarized by percentages for categorical variables and means for continuous variables and were compared by use of χ² tests and t tests, respectively. Nonparametric tests were used for comparisons of cardiopulmonary bypass duration and number of anastomoses, evaluated with the Wilcoxon rank-sum test.

A multivariate regression model was used to assess the relationship between vein harvesting method and in-hospital clinical outcomes and contained the following covariates: age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, prior myocardial infarction, acuity, vascular disease, diabetes mellitus, renal failure or creatinine ≥2 mg/dL, chronic obstructive pulmonary disease, and body mass index. Dichotomous outcomes were incorporated into a logistic regression model (and adjusted values generated with direct standardization), whereas continuous outcomes were log transformed before incorporation into a linear regression model. P values were generated from the multivariate regression models.

The risk of death or repeat revascularization by vein harvest method was compared by use of the Wald test within a Cox proportional hazards model adjusting for the following covariates: age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, prior myocardial infarction, acuity,
vascular disease, diabetes mellitus, renal failure or creatinine ≥ 2 mg/dL, chronic obstructive pulmonary disease, body mass index, and medical center. The proportional hazards assumption was explored, including log-log plots. These analyses provided evidence supporting the proportional hazards assumption.

Propensity-matched analyses were conducted on each of the end points (mortality or repeat revascularization) to arrive at an estimate of the independent influence of vein harvesting method. A patient's estimated propensity (propensity score) was calculated for receiving EVH with a model that included age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, history of a myocardial infarction, priority, vascular disease, diabetes mellitus, chronic obstructive pulmonary disease, body mass index, renal failure or creatinine ≥ 2 mg/dL, and medical center. Patients were then stratified into blocks based on decile of their propensity score. Propensity scores were balanced between the 2 vein harvesting methods (set at an α = 0.01) after stratification. A Cox proportional hazards regression model was then developed (for each outcome measure) to estimate the long-term hazard of vein harvesting method, stratified by decile of propensity score. To account for the effect of medical center, the Cox model also included medical center as a covariate.

We introduced both medical center and year of procedure as terms in the Cox models to assess the association of these variables with each outcome. Potential interactions between year and vein harvesting method, as well as medical center and vein harvesting method, were tested. Analyses were also repeated for those patients surviving beyond 90 days of their index procedure. Crude curves were created according to the nonparametric Kaplan-Meier method for each of the end points, and adjusted survivorship was plotted through the use of the method proposed by Zhang and colleagues. Unlike the method introduced by Ghali et al., the method furthered by Zhang et al does not force proportional hazards on the difference of the 2 vein harvesting groups.

Adjusted survival curves were created with the R statistical program (version 2.6.0, Foundation for Statistical Computing). All other statistical analyses were performed with Stata release 11.0 software (Stata Corp, College Station, Tex).

Results

Study Population

Of the 8542 patients undergoing first-time isolated CABG surgery in northern New England from 2001 through 2004, 52.5% had their saphenous vein harvested with endoscopy. There were 46483 patient-years of follow-up (4062 OVH, 4480 EVH). An increasing percentage of procedures were performed over time with EVH in northern New England (34% in 2001, 75% in 2004; Figure 1). During this time frame, the range of EVH use across centers (center minimum to center max) was quite variable: 2001, 0% to 87%; 2002, 1% to 91%; 2003, 11% to 96%; and 2004, 28% to 97%.

Baseline Characteristics

Baseline characteristics of the patients undergoing OVH versus EVH are shown in Table 1. Only small differences in patient, disease, and procedural characteristics were noted. Patients undergoing EVH were more likely to be male and had more vascular disease. They were less likely to have a history of myocardial infarction and congestive heart failure. They were more likely to have 2-vessel disease and less likely to have 3-vessel disease. Cardiopulmonary bypass duration was similar between groups, although the EVH cohort had more patients receiving an internal mammary graft and a greater number of distal anastomoses.

Clinical Outcomes

Potential interactions between vein harvesting method and either year of procedure or medical center were explored. In all cases, interaction terms were nonsignificant (P > 0.05); thus, results for the entire surgical cohort during this time period are reported.

In-Hospital Outcomes

Adjusted clinical outcomes are listed in Table 2. Use of OVH was associated with an increased postoperative leg wound infection (1.1 versus 0.2, respectively; P < 0.001). EVH was associated with an increase in return to the operating room for postoperative bleeding (2.4 versus 1.7, respectively; P = 0.03).

Long-Term Outcomes

Long-term outcomes were adjusted for patient and disease characteristics and medical center. EVH was significantly associated with a reduced risk of mortality (adjusted hazard ratio [HR], 0.74; 95% confidence interval [CI], 0.60 to 0.92; Figure 2). HRs for mortality by medical center (along with 95% CI) are shown in Figure 1 in the online-only Data Supplement. EVH was associated with an insignificant increased risk of repeat revascularization (adjusted HR, 1.29; 95% CI, 0.96 to 1.74; Figure 3). HRs for repeat revascularization by medical center (along with 95% CI) are shown in Figure II in the online-only Data Supplement.

The association of EVH relative to OVH (for each outcome) was analyzed with propensity score analysis. Findings from this analysis were akin to those derived from Cox models: EVH was significantly associated with a reduced risk of mortality (HR, 0.74; 95% CI, 0.59 to 0.93) but insignificantly associated with repeat revascularization (HR, 1.24; 95% CI, 0.90 to 1.71).

The present findings were explored across medical center and time. For each of the outcome measures, the magnitude of the association of EVH varied across medical centers. In the case of mortality, the directionality of the influence of EVH was consistent. In the case of risk of repeat revascularization, the adjusted HRs varied from 0.35 to 4.95, with 2 of the 8 institutions having a reduction in risk with the use of EVH. The relationship between EVH and long-term outcomes was consistent across time. The influence of time (year of the index procedure) was explored in a Cox proportional hazards model after adjustment for patient and disease characteristics and medical center. In both instances, year of the procedure was not an independent risk factor.

Discussion

The present report describes a regional investigation into the use of EVH versus OVH of the saphenous vein. Over the course the study period, EVH increased markedly from 34% in 2001 to 75% in 2004. By 2005, it approached 80%, effectively becoming a routine surgical approach and thereby precluding inclusion of more current data in the present
analysis. This pattern was seen across all medical centers, although the rate of adoption differed. Endoscopy was associated with a significant reduction of in-hospital leg wound infection but an increase in return to the operating room for bleeding. There was no evidence of significant long-term harm associated with EVH, as measured by long-term mortality or repeat revascularization. These findings were consistent across medical centers and time.

Previous studies have reported on the association of EVH versus OVH with in-hospital outcomes such as leg wound infection, incisional leg pain, the histological condition of the vein, and mortality. Physicians in northern New England (during 2001 to 2004) favored EVH among patients with a greater body surface area because of an impression that these patients would have a higher risk of leg wound infection with an open procedure (greater dissection to isolate the saphenous vein may lead to a greater risk of infection). Theoretically, the use of an endoscopic approach should reduce leg wound infection and pain as a result of the reduced length of an open wound. In a randomized trial, Hayward et al found no

<table>
<thead>
<tr>
<th>Variable</th>
<th>OVH</th>
<th>EVH</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiopulmonary bypass duration (median), min*</td>
<td>90</td>
<td>90</td>
<td>0.18</td>
</tr>
<tr>
<td>Off-pump surgery, %</td>
<td>13.9</td>
<td>13.0</td>
<td>0.22</td>
</tr>
<tr>
<td>Anastomoses (median), n*</td>
<td>3</td>
<td>4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No internal mammary artery use, %</td>
<td>4.9</td>
<td>3.1</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

COPD indicates chronic obstructive pulmonary disease. For variables with 1 category, the $\chi^2$ P value represents the comparison (with respect to the variable of interest) of patients whose procedure was conducted with OVH versus EVH. For those variables with >1 category, the $\chi^2$ P represents the comparison (across categories of the variable of interest) of patients whose procedure was conducted with OVH versus EVH.

*P is from the Wilcoxon rank sum test.

Red blood cell transfusion, %* | 49.9 | 49.0 | 0.41 |

*Any transfusion given perioperatively.
†Among patients discharged alive.
‡Outcome measure was log-transformed.

### Table 1. Preoperative and Intraoperative Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>OVH</th>
<th>EVH</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedures, n</td>
<td>4062</td>
<td>4480</td>
<td></td>
</tr>
<tr>
<td>Medications, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin within 7 d</td>
<td>85.0</td>
<td>88.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>$\beta$-blocker within 24 h</td>
<td>75.6</td>
<td>82.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Demographics, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;60</td>
<td>26.5</td>
<td>28.3</td>
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<tr>
<td>60–69</td>
<td>31.8</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>70–79</td>
<td>33.4</td>
<td>30.3</td>
<td>0.01</td>
</tr>
<tr>
<td>≥80</td>
<td>8.2</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Female gender</td>
<td>29.2</td>
<td>25.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;31</td>
<td>67.0</td>
<td>68.0</td>
<td></td>
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<tr>
<td>31–36</td>
<td>23.7</td>
<td>23.1</td>
<td>0.02</td>
</tr>
<tr>
<td>≥37</td>
<td>9.3</td>
<td>9.0</td>
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</tr>
<tr>
<td>Body surface area, m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1.70</td>
<td>10.8</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>1.70–1.99</td>
<td>40.4</td>
<td>39.0</td>
<td>0.03</td>
</tr>
<tr>
<td>≥2.00</td>
<td>48.8</td>
<td>51.2</td>
<td></td>
</tr>
<tr>
<td>Comorbidities, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>35.1</td>
<td>36.9</td>
<td>0.07</td>
</tr>
<tr>
<td>Vascular disease</td>
<td>21.8</td>
<td>23.9</td>
<td>0.02</td>
</tr>
<tr>
<td>COPD</td>
<td>10.4</td>
<td>9.8</td>
<td>0.33</td>
</tr>
<tr>
<td>Dialysis or creatinine &gt;2 mg/dL.</td>
<td>3.7</td>
<td>3.5</td>
<td>0.60</td>
</tr>
<tr>
<td>Cardiac history, %</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Prior myocardial infarction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>53.7</td>
<td>57.5</td>
<td></td>
</tr>
<tr>
<td>&lt;7 d before procedure</td>
<td>19.8</td>
<td>19.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≥7 d before procedure</td>
<td>26.6</td>
<td>23.0</td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>13.4</td>
<td>11.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cardiac anatomy and function, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left main stenosis, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50</td>
<td>69.7</td>
<td>70.0</td>
<td></td>
</tr>
<tr>
<td>50–89</td>
<td>26.0</td>
<td>25.7</td>
<td>0.81</td>
</tr>
<tr>
<td>≥90</td>
<td>4.4</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Diseased vessels, n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10.3</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>35.4</td>
<td>39.2</td>
<td>0.03</td>
</tr>
<tr>
<td>3</td>
<td>54.4</td>
<td>50.9</td>
<td></td>
</tr>
<tr>
<td>Ejection fraction, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥40</td>
<td>73.0</td>
<td>79.9</td>
<td></td>
</tr>
<tr>
<td>&lt;40</td>
<td>12.5</td>
<td>13.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Missing</td>
<td>14.5</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Priority, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urgent</td>
<td>72.6</td>
<td>71.2</td>
<td>0.16</td>
</tr>
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(Continued)
difference in leg wound infection by method of vein harvesting. In another randomized trial, Kiaii et al\textsuperscript{15} reported a lower rate of leg wound infections at discharge among EVH (0\% versus 4\%; \( P=0.12 \)) and out to 6 weeks after surgery (4\% versus 25\%; \( P<0.001 \)). The use of EVH has been associated with reduced pain and increased mobility relative to OVH.\textsuperscript{16} Kiaii et al found no evidence of significant damage through histological assessment among 13 open and 15 endoscopically harvested veins and surmised that postoperative myocardial infarctions or graft closures were not likely secondary to endothelial injury from the vein harvest. Other series have reported similar findings using light or electron microscopy.\textsuperscript{17}

In an observational study, Lopes et al\textsuperscript{4} reported a significantly higher mortality rate 3 years beyond the index admission among patients having EVH (7.4\%) versus OVH (5.8\%; \( P=0.005 \)). This report documents a small but significant decrease in mortality within 4 years of the index admission (11.3\% for EVH versus 13.8\% for OVH; \( P<0.001 \)). Others have noted significant differences in leg wound infections between EVH and OVH when patients are followed up beyond discharge. Among patients randomized to EVH versus OVH, Kiaii et al\textsuperscript{15} reported 16 additional leg wound

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**Figure 2.** Adjusted risk of mortality by vein harvesting approach (2001 to 2004). The HR is for EVH relative to OVH related to mortality. Adjusted for age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, history of myocardial infarction, acuity, vascular disease, diabetes mellitus, renal failure and/or elevated creatinine, chronic obstructive pulmonary disease, body mass index, and medical center.

**Figure 3.** Adjusted risk of repeat revascularization by vein harvesting approach (2001 to 2004). The HR is for EVH relative to OVH related to risk of repeat revascularization. Adjusted for age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, history of myocardial infarction, acuity, vascular disease, diabetes mellitus, renal failure and/or elevated creatinine, chronic obstructive pulmonary disease, body mass index, and medical center.
infections occurring beyond the index admission (3 additional among EVH patients, 13 among OVH patients). Of all wound infections reported by Kiaii et al, 18.4% occurred beyond the hospital admission. It is possible that this increased rate of infection is causally related to the increased long-term mortality. However, the underlying mechanism for this long-term effect is uncertain; thus, this finding remains only hypothesis generating.

In a meta-analysis of 27 published studies, Athanasiou et al18 found a reduced rate of wound healing disturbances among patients undergoing EVH versus OVH. Among the 12 randomized trials within this meta-analysis, EVH was associated with a significant reduced risk (4% versus 13%; odds ratio, 0.24) of noninfective wound disturbances (defined as “wound drainage, hematoma, dehiscence, necrosis, need for surgical debridement, and seroma formation”).

Other studies have investigated the association of harvesting method on long-term outcomes, including infection, pain, patient satisfaction, mortality, and risk of repeat revascularization. Hayward et al14 found no differences in leg wound infection, pain, and physical and mental health within 6 weeks of the index admission in a randomized trial of 100 patients. However, patients in the EVH arm had a significantly improved perception of the cosmetic result of the leg incision relative to those having OVH (P=0.03). Yun et al19 investigated outcomes (graft patency and leg wound infections) at 6 months in a randomized trial of 200 patients. In that study, endoscopy was associated with a reduced risk of leg wound infection (7.4% versus 19.4%; P=0.014) and no increased risk of graft occlusion. Allen et al20 conducted a randomized trial among 112 patients undergoing isolated CABG surgery. No significant differences in 5-year event-free (freedom from death, myocardial infarction, recurrent angina) survival were identified (75% for EVH versus 74% for OVH; P=0.85). Lopes et al21 reported on long-term survivorship, myocardial infarction, and repeat revascularization among 3014 patients (1753 EVH, 1247 OVH) undergoing first-time isolated CABG surgery.4 Patients were recruited into this study as part of a larger multicenter randomized trial investigating the use of vein graft treatments. EVH was associated with a higher adjusted risk of both death (HR, 1.5; P=0.005) and the combined end point of death, myocardial infarction, or repeat revascularization (HR, 1.22; P=0.04). In a recent single-center observational study of 5825 patients undergoing CABG and/or valve surgery, Ouzounian et al23 reported a significant protective effect of EVH on leg wound infections (odds ratio, 0.48; P=0.003) but reported no differences in mortality, whether in-hospital or midterm. Additionally, patients receiving EVH had a reduced (odds ratio, 0.74; P=0.01) odds of readmission for unstable angina.

Two findings from the present analysis are noteworthy. First, the results detailed here contradict those of Lopes et al,4 who reported an adjusted HR of 1.5 (P=0.005) for the influence of EVH on survival within 3 years of surgery. In the present study, EVH was associated with a 20% reduced risk of mortality 4 years beyond the index admission. When this outcome is conditioned for survival up to 90 days beyond the index admission, EVH was associated with a significant reduction in risk of long-term mortality (adjusted HR, 0.74; 95% CI, 0.60 to 0.92). Second, EVH did not significantly increase the risk of repeat revascularization after adjustment for patient and disease characteristics (adjusted HR, 1.10; 95% CI, 0.96 to 1.74). In theory, endothelial damage may arise during the endoscopic procedure. Given that EVH was not associated with a diminishment in repeat revascularization, the underlying mechanism supporting the apparent effect of EVH on long-term mortality is unclear and worthy of further investigation.

In this regional observational cohort study, several methods were used to control for potentially confounding factors, including propensity score analysis and logistic regression for in-hospital outcomes, as well as Cox proportional hazards regression for long-term outcomes. Some investigators have criticized the use of such methods for their inability to adequately balance other potential confounding factors and have suggested the use of propensity scoring in the setting of an observational study.22 Thus, the association between EVH use and each of the primary outcomes was explored through the use of propensity scoring. In all cases, such analyses provided consistent findings related to the influence of the vein harvesting method. Although the present data did not allow validation of repeat revascularization with angiography throughout the 4-year follow-up period, a patient’s risk of reintervention, whether percutaneous coronary intervention or subsequent CABG surgery, was confirmed if performed at any of the 8 participating northern New England medical centers. The influence of EVH on outcomes may be attributed in part to the skill level of the practitioner, in many cases a physician assistant. It is likely that this skill level influenced the variability in the directionality of the influence of EVH on the risk of repeat revascularization. Although such data were not available through the NNECDSG regional registries, the influence of time was explored. Year of the index procedure was not a significant risk factor for any of the primary endpoints.

Conclusions
The use of EVH was not associated with harm, as measured by a significant diminishment in long-term survival or repeat revascularization. These findings, along with the previously reported short-term benefits of reduced morbidity, suggest that EVH is a safe and viable technique for obtaining saphenous vein conduit for CABG surgery. Additional studies are warranted to improve our understanding of the mechanism by which EVH influences long-term outcomes, as well as how clinical teams can maximize the utility of this technique.

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Disclosures
None.
References


CLINICAL PERSPECTIVE

Use of endoscopic saphenous vein harvesting has developed into a routine surgical approach at many cardiothoracic surgical centers, although its association with long-term morbidity and mortality has recently been called into question. We undertook a retrospective analysis of our experience in northern New England during a time period in which both open and endoscopic techniques were being performed. From 2001 to 2004, 8542 patients underwent isolated coronary artery bypass grafting procedures, 52.5% with endoscopic vein harvesting. Surgical discretion dictated the vein harvest approach. The main outcomes were death and repeat revascularization within 4 years of the index admission. The use of endoscopic vein harvesting increased from 34% in 2001 to 75% in 2004. In general, patients undergoing endoscopic vein harvesting had greater disease burden. Endoscopic vein harvesting was associated with an increased adjusted risk of bleeding requiring a return to the operating room (2.4 versus 1.7; P=0.03) but a decreased risk of leg wound infections (0.2 versus 1.1; P<0.001). Use of endoscopic vein harvesting was associated with a significant reduction in long-term mortality (adjusted hazard ratio, 0.74) but a nonsignificant increased risk of repeat revascularization (adjusted hazard ratio, 1.29). Similar results were obtained in propensity-matched analysis. These findings suggest that endoscopic vein harvesting is a safe and viable technique for obtaining saphenous vein conduit for coronary artery bypass grafting surgery. Additional studies are warranted to improve our understanding of the mechanism by which endoscopic vein harvesting influences long-term outcomes, as well as how clinical teams can maximize the utility of this technique.
Long-Term Outcomes of Endoscopic Vein Harvesting After Coronary Artery Bypass Grafting

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SUPPLEMENTAL MATERIAL

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SUPPLEMENTAL METHODS
The risk of death or repeat revascularization by vein harvest method was compared using the Wald test within a Cox Proportional Hazards model adjusting for the following covariates: age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, prior myocardial infarction, acuity, vascular disease, diabetes, renal failure or creatinine ≥2 mg/dl, chronic obstructive pulmonary disease, body mass index and medical center. The proportional hazards assumption was explored, including log-log plots. These analyses provided evidence supporting the proportional hazards assumption.

SUPPLEMENTAL FIGURE
Supplemental Figure 1. Hazard ratios (HR) for mortality by medical center.
Boxes represent the estimate for each medical center’s HR. Each HR has an adjoining 95% confidence interval. For a given medical center, confidence intervals that overlap with a HR of “1” suggest that no significant increased hazard is present for that medical center related to EVH and mortality. An asterisk (*) represents an insufficient case count to derive a reliable HR estimate for a given medical center.

**Supplemental Figure 2.** Hazard ratios (HR) for risk of repeat revascularization by medical center.

Boxes represent the estimate for each medical center’s HR. Each HR has an adjoining 95% confidence interval. For a given medical center, confidence intervals that overlap with a HR of “1” suggest that no significant increased hazard is present for that medical center related to EVH and risk of repeat revascularization.
Supplemental References

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