From the Society for Vascular Surgery

Active smoking in claudicants undergoing lower extremity bypass predicts decreased graft patency and worse overall survival

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ABSTRACT

Objective: Performing lower extremity bypass (LEB) in actively smoking claudicants remains controversial. Whereas some surgeons advocate a strict nonoperative approach to active smokers, citing perceived inferior outcomes, others will proceed with surgical bypass if the patient is anatomically suited and medical management has failed. The purpose of this study was to determine the impact of active smoking on LEB outcomes among claudicants.

Methods: All patients undergoing infrainguinal LEB for claudication in the Vascular Study Group of New England from 2003 to 2016 were analyzed. Smoking was defined as active tobacco use within 1 month of surgery. End points included in-hospital outcomes; long-term primary, assisted primary, and secondary patency; and mortality. Univariate, Cox multivariable, and Kaplan-Meier methods were used to determine the impact of smoking. Propensity score matching was performed to control for intergroup differences.

Results: Of 1789 LEBs, 971 (54%) were performed in nonsmokers and 818 (46%) in smokers. The follow-up rate was 87% at a mean of 382 days (standard error, ±6.8 days). Smokers were younger (60 vs 68 years; $P < .001$) and were less likely to have multiple comorbidities, including hypertension, coronary artery disease, congestive heart failure, diabetes, and chronic renal insufficiency ($P \leq .05$); they were more likely to have an above-knee popliteal bypass target (52% vs 43%; $P = .001$). Smokers also had lower rates of postoperative major cardiac events (2.4% vs 5.3%; $P = .002$) and perioperative blood transfusion (5.6% vs 11%; $P < .001$) compared with nonsmokers, but there was no difference in respiratory complications, wound complications, or mortality. At 2-year follow-up, smokers demonstrated inferior primary patency (48% vs 61%; $P = .03$) and assisted primary patency (59% vs 74%; $P = .01$), with comparable rates of secondary patency and overall mortality. Propensity matching yielded two similar groups (n = 450 for each). Propensity-matched smokers had significantly decreased 2-year primary patency (43% vs 58%; $P = .02$), assisted primary patency (54% vs 71%; $P = .03$), and 10-year survival (69% vs 76%; $P < .01$). Cox multivariable analysis confirmed that smoking was an independent predictor of diminished primary patency (hazard ratio [HR], 1.3; 95% confidence interval [CI], 1.0-1.6; $P = .03$), assisted primary patency (HR, 1.4; 95% CI, 1.1-1.8; $P = .004$), and overall survival (HR, 1.3; 95% CI, 1.1-1.5; $P < .001$).

Conclusions: Despite the fact that smokers are younger and have fewer comorbidities than nonsmokers, active smoking at the time of LEB for claudication is associated with decreased long-term patency and decreased overall survival. Surgeons should consider smoking an important risk factor for worse LEB outcomes in smokers compared with nonsmokers. (J Vasc Surg 2018;■:1-10.)

Active smoking at the time of surgery is a known risk factor for poor perioperative outcomes,[1,2] early graft failure[3,4] and long-term patency loss[5] in lower extremity bypass (LEB). Smoking cessation before surgery may improve limb-related outcomes as well as overall survival and is therefore explicitly recommended by the Society for Vascular Surgery for claudicants.[6] Efforts are currently under way to better determine improved techniques in smoking cessation.[7] Accordingly, given the elective nature of intervening among claudicants,

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Author conflict of interest: none.

Presented at the 2017 Vascular Annual Meeting of the Society for Vascular Surgery, San Diego, Calif, May 31-June 3, 2017.

Additional material for this article may be found online at www.jvascsurg.org.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

https://doi.org/10.1016/j.jvs.2017.12.044

some practitioners will advocate a strict nonoperative policy toward smokers, citing inferior surgical outcomes in active smokers, whereas others will proceed with surgical bypass irrespective of smoking status and medical therapeutic options if the patient is anatomically suited.

To date, most prior work addressing the effect of smoking on LEB outcomes has addressed mixed populations of patients with critical limb ischemia (CLI) and claudication.[4,5] In CLI patients, the possibility of delaying surgery may not be feasible. Furthermore, the majority of studies have focused on perioperative and short-term outcomes. There are few long-term data examining the impact of active smoking on graft patency. Estimation of the effect of smoking on graft patency would prove valuable in counseling of patients and therapeutic decision-making and ultimately have the potential to improve efforts aimed at preoperative smoking cessation.

The purpose of this study was to determine the effects of active smoking on perioperative outcomes and long-term patency after LEB for claudication. Furthermore, we sought to determine whether there was any benefit for patients who quit smoking in the follow-up period.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected data from the Vascular Study Group of New England database
- **Take Home Message:** Smokers with claudication who undergo lower extremity bypass have lower long-term primary and assisted primary patencies and shorter 10-year survival than nonsmokers.
- **Recommendation:** The authors recommend that risk factor modification include smoking cessation before revascularization for claudication to optimize patency and survival.

METHODS

Database and cohort assembly. All LEBs performed for claudication in the Vascular Study Group of New England (VSGNE) from 2003 to 2016 were studied. The VSGNE is a regional vascular quality initiative that has been described in detail previously.[8,9] Centers participating in the VSGNE enter detailed patient, operative, and follow-up information into a prospectively maintained, procedure-based data set. Data quality is ensured through center feedback and data audits. The VSGNE database was selected for this study because it has been maintained for >10 years, and follow-up data are relatively complete for LEB. The VSGNE contains deidentified patient data, and as a result, this study was exempt from Institutional Review Board approval and consent was not necessary.

Bypass procedures that were included in the study cohort were infrainguinal bypasses for claudication during the study period. Only the first bypass for each patient was analyzed; any subsequent bypass on either extremity was excluded. Procedures were also excluded if the indication for bypass was aneurysmal disease. Regarding technical factors, procedures were excluded if a concurrent suprainguinal bypass was performed or if a nonautologous biologic or a composite conduit was used.

All centers performing LEB that met inclusion criteria during the study period were included. Descriptive analyses of center-level behavior were performed to determine the proportion of nonsmokers and smokers undergoing LEB across the region.

Exposure and in-hospital outcome measures. Patients were classified as active smokers if they attested to smoking within 1 month of surgery and as nonsmokers if they had a history of remote smoking or never smoked. Patients using smokeless tobacco were not considered smokers. A single patient was excluded who had no information on tobacco use at the time of surgery. In-hospital outcomes targeted medical complications (cardiac and respiratory complications), bleeding-related outcomes (estimated blood loss, mean procedure time, and blood transfusion), and limb-related outcomes (infectious complications, reoperation, graft occlusion at discharge, and ipsilateral major amputation). Major cardiac event was defined as the occurrence of new myocardial infarction, dysrhythmia, or new-onset congestive heart failure.[10] Respiratory complications were defined as the occurrence of pneumonia or reintubation. Length of stay and 30-day mortality were also analyzed on the basis of smoking status.

Long-term follow-up. In the study cohort, 86.7% of patients had follow-up data from at least one follow-up visit. Mean follow-up was 382 days (standard error, ±6.8 days), with no significant difference based on the exposure variable (smokers, 395 ± 7.5 days; nonsmokers, 371 ± 11.8 days; $P = .08$). Of the remaining patients, 7.0% were lost to follow-up. In addition, 6.3% of patients were not included in long-term outcome analyses because of incomplete follow-up data but were not considered lost to follow-up (based on Vascular Quality Initiative [VQI] recommendations) if the bypass was performed within 18 months of data harvest, the patient died before discharge from index surgery, or the patient underwent surgery at a center with overall <50% follow-up rate.

Long-term outcomes included primary patency, assisted primary patency, and secondary patency.[11] Overall mortality was also determined as an outcome, and notably, the VSGNE obtains mortality data for all patients with none lost to follow-up. As a result, mean follow-up for the all-cause mortality end point was considerably