



Outcomes of open and endovascular lower extremity revascularization in active smokers with advanced peripheral arterial disease

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ABSTRACT

Objective: Concern over perioperative and long-term durability of lower extremity revascularizations among active smokers is a frequent deterrent for vascular surgeons to perform elective lower extremity revascularization. In this study, we examined perioperative outcomes of lower extremity endovascular (LEE) revascularization and open lower extremity bypass (LEB) in active smokers with intermittent claudication (IC) and critical limb ischemia (CLI).

Methods: Active smokers undergoing LEE or LEB from 2011 to 2014 were identified in the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) targeted vascular data set. Patient demographics, comorbidities, anatomic features, and perioperative outcomes were compared between LEE and LEB procedures. Subgroup analysis was performed for patients undergoing revascularization for IC and CLI independently.

Results: From 2011 to 2014, 4706 lower extremity revascularizations were performed in active smokers (37% of all revascularizations). In this group, 1497 were LEE (55.6% for CLI, 13.4% for below-knee pathology) and 3209 were LEB (68.9% CLI, 34.7% below-knee). Patients undergoing LEE had higher rates of female gender, hypertension, end-stage renal disease, and diabetes (all $P \leq .02$). LEE patients also had a higher frequency of prior percutaneous interventions (22.7% vs 17.2%; $P < .01$) and preoperative antiplatelet therapy (82.3% vs 78.7%; $P = .02$). On risk-adjusted multivariate analysis, LEE patients had higher need for reintervention on the treated arterial segment than LEB (5.1% vs 5.2%; odds ratio [OR], 1.52; 95% confidence interval [CI], 1.08-2.13; $P = .02$) but had lower wound complications (3.1% vs 13.2%; OR, 0.32; 95% CI, 0.23-0.45; $P < .01$) and no statistically significant difference in 30-day mortality (0.6% vs 0.9%), myocardial infarction or stroke (1.1% vs 2.6%), or major amputation (3.2% vs 2.1%) in the overall cohort of active smokers. In the IC subgroup, myocardial infarction or stroke was significantly higher in the LEB group (1.9% vs 0.6%; OR, 1.83; 95% CI, 1.17-1.97; $P = .03$), although no difference was found in the CLI subgroup (2.8% vs 1.4%; OR, 0.75; 95% CI, 0.37-1.52; $P = .42$). Also in IC group, there was a trend for lower major amputation rates ≤ 30 days in the LEE group, whereas in the CLI group, LEE had a trend toward higher risk of early amputation compared with LEB.

Conclusions: In active smokers, LEB for IC and CLI requires fewer reinterventions but is associated with a higher rate of postoperative wound complications compared with LEE revascularization. However, the risk for limb amputation is higher in actively smoking patients when treated by LEE compared with LEB for CLI. Importantly, cardiovascular complications are significantly higher in actively smoking patients with IC undergoing LEB compared with LEE. This additional cardiovascular risk should be carefully weighed when proposing LEB for actively smoking patients with nonlimb-threatening IC. (J Vasc Surg 2017;65:1680-9.)

Peripheral arterial disease (PAD) is an affliction affecting nearly 200 million individuals worldwide, ranging from asymptomatic disease to severe limb-threatening

ischemia.¹ Smoking has been clearly implicated as one of the most significant modifiable risk factors contributing to both the development of PAD and progression of disease once diagnosed.²⁻⁶

Historical observational data have shown that continued smoking is associated with higher rates of amputation, death, and myocardial infarction (MI) in patients with PAD compared with those who quit.⁷ The Society for Vascular Surgery practice guidelines for atherosclerotic occlusive disease of the lower extremities include smoking cessation as a Grade IA recommendation in the management of asymptomatic disease and intermittent claudication (IC).⁸

Increasing evidence shows that continued smoking leads to worse outcomes after various types of surgical intervention.⁹ In vascular surgery, smoking has been associated with early graft failure after infrainguinal

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bypass surgery.¹⁰⁻¹³ In addition, smoking cessation is associated with decreased mortality and improved amputation-free survival among patients with symptomatic PAD.¹⁴

Because traditional open surgery and more complex endovascular options are available for treating symptomatic PAD, great variation exists in practice patterns among vascular specialists who perform these treatments for patients with IC and critical limb ischemia (CLI).¹⁵ Specifically in smokers, practitioners must weigh the effect of continued smoking on outcomes after peripheral arterial interventions and decide when to offer open or endovascular revascularization to patients with nonlimb-threatening ischemia.

In this regard, there are limited contemporary data regarding the comparative outcomes among current smokers undergoing open lower extremity bypass (LEB) and lower extremity endovascular (LEE) revascularization for advanced peripheral arterial disease. In this study, we sought to evaluate the perioperative outcomes of LEE revascularization and LEB in a nationwide contemporary cohort of current smokers with IC and CLI.

METHODS

Data source. We retrospectively analyzed the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) Targeted Open Lower Extremity Revascularization and Lower Extremity Endovascular Revascularization Participant Use Data Files (PUFs) consisting of all qualifying procedures performed from January 1, 2011, to December 31, 2014, inclusively. The ACS NSQIP is a nationally validated, risk-adjusted, outcomes-based program to measure and improve the quality of surgical care in the United States. The data in the general and procedurally targeted databases are collected and entered by surgical clinical reviewers who are certified by the ACS. Strict variable definitions are used when data are collected to ensure consistency across participating centers, and periodic auditing is used to ensure accuracy.¹⁶

The procedurally targeted databases collect procedure-specific demographics, anatomic, and perioperative details, and 30-day postoperative outcomes data, which first became available in 2011. We then merged the targeted databases with the general PUF by the deidentified Case ID, allowing for both procedure-specific and general variables and outcomes collected in NSQIP to be analyzed for all cases. The NSQIP database is exempt from requiring informed consent from individual patients and does not require Institutional Review Board approval for analysis.

Cohort and variables. Patients who underwent LEB or LEE revascularization between 2011 and 2014 were identified from the NSQIP targeted database. The patients in this surgical group who were reported to have been

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) data
- **Take Home Message:** Analysis of 30-day outcome in 4706 active smokers undergoing lower extremity revascularization revealed that open surgery resulted in lower rate of early amputation but more wound infection and a higher rate of cardiovascular complications than endovascular repair.
- **Recommendation:** The authors suggest smoking cessation and avoiding open surgical bypass in claudicant patients who smoke.

smokers within the past year, a defined variable in the general NSQIP PUF, were selected for our study group.

Preoperative variables analyzed were age, gender, race, and comorbid conditions, including chronic obstructive pulmonary disease, congestive heart failure, hypertension requiring medication, diabetes mellitus, end-stage renal disease, chronic steroid use, obesity, dependent functional status, and high-risk physiology, defined as a recent adverse cardiac event within the past 6 months. Preoperative use of antiplatelet therapy, statins, and β -blockers was evaluated. Data regarding preoperative ankle-brachial indices were also identified, as were whether the procedure performed was deemed an emergency and whether the indication for the procedure was claudication, rest pain, or tissue loss. The latter two comprised the definition of the CLI cohort.

Perioperative variables analyzed were type of anesthesia used, below-knee vs above-knee target, bleeding requiring intraoperative or postoperative transfusion, and operative time. A below-knee target was defined as tibial angioplasty or stenting for the LEE group and bypass distal to the popliteal artery for the LEB group. Postoperative outcomes examined were 30-day mortality and postoperative occurrence of MI, stroke, and wound complications, major reintervention on the treated arterial segment, major amputation, venous thromboembolism, frequency of discharge to home vs another facility, and unplanned readmission. Hospital length of stay was also tabulated.

Statistical analysis. Univariate and multivariate analyses were performed comparing current smokers who underwent LEE with those who underwent LEB. Demographics, perioperative variables, and postoperative outcomes defined in the previous section were analyzed. Categorical variables were compared by χ^2 test, and continuous variables were compared by the Student *t*-test. A priori adjustments for age, gender, race, body mass index, chronic obstructive pulmonary disease,

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