# Mid-term results with laser atherectomy in the treatment of infrainguinal occlusive disease

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***Background:*** **Laser atherectomy offers a potential intervention for multivessel infrainguinal disease in patients with poor revascularization options. Despite promising early results reported in the literature, the proper patient population who might benefit from laser atherectomy has yet to be determined.**

***Methods:*** **From July 2004 to June 2006, patients undergoing laser atherectomy were retrospectively reviewed and assessed for comorbidities, operative and follow-up variables potentially associated with the end points of nondefinitive therapy, and limb salvage.**

***Results:*** **During the study period, 40 patients (21 women, 19 men) underwent laser atherectomy, and the average follow-up was 461 ± 49 days (range, 17 to 1050 days). Their average age was 68 ± 2 years (range, 43 to 93 years). The indication for laser atherectomy was critical limb ischemia in 26 (65%) and lower limb claudication in 11 (35%). A total of 47 lesions were treated in the following arterial segments: 34 femoropopliteal and 13 infrapopliteal. Femoropopliteal distribution by the Trans-Atlantic Society Classification (TASC) was A in 3, B in 17, C in 10, D in 4, and infrapopliteal lesions distribution was A in 1, B in 3, C in 4, and D in 5. Adjunctive angioplasty was used in 75% of cases. The overall technical success rate (<50% residual stenosis) was 88%. Laser atherectomy–based treatment was the definitive therapy for 23 patients (58%), and the overall 12-month primary patency was 44%. The limb salvage rate at 12 months in 26 patients with critical limb ischemia was 55%. Renal failure was a risk factor for amputation ($P < .001$) and failed primary patency ($P < .05$), type 2 diabetes mellitus was a risk factor for amputation ($P < .05$), and poor tibial runoff was associated with failed primary patency and amputation ($P < .05$). Outcome was associated with the number of patent infrapopliteal runoff vessels.**

***Conclusion:*** **These data demonstrate that laser atherectomy can be used with high initial technical success rate. Chronic renal failure and diabetes are risk factors for a negative outcome. Poor results in patients with diabetes and renal failure necessitate careful case selection in this subgroup, in which laser atherectomy is less likely to provide a definitive revascularization result or limb salvage. (J Vasc Surg 2007;46:289-95.)**

Laser atherectomy, also known as laser-assisted balloon angioplasty, was initially introduced in the 1980s for the treatment of peripheral arterial disease.[1] Neodymium:YAG lasers successfully delivered sufficient energy to debulk and successfully cross long occlusions and stenosis.[2] Unfortunately, a great deal of thermal energy was produced, leading to vessel wall damage. The resulting injury led to a high incidence of vessel thrombosis, spasm, and subsequent revascularization failure.

The excimer laser overcomes several technical shortcomings of earlier laser-based therapies and has been introduced as a vascular atherectomy device. Lower energy photons cause less thermal damage, and more flexible catheters result in less vessel wall perforation. Laser atherectomy is a potential option for patients that are a high surgical risk because of poor underlying physiology or complex lesion anatomy. Short-term outcomes from multicenter trials cite patency rates as high as 93% at 6 months in patients with critical limb ischemia.[3]

Despite this, skepticism exists about the long-term results of laser atherectomy and its place in the ever-growing list of endovascular therapies. The primary trials supporting the use of the excimer laser were industry-sponsored and subject to significant critique by the surgical community.[3,4] The purpose of this study was to examine contemporary outcomes associated with laser-assisted lower extremity revascularization outside of the confines of a clinical trial.

## METHODS

**Patient selection and data collection.** From July 2004 through June 2006, all patients undergoing catheter-based atherectomy of the infrainguinal arterial circulation were identified in a prospectively maintained computerized database (Common Procedural Codes 35495 and 45493), and all laser cases were then selected. The decision to use laser-assisted revascularization was based on clinical evaluation, anatomic factors, and the attending surgeon's preference. The study was approved by the University and Medical Center Institutional Review Board of the East Carolina University.

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Once identified, preoperative, procedural, and outcome variables were collected from the computerized patient care records. Basic demographic data were recorded, omitting patient identifying information. The indication for revascularization was classified by the criteria of Rutherford et al.[5] Patient comorbidities were defined as:

- diabetes mellitus: medical treatment for diabetes;
- hypertension: medical treatment for hypertension;
- hyperlipidemia: medical treatment of dyslipidemia or total cholesterol >200 mg/dL;
- tobacco use: recorded as both lifetime tobacco use and current use;
- coronary disease: medical therapy for coronary vascular disease or prior coronary revascularization;
- renal insufficiency: serum creatinine >1.5 mg/dL; and
- dialysis: chronic renal replacement therapy.

Perioperative medical management was noted and the following variables were dichotomized: aspirin use, clopidogrel (Plavix, Sanofi-Aventis, Bridgewayer, NJ) use, warfarin (Coumadin, Bristol-Myers Squibb, Princeton, NJ) use, and lipid-lowering therapy.

Critical limb ischemia (CLI) was defined as a Rutherford category >3.

Anatomic and morphologic characteristics were obtained by review of the archived images from the individual cases. Calibrated angiography was used to determine lesion lengths. The segment of intervention (femoropopliteal or infrapopliteal) was noted along with the number of patent tibial runoff vessels to the foot. These data were used to assign the target lesion with a TransAtlantic Inter-Society Consensus (TASC) classification (Appendix, online only).[6] Adjunctive endovascular procedures (angioplasty or stenting) and open procedures were documented.

**Procedure.** Monitored anesthetic care was used in most cases. Selective arteriography was obtained through contralateral retrograde femoral access or ipsilateral antegrade femoral access by using a 5F or 6F system. After localizing the index lesion, an attempt was made to cross the lesion with standard guidewire technique. This typically involved the use of a hydrophilic 0.035-inch guidewire or 0.014-inch/0.018-inch wire with a shapeable tip, avoiding subintimal passage. For lesions resistant to guidewire traversing, the laser "step-by-step" technique was used.[7] In brief, the step-by-step technique involves using brief applications of laser energy to allow serial advancement of the catheter and guidewire through the lesion.

Atherectomy was undertaken using the CLiRpath 308-nm wavelength excimer laser system (Spectranetics, Colorado Springs, Colo). The index lesion was debulked, and adjunctive angioplasty or stenting was then undertaken at the discretion of the operating surgeon. Stenting was used in a selective fashion only in flow-limiting dissections and recalcitrant lesions.

Technical success was defined as the ability to cross the target lesion with a wire, and achieve a residual stenosis <50% in all lesions treated, which is a definition derived from the Laser Angioplasty to treat Critical Limb Ischemia (LACI) trial.[3] Hemodynamic success was defined at an increase in ankle-brachial index (ABI) ≥0.1 or increase in plethysmographic tracing of ≥5 mm, or both.

All patients underwent risk-factor examination and modification in conjunction with their primary care provider. All attempts were made to optimize lipid profile, glycemic control, and hypertension management.

**Procedural complications.** Major and minor adverse events were recorded from the medical record. These included patient mortality from any cause, vessel damage from the catheter (dissection or perforation), access site complications, and any other untoward event.

**Long-term end points.** Primary patency and limb salvage were the principle end points in this study. Patency was determined by the guidelines of Rutherford et al and used routine physiologic examinations in those patients without a palpable pulse.[5] Duplex ultrasound surveillance was not used in these patients. Deterioration in clinical status or hemodynamics prompted further imaging. Failure of limb salvage was defined as a major amputation ipsilateral to the target lesion. Total follow-up time was recorded for each patient as well as the time to failed primary patency or amputation, where appropriate.

**Statistical analysis.** Patient demographic, comorbidity, medical therapy, and anatomic characteristic variables were compared for each long-term outcome (primary patency and limb salvage in critical limb ischemia cases). Categoric variables were analyzed using $\chi^2$ with the Fisher exact test as appropriate. Continuous variables were analyzed using the Student *t* test and are presented as mean ± standard error. A $P < .05$ was considered significant for all statistical analysis. Kaplan-Meier life tables were created for each significant variable with respect to the long-term outcomes. The analysis was generated using SAS 9.1 software (SAS Institute Inc, Cary, NC).

## RESULTS

During the 24-month study period, 40 patients underwent revascularization with laser atherectomy (Table I). Most of these patients had rest pain or tissue loss as an indication for revascularization. Hypertension was nearly ubiquitous in the study population, and diabetes mellitus, hyperlipidemia, and tobacco abuse were present in more than half the patients. Most patients were maintained on antiplatelet therapy in the perioperative period. During the same time period, an additional 197 endovascular femoropopliteal or femoropopliteal with tibial interventions were performed. The use of the laser catheter was at the discretion of the attending surgeon and reserved for cases when a guidewire could not be readily passed through a target lesion into the distal circulation.

A total of 47 lesions were treated in these 40 patients, and 34 were femoropopliteal arterial distribution (Table II). TASC C or D lesions made up 41% of the femoropopliteal lesions and 69% of the infrapopliteal lesions. Adjunctive angioplasty was used in 75% of the lesions, and 13% required selective stenting. The initial technical success rate was 88%, with a total major and minor adverse event rate of

**Table I.** Patient characteristics

| *Characteristic** | *No. or mean* | *% or range* |
|---|---|---|
| Demographics | | |
| Patients | 40 | 100 |
| Age, years | 67.9 ± 2.1 | (43-93) |
| Female gender | 21 | 52 |
| Indication–Rutherford category | | |
| 3–Severe claudication | 14 | 35 |
| 4–Ischemic rest pain | 11 | 28 |
| 5–Minor tissue loss | 15 | 38 |
| Clinical | | |
| Diabetes mellitus | 22 | 55 |
| Type I | 2 | 5 |
| Type II | 20 | 50 |
| Hypertension | 37 | 93 |
| Hyperlipidemia | 23 | 58 |
| Tobacco (any history) | 27 | 68 |
| Coronary artery disease | 18 | 45 |
| Serum creatinine (mg/dL) | 1.1 ± 0.08 | |
| Dialysis | 5 | 13 |
| Medical management | | |
| Aspirin | 31 | 78 |
| Clopidogrel | 26 | 65 |
| Warfarin | 7 | 18 |
| Lipid therapy | 19 | 48 |
| Follow-up, mean (days) | 461 ± 49 | (17-1050) |

*Categoric data are presented as number and percentage; continuous data as mean ± standard error (range).

**Table II.** Characteristics of 47 lesions treated by laser atherectomy in 40 patients

| *Characteristic* | *No.* | *%* |
|---|---|---|
| Femoropopliteal segment | | |
| Lesions, n | 34 | |
| Occluded, n | 14 | 41 |
| TASC A | 3 | 9 |
| TASC B | 17 | 50 |
| TASC C | 10 | 30 |
| TASC D | 4 | 12 |
| Infrapopliteal segment | | |
| Lesions, n | 13 | |
| Occluded, n | 7 | 54 |
| TASC A | 1 | 8 |
| TASC B | 3 | 23 |
| TASC C | 4 | 31 |
| TASC D | 5 | 39 |
| Adjunctive procedures | | |
| None | 6 | 15 |
| PTA | 30 | 75 |
| Stent | 5 | 13 |
| Hybrid | 3 | 8 |
| Open/endovascular | | |
| Tibial runoff | | |
| 0 | 5 | 13 |
| 1 | 20 | 50 |
| 2 | 7 | 18 |
| 3 | 8 | 20 |

*TASC,* TransAtlantic Inter-Society Consensus; *PTA,* percutaneous transluminal angioplasty.

**Table III.** Perioperative outcome after laser atherectomy

| | *No. or mean* | *%* |
|---|---|---|
| Technical success | 35 | 88 |
| Hemodynamic success* | 30 | 75 |
| Change in ABI (mean ± SE) | >0.26 ± 0.03 | |
| Adverse event | 13 | 33 |
| Death (30 day) | 2 | 5 |
| Vessel perforation | 2 | 5 |
| Hematoma or bleeding | 1 | 3 |
| Dissection (nonflow limiting) | 5 | 13 |
| Arteriovenous fistula | 1 | 3 |
| False aneurysm | 1 | 3 |
| Other | 1 | 3 |

*ABI,* Ankle-brachial index; *SE,* standard error.
*Defined as an increase in ABI >0.1.

33% (Table III). Hemodynamic improvement was noted in 75% of cases, with at least a 0.1 increase in ABI or 5 mm improvement in pulse volume recording tracing. A guidewire was placed distal to the target lesion in all of the cases.

The 30-day adverse event rate was 33%, with two deaths in this time period (Table III); neither was related to the revascularization procedure. All other complications were managed conservatively, and no emergency procedures were required.

During the mean follow-up of 461 ± 49 days, laser-assisted revascularization was a definitive mode of revascularization (remained primarily patent) in 23 of 40 total cases (Table IV). Limb salvage was achieved in 19 of 26 cases of CLI (4 above knee amputations, 3 below knee amputations). There was no limb loss in patients with severe claudication. The CLI population had a higher incidence of diabetes, renal insufficiency, and dialysis dependence compared with the total group. CLI with diabetes and renal insufficiency were associated with limb loss ($P < .05$). Renal failure with dialysis dependence ($P < .01$) and poor tibial runoff ($P < .05$) was associated with failure of primary patency and limb loss. Kaplan-Meier life-table analysis demonstrated primary patency (all patients) and limb salvage (CLI patients) probabilities at 12 months were 43.8% ± 0.1% and 55.0% ± 0.2%, respectively (Figs 1 and 2). Nine of the 17 patients who failed primary patency went on to a secondary revascularization (repeat endovascular procedures, 2; surgical bypass, 7).

## DISCUSSION

Recently, many authors have suggested that the endovascular technique should surpass surgical bypass as the first-line therapy for chronic lower extremity ischemia.[8-10] The interventional literature has consistently supported this first-line angioplasty approach, but the surgical literature remains, as expected, guarded at times. The principle arguments against a primary endovascular approach to infrainguinal occlusive disease is purportedly the higher patency rates realized with surgical bypass grafts and the possibility of converting a relatively simple open revascularization to a more complex one. This argument is offset by the reported

**Table IV.** Univariate analysis of patient and anatomic variables associated with primary patency (all patients) and limb salvage (patients with critical limb ischemia)

| Variables* | *Primary patency, n (%) (all patients, n = 40)* | | *Limb salvage, n (%) (CLI patients, n = 26)* | |
|---|---|---|---|---|
| | *Yes* | *No* | *Yes* | *No* |
| Patient variables | | | | |
| Number | 23 | 17 | 19 | 7 |
| Age, years | 69.9 ± 2.8 | 65.2 ± 3.1 | 64.1 ± 3.1 | 49.2 ± 4.9 |
| Female gender | 13(61) | 8(47) | 11(58) | 3(42) |
| Critical limb ischemia | 15(65) | 14(82) | N/A | N/A |
| Diabetes | 11(47) | 7(41) | 11(58) | 6(86)† |
| Hypertension | 22(96) | 15(88) | 17(89) | 7(100) |
| Hyperlipidemia | 11(48) | 12(71%) | 12(63) | 6(86) |
| Tobacco | 15(65) | 12(71) | 11(58) | 5(71) |
| Coronary disease | 12(52) | 6(35) | 9(47) | 4(57) |
| Renal insufficiency‡ | 4(17) | 7(41) | 4(21) | 5(71)† |
| Dialysis | 0(0) | 5(29)§ | 1(5) | 4(57)§ |
| Medical management | | | | |
| Aspirin | 18(78) | 13(76) | 15(79) | 6(86) |
| Clopidogrel | 14(61) | 12(71) | 10(53) | 5(71) |
| Warfarin | 5(22) | 2(12) | 5(26) | 1(14) |
| Lipid therapy | 9(39) | 19(59) | 11(58) | 5(57) |
| Anatomic characteristics | | | | |
| Femoropopliteal–Any | 19(82) | 15(88) | 11(58) | 3(43) |
| Femoropopliteal–TASC C or D | 6(26) | 8(47) | 6(31) | 1(14) |
| Infrapopliteal–Any | 8(35) | 5(29) | 9(47) | 4(57) |
| Infrapopliteal–TASC C or D | 5(22) | 4(24) | 6(32) | 3(43) |
| Tibial runoff | 1.7 ± 0.2 | 1.1 ± 0.2† | 0.9 ± 0.2 | 0.3 ± 0.2† |
| Runoff >1 vessel | 12(52) | 3(18)† | 6(31) | 0(0)† |
| Initial technical success | 20(87) | 15(88) | 17(89) | 6(86) |
| Initial hemodynamic success | 11(48) | 7(41) | 7(37) | 3(43) |

*CLI,* Critical limb ischemia = Rutherford category >3; *TASC,* TransAtlantic Inter-Society Consensus; N/A, not applicable.
*Categoric values presented as number (%); continuous variables as mean ± standard error.
†$P < .05$.
‡Serum creatinine >1.5 mg/dL.
§$P < .01$.

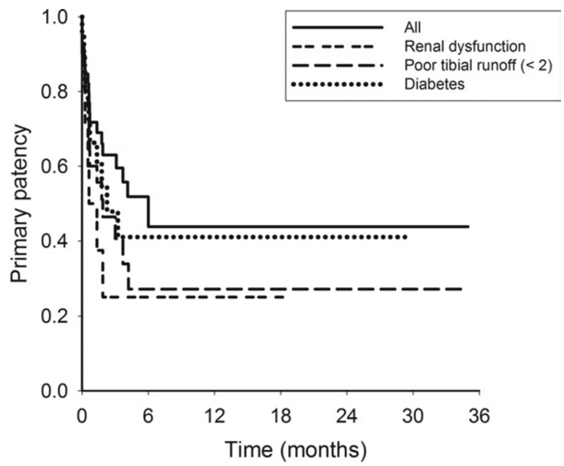
higher costs of surgical revascularization and the often-significant morbidity associated with lower extremity bypass.[11,12] We have maintained an aggressive stance towards endovascular-based revascularization, primarily because of the morbidity associated with surgical revascularization in this high-risk, underserved patient population.

This study used a catheter-based excimer laser atherectomy system. The catheter contains a flexible fiberoptic channel that allows the remote delivery of 308-nm wavelength energy to the target lesion. A unique property of this ultraviolet excimer laser is that it selectively ablates atherosclerotic plaque and thrombus.[13,14] The goal of laser-based endovascular therapy is to primarily treat appropriate lesions and convert more complex angiographic scenarios to those more amenable to angioplasty. In addition, the laser catheter assists in traversing total occlusions with the avoidance of subintimal techniques.

Laird et al[3] described the contemporary trial justifying the use of a laser-based revascularization strategy. The LACI was a prospective trial that enrolled 145 patients deemed to be poor surgical candidates. Laser-assisted revascularization achieved a high initial technical success rate and a 6-month limb salvage rate of 93%. These high initial success rates were in the face of mostly TASC C and D lesions. Data were only collected to the 6-month trial end point. The principle critiques of this study include its nonrandomized design and small sample size for a multicenter study. Nonetheless, one can conclude from the LACI trial that laser-assisted angioplasty can be used across a wide range of complex anatomic lesions with a high technical success rate and admirable short-term success rates. These data were echoed in a subsequent European study citing 6-month limb salvage >90%.[4]

Advocates of a primary endovascular approach to lower extremity ischemia cite procedural morbidity and patient preference toward a more minimally invasive approach as the primary driving forces. Indeed, the morbidity of surgical lower extremity revascularization can be significant. A recent study from Conte et al[15] demonstrated a 30-day morbidity of 17.6% and mortality of 2.7% after lower extremity bypass. In fact, total morbidity, including minor events, is undoubtedly much higher for these patients.[16]

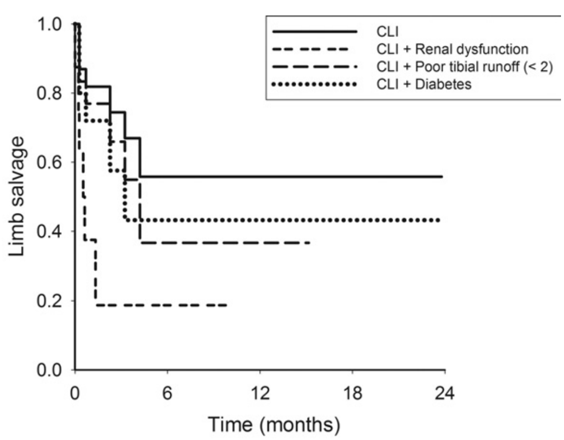
The study presented here found a total complication rate of 33%; however, most of these were anatomic suboptimal results and did not alter the length of stay or short-term morbidity to the patient. Our practice includes a high




Number at risk:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| All: | 40 | 12 | 9 | 8 | 3 | 1 | 0 |
| Renal: | 11 | 6 | 1 | 0 | | | |
| Runoff: | 25 | 4 | 3 | 2 | 1 | 1 | 0 |
| DM: | 22 | 6 | 5 | 4 | 1 | 0 | |

**Fig 1.** Kaplan-Meier curve shows primary patency of revascularization of 40 patients undergoing laser atherectomy. *Renal,* Renal dysfunction (serum creatinine >1.5 mg/dL); *Runoff,* patent tibial runoff vessels <2; *DM,* diabetes mellitus.




Number at risk:

| | | | | | |
|---|---|---|---|---|---|
| All: | 26 | 6 | 3 | 1 | 0 |
| Renal: | 9 | 1 | 0 | | |
| Runoff: | 20 | 2 | 1 | 0 | |
| DM: | 17 | 3 | 2 | 1 | 0 |

**Fig 2.** Kaplan-Meier curve for limb salvage of 26 patients with critical limb ischemia *(CLI)*, defined as Rutherford category >3, undergoing laser atherectomy. *Renal,* Renal dysfunction (serum creatinine >1.5 mg/dL); *Runoff,* patent tibial runoff vessels <2; *DM,* diabetes mellitus.

prevalence of socioeconomically disadvantaged patients. These patients are often at higher surgical risk, because they tend to present with poorly managed risk factors and advanced ischemic disease.[17] In the face of these data, a minimally invasive approach is justified in higher-risk patients, especially those without a suitable conduit.

Primary patency was defined as continued hemodynamic improvement in the setting of clinical improvement. Limb salvage was defined as freedom from major amputation ipsilateral to the site of laser intervention. Within the confines of these definitions, the 12-month primary patency and limb salvage rates were 44% and 55%, respectively, by life-table analysis (Figs 1 and 2). This number contrasts sharply with the aforementioned LACI trials.[3,4] These divergent results have several possible explanations:

1. This study is a retrospective review, subject to all the common critiques.
2. Although this was one of the larger single-institution excimer laser series for lower extremity revascularization, the number of patients enrolled was relatively small, and therefore treatment failure in a small number of patients has a major impact on outcome. Divergence in real-world clinical outcomes and those achieved on clinical trials is well described throughout a variety of clinical disciplines.[18]
3. The series we have presented has a significant number of patients with renal insufficiency and dialysis dependence. These variables were not specifically reported in the above-cited multicenter trials; thus, comparison is difficult. Our data do not reproduce the impressive results of the LACI trials, but instead coincide with earlier excimer laser results described in the literature.[19]

In our study, diabetes was found to be a significant factor associated with limb loss but not with initial treatment failure. Diabetes has previously been described as an independent risk factor for poor outcomes and limb loss by other authors as well.[20-24] An important factor in this correlation is that this deleterious role of diabetes mellitus can be minimized with appropriate glycemic control.[25,26] Macrovascular and microvascular circulation are both influenced by the presence of diabetes and the level of glycemic control. Using glycosylated hemoglobin ($HbA_{1c}$) as a surrogate, the vascular surgeon can readily monitor and optimize glycemic control in the diabetic patient with lower extremity ischemia. Accordingly, our patients with diabetes mellitus undergoing laser atherectomy all received appropriate periprocedural glucose control, and appropriate referrals were made for those patients with evidence of poor historic blood glucose control.

The other major clinical variable identified in this analysis was renal dysfunction. This study identified dialysis dependence as a risk factor for both revascularization failure and limb loss. In addition, renal insufficiency was associated with limb loss (Table IV). The negative impact of poor renal function was profound, with all dialysis patients requiring a second attempt at revascularization ≤6 months and all but one dialysis patient undergoing major amputation. Like diabetes, renal dysfunction has been well documented as an independent risk factor for short-term and long-term outcomes in the patient undergoing both open and percutaneous lower extremity revascularization.[12,27,28] The significant risk of cardiovascular complications in this patient population makes a minimally invasive approach attractive; however, this enthusiasm is dampened by poor revascularization outcomes described in this study and others noted above.

An important observation in this study is that retrospective TASC classification was not a predictor of revascularization success or limb salvage; however, tibial runoff was a correlate of both durability and limb salvage. The discordance between TASC classification and outcome in this series has several possible explanations:

First, although lesion length and resultant TASC classification has been a widely accepted method for predicting outcome after lower extremity revascularization, there are reports in the literature of equivalent outcomes regardless of anatomic characteristics.[6,9,29]

Second, and more probable, is the significant risk of a type II error because of the sample size in this study. The possibility of a type II error is supported by the observation that, while statistically not significant, there was a trend towards failure of primary revascularization in those patients with TASC C and D lesions. As expected, poor runoff was a marker for both failure and limb loss, as has been well described in other endovascular revascularization series.[30]

Of importance is that the primary patency rate presented in this study is similar or worse than that in other reports. The 1-year primary patency rate of 44% is poor compared with surgical revascularization and marginal compared with other endoluminal therapies. In our own experience, 6-month and 12-month patency of femoropopliteal intervention with and without concurrent tibial intervention is 60% and 53%, respectively (unpublished data). This is similar to the cited reports and suggests that there is no mid-term or long-term advantage to laser-assisted revascularization compared with any other endoluminal approach. Use of the laser allowed for an improved technical success rate, which approached a 90%; however, this high immediate success rate did not translate into long-term success. This likely represents a case-selection bias, because the laser was not used on cases where a guidewire could be easily passed to the distal circulation. Without a randomized study, this question is difficult to address, but admittedly the data are not positive.

Limitations of this study have largely been discussed and include the retrospective nature and relatively small sample size. Also, because of the small sample size, patients with severe claudication (Rutherford category 3) were included with patients presenting with CLI. The analysis failed to demonstrate a difference in these two groups with respect to primary patency. One could conclude that these data demonstrate that anatomic factors, not the indication for revascularization, are the more important determinants for outcome; however, the small number of patients in each group makes this study underpowered to answer that question. Furthermore, this same size constraint makes it impossible to answer this and other questions with multivariate statistical methods. In addition, single-institution series are often biased toward a particular patient demographic or practice pattern. These data do represent a real-world application of excimer laser technology for lower extremity revascularization, however, and overall results tend to mirror other contemporary percutaneous revascularization reports.[9,19,31]

## CONCLUSION

These data demonstrate that laser-assisted revascularization of the infrainguinal circulation is technically feasible outside the confines of a clinical trial. The initial technical success rate approached 90%, and most lesions were treated with the avoidance of stenting. Those patients with diabetes and renal dysfunction faired poorly with respect to durability and ultimate limb salvage, however. Because of these poor outcomes, it is difficult to recommend laser revascularization as primary therapy for these patients, and therefore, surgical revascularization should be strongly considered, especially in low-risk or intermediate-risk patients. When undertaking laser atherectomy in higher-risk patients, expectations should be lowered and patients counseled appropriately. Finally, the dismal results in dialysis-dependent patients with CLI require careful consideration and argue against laser-assisted revascularization for most.

## AUTHOR CONTRIBUTIONS

Conception and design: MS, DD, SVP, FP, WB, SP
Analysis and interpretation: MS, DD, SVP, FP, WB, SP
Data collection: DD, SVP
Writing the article: MS, DD, SVP
Critical revision of the article: MS, DD, SVP, FP, WB, SP
Final approval of the article: MS, DD, SVP, FP, WB, SP
Statistical analysis: MS, DD, SVP
Obtained funding: MS
Overall responsibility: MS

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## Appendix (online only)

TransAtlantic Inter-Society Consensus (TASC) classification for femoropopliteal and infrapopliteal lesions

| *TASC classification* | *Characteristics* |
|---|---|
| Femoropopliteal | |
| A | A single stenosis ≤3 cm long, not at the origin of the superficial femoral or distal popliteal artery |
| B | A single stenosis or occlusion 3 to 5 cm long not involving the distal popliteal, or multiple stenoses or occlusions, each <3 cm long |
| C | A single stenosis or occlusion ≥5 cm long, or multiple lesions each 3 to 5 cm long |
| D | Complete occlusion of the femoral arteries, or complete occlusion of the popliteal artery and proximal trifurcation |
| Infrapopliteal | |
| A | A single stenosis <1 cm long of the tibial or peroneal vessels |
| B | Multiple focal stenosis <1 cm long, one or two stenoses <1 cm involving the trifurcation, or short stenosis of the tibial arteries in conjunction with femoral angioplasty |
| C | Stenosis 1 to 4 cm long or occlusion 1 to 2 cm long of the tibial arteries, or extensive stenosis of the trifurcation |
| D | Occlusion >2 cm long or diffuse infrapopliteal lesions |