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Reinterventions In Peripheral Arterial Disease: Claudication Versus Chronic Limb-Threatening Ischemia - A Retrospective Study And Review Of The Literature

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Reinterventions in Peripheral Arterial Disease: Claudication versus Chronic Limb-threatening Ischemia - A Retrospective Study and Review of the Literature

A Thesis Submitted to the Yale University School of Medicine in Partial Fulfillment of the Requirements for the Degree of Doctor of Medicine

By

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REINTERVENTIONS IN PERIPHERAL ARTERIAL DISEASE: CLAUDICATION VERSUS CHRONIC LIMB-THREATENING ISCHEMIA

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ABSTRACT

Objective

Patients with peripheral artery disease (PAD) present with claudication or chronic limb threatening ischemia (CLTI). CLTI patients have a more advanced stage of atherosclerosis and increased comorbidities compared to claudicants, and are at an elevated risk of major amputation and mortality after lower extremity revascularization (LER). However, the frequency of reinterventions for claudication and CLTI have not been compared. Our hypothesis is that patients with CLTI undergo more frequent reinterventions to prevent major amputation compared to patients with claudication.

Methods

A single-center retrospective chart review of consecutive patients undergoing LER for PAD in 2013-2015 was performed. Patients were stratified based on indication for revascularization into claudication or CLTI. Patient characteristics, outcomes, and reinterventions were compared between the two groups. A comprehensive literature review in PubMed was also performed to summarize

the findings from the literature with respect to reinterventions for patients undergoing LER for PAD.

Results

There were 826 patients undergoing LER and 44% (N=361) had CLTI. Patients treated for CLTI were more likely to be smokers (p<.001), have diabetes (p<.001), chronic renal insufficiency (p<.001), end stage renal disease (p<.001), and cardiac disease (p<.001). CLTI patients were less likely to be on optimal medical management as reflected by decreased rate of aspirin (p<.001), ADP receptor/P2Y12 inhibitors (p<.001), and statins (p<.001) compared to patients with claudication. Patients with CLTI had significantly higher major amputation (3.7% vs .2%, P<.001) and mortality (1.4% vs .2%, P=.092) at 30 days. At long-term follow up, patients with CLTI had higher rates of major amputation (15.5% vs 1.3%, P < .001) and mortality (37.1% vs 18.1%, P < .001) compared to patients with claudication. There was a significant difference in mean follow-up time between the two cohorts (claudication: 3.7 ± 1.5 years vs CLTI: 2.6 ± 1.8 years, P <.001). There was no significant difference in the ipsilateral reintervention rate between the two groups (claudication: 39.6% vs CLTI: 42.7%, P=.37) or the mean number of ipsilateral reinterventions (claudication: 2.0± 1.6 vs CLTI: 2.0 ± 1.7). However, after adjusting for follow-up time, the mean number of reinterventions per year (frequency of reintervention) was significantly higher for CLTI patients compared to patients with claudication (1.4 ± 2.2 vs .6 ± 0.7 intervention per year, P <.001).

The literature review yielded 96 articles which met inclusion criteria including explicit report of reintervention rate in study cohorts composed of claudication and/or CLTI patients. Of those articles with large cohort size and similar follow-up as this study, reintervention rates ranged from 11% to 41.3% in those with claudication. In those with CLTI, the range was 11.6% to 61%. Only three articles specified reintervention frequency.

Conclusion

Patients undergoing LER for CLTI undergo more frequent reinterventions over time compared to patients treated for claudication. The current literature is limited to describing reintervention rates as percentage of patients undergoing any reintervention. Research on reinterventions after LER should include reporting of the frequency of reintervention adjusted for the follow up period.

Published in part:

The content presented in this thesis has been adapted from the following published article:

Mohamedali A, Kiwan G, Kim T, Zhang Y, Zhuo H, Tonnessen B, Dardik A, Chaar CIO. Reinterventions in Patients with Claudication and Chronic Limb Threatening Ischemia. *Annals of Vascular Surgery*, 2021.

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INTRODUCTION:

Peripheral arterial disease (PAD) is atherosclerotic disease that leads to blockage of arteries of the lower extremities, predominantly. The prevalence of lower extremity PAD is estimated at 5.5% among adults 40 years and older. [1] The two main presentations include claudication and chronic limb threatening ischemia (CLTI). While claudication consists of leg pain that can limit lifestyle, CLTI, defined by rest pain or tissue loss, can cause limb loss and usually requires revascularization. [2] Patients with CLTI typically have increased comorbidities compared to claudicants and are at higher risk of adverse limb and cardiovascular events.[3] Patients with claudication have consistently demonstrated improved perioperative and long-term outcomes after LER, including lower rates of major amputation, mortality, and readmission compared to patients with CLTI. [4,5] Reinterventions after LER for CLTI have been shown to be more common than those for claudication.[5-9]

A study of 4706 patients undergoing LERs found that of the 1497 lower extremity endovascular revascularizations (LEE), 55.6% were performed for the treatment of CLTI while 13.4% were performed for intermittent claudication. Similar proportions were observed with lower extremity bypass (LEB) as well.[3] In another study, Bodewes et al compared patients undergoing primary bypass with those undergoing secondary bypass stratified by symptom status (CLTI vs. claudication). Of 4,540 patients undergoing primary bypass, 68% were for CLTI. CLTI patients then also made up the largest portion of those undergoing secondary bypass after previous bypass or endovascular intervention.[8] While some studies provide some insight into the risk of reintervention of patients with claudication and CLTI, the frequency of reinterventions between the two groups has not been specifically studied. Also, factors associated with reintervention have not been elucidated. This study examines the pattern and frequency of reinterventions after LER for patients with claudication and CLTI in a single tertiary care center. We hypothesize that CLTI patients undergo more frequent reinterventions compared to patients with claudication. Additionally, an extensive literature review regarding reinterventions after LER in patients with CLTI and claudication was performed and compared to our institutional experience in order to put our findings in context of the current knowledge.

METHODS:

Contributions: The study subject and design were decided upon by Dr. Cassius Iyad Ochoa Chaar and Alaa Mohamedali. Statistical analysis was completed by Haoran Zhuo and Yawei Zhang. The writing of the manuscript was completed by Alaa Mohamedali with revisions and nuanced data interpretation in conjunction with Dr. Chaar. Revision suggestions were provided by Dr. Alan Dardik.

Ethics Statement: This study was approved by the Institutional Review Board (IRB) of Yale University, and the protocols used comply with the Declaration of Helsinki on research ethics.

Human Subjects Research: As the method of study was retrospective and patient data was anonymized, the IRB waived the informed consent requirement for patient participation in this study due to its retrospective design.

Study Design

A retrospective review of charts in the electronic medical records (EMR) of consecutive patients undergoing LER for PAD in 2013-2015 by various providers from different specialties in a single tertiary care center was performed. Using Current Procedural Terminology (CPT) codes, we identified patients who underwent revascularizations for PAD. Inpatient as well as outpatient procedures were captured. Patients were stratified based on the indication for initial therapy as CLTI or claudication during the study period. Patient MRNs were recorded and linked to ID numbers in REDCap, a HIPAA-secure database, for systematic data collection and review. This study was approved by the Institutional Review Board (IRB) of Yale University, and the protocols used comply with the Declaration of Helsinki on research ethics. The IRB waived the informed consent requirement for patient participation in this study due to its retrospective design.

Patient characteristics

Patient demographics, comorbidities, and preoperative medications were recorded and saved on REDCap.[10] Comorbidities included diabetes, chronic renal insufficiency (Creatinine >1.5 mg/dL or GFR <60 mL/min), end-stage renal disease (ESRD) (hemodialysis (HD)/peritoneal dialysis/renal transplant), hypertension, hyperlipidemia, coronary artery disease (CAD) (defined as history of myocardial infarction (MI), coronary stent/angioplasty, or coronary artery bypass graft (CABG)), congestive heart failure (CHF), stroke, hypercoagulable disease, and any history of cancer. History of prior endovascular and open procedures for LER were noted. A preoperative baseline ankle-brachial index (ABI) was included when performed and the use of medications, specifically antiplatelets, anticoagulants and statin were also documented.

Procedures

The first intervention in the EMR during the study period was captured. Each procedure date, indication (claudication or CLTI), procedure type, and anatomical level were noted. Procedures were divided into endovascular, open, and hybrid procedures (combining open and endovascular components for therapy). Additionally, the endovascular interventions used - balloon angioplasty, stenting or atherectomy- and conduit used in surgical bypass were recorded. Open procedures consisted of bypass procedures as well as endarterectomy typically involving the femoral arteries.

Perioperative Outcomes

Post-operative outcomes (30 days following surgery) were noted. Complications included hematoma, pseudoaneurysm, bleeding, wound infection, pneumonia, urinary tract infection, arterial thrombosis, deep vein thrombosis, pulmonary embolism, myocardial infarction (MI), stroke, acute renal failure, acute/new hemodialysis, return to operating room (OR), major amputation, and mortality. Bleeding was defined as any transfusion requirement or return to OR for bleeding. Major amputation was defined as amputation at or above the ankle.

Long-term Outcomes

All reinterventions for LER after the index intervention were captured from the EMR. The overall reintervention rate was defined as the percentage of patients requiring any reintervention on any extremity in both groups after the index LER. Ipsilateral reintervention rate was derived from patients who underwent ipsilateral reintervention to the index LER. The frequency of overall reinterventions as well as ipsilateral reinterventions were calculated and then adjusted for follow up time. Long-term major amputation and mortality were captured. Kaplan-Meier curves for overall survival as well as freedom from major amputation were derived. A multivariable regression analysis identifying the factors associated with ipsilateral reintervention was performed.

Definitions

The reintervention rate was defined as the percentage of patients undergoing reinterventions. The frequency of reinterventions was calculated as the total number of reinterventions divided by the number of patients who underwent any reintervention in each group. In order to account for possible differences in follow up time, the frequency of reinterventions was divided by the mean follow-up time in years.

Statistical Analysis

Continuous data was reported as mean ± standard deviation. Categorical data was reported as percentages. $P < 0.05$ was considered statistically significant (denoted in bold). Differences between the two cohorts were compared using Chi-Square test for categorical variable and student t-test for continuous variables. Multivariable regression was performed to determine the factors associated with reinterventions between patients initially treated for claudication and those treated for CLTI. These included indication (CLTI vs claudication), smoking, race, age, BMI, diabetes, CHF, CAD, hypertension, hyperlipidemia, prior endovascular procedure, aspirin, ADP receptor/P2Y12 inhibitors, statins, anticoagulation, and procedure type (Open surgery including hybrid vs Endovascular). Kaplan Meier curves comparing the two groups were generated for freedom from major amputation and overall survival.

Review of the Literature

Database search: A systematic search was conducted in PubMed in November 2021 with the assistance of a medical librarian (C.B.) for the publication period of 1990-2021. Searches consisted of all possible combinations of a total of eight key terms including: frequency, reintervention rate, reintervention, critical limb ischemia, critical limb threatening ischemia, chronic limb ischemia, chronic limb threatening ischemia, and claudication. Additionally, manual search of the reference lists of relevant articles was conducted.

Study Selection: Titles and abstracts of relevant articles were screened and certain criteria was determined for selection of articles for inclusion through full-text evaluation. Included were studies reporting reintervention rate, duration of follow-up after reintervention, reintervention frequency, and number of reinterventions for patients undergoing reinterventions for PAD manifesting as claudication and/or CLTI. Studies were excluded if they did not specifically state the aforementioned criteria. Studies were also excluded if they did not meet the working definitions in this study, including exclusion of studies that reported reintervention rate as number of procedures or number of limbs rather than number of patients. A full text review was performed to confirm all selected studies' content.

Eligibility Criteria: Original studies reporting reinterventions among PAD patients were evaluated. This included studies describing patients undergoing various types of endovascular and open LER procedures in various extremity vessels. Studies that were unclear or did not explicitly stratify the patient population using the aforementioned key terms of interest were excluded. Only papers explicitly addressing reinterventions and their frequency among PAD patients, were included. Studies which included amputations in the reported reintervention rate, or reported LER for other indications such as aortic aneurysms, upper limb arterial disease, Beurger's disease, radiation-induced lower limb arteriopathy or acute ischemia were excluded. For ease of comparison, studies which solely reported freedom from reintervention or freedom from target lesion revascularization/target extremity revascularization were also excluded as they did not shed light on the frequency of reinterventions. Studies evaluating both open and endovascular procedures were included. Conference abstracts, presentations, ongoing studies, unpublished studies and studies whose full text was not able to be obtained were excluded.

Data extraction: This author independently extracted the data into a Microsoft Excel (version 16.16.27 (201012) 2016; Microsoft, Redmond, Washington), including details of publication (study first author, reintervention criteria, and demographics of enrolled patients (claudication vs CLTI vs both). Additionally, type of study, sample size, follow-up period, mean number of reinterventions, frequency of reinterventions, and frequency of reinterventions over time were recorded as possible. The primary outcomes assessed for comparison to the current study were reintervention rates and reintervention frequencies in patients with claudication and/or CLTI.

RESULTS:

Patient Characteristics

There were 826 patients (840 limbs) undergoing LER – 361 (44%) patients presented with CLTI and 465 (56%) presented with claudication. The group of patients with CLTI had predominantly tissue loss (85%). There was no difference in age or sex between the two groups. Of those presenting with claudication, 89.4% were current or former smokers compared to 71% in those with CLTI ($P < .001$). Patients treated for claudication were more likely to be white (83.6% vs 67.9%, $P < .001$). CLTI patients had higher rates of diabetes (66.8% vs 45.2%, $P < .001$), chronic renal insufficiency (24.4% vs 9.3%, $P < .001$), ESRD (12.5% vs 1.3%, $P < .001$), and CHF (19.4% vs 9.9%, $P < .001$).

However, CLTI patients were less likely to have hypertension (87.5% vs 93.2%, $P = .004$), hyperlipidemia (60.4% vs 79.9%, $P < .001$), and CAD (45.8% vs 60.2%, $P < .001$) compared to patients with claudication. Patients with claudication were more likely to have had prior endovascular intervention (31.4% vs 14.7%, $P < .001$). Additionally, patients treated for claudication were more likely to be treated with aspirin (83.6% vs 63.8%, $P < .001$), ADP receptor/P2Y12 inhibitors (44.7% vs 28.9%, $P < .001$), and statins (77.4% vs 65.6%, $P < .001$) prior to LER. With respect to preprocedural ABI values, patients with claudication had higher ABI readings compared to those with CLTI ($.68 \pm .15$ vs 0.60 ± 0.21, $P < .001$). (**Table I**)

Table I. Patient demographics and clinical characteristics with claudication and CLTI undergoing lower extremity revascularization.

Patients Characteristics	**Claudication (N = 465), N (%)**	**CLTI (N = 361), N (%)**	**P-value**
Demographics			
Age (Mean ± SD)	68.2 ± 10.1	69.3 ± 12.4	0.2
Male	292 (62.8)	216 (59.8)	0.386
Smoking			**<.001***
Former	256 (55.4)	164 (45.6)	
Current	157 (34.0)	91 (25.3)	
Nonsmoker	49 (10.6)	105 (29.2)	
Race			**<.001***
White	381 (83.6)	241 (67.9)	
African American	43 (9.4)	73 (20.6)	
Other	32 (7.0)	41 (11.6)	
Body Mass Index (Mean ± SD)	28.4 ± 5.9	28.8 ± 6.7	0.393
Comorbidities			
Diabetes	210 (45.2)	241 (66.8)	**<.001***
Chronic renal insufficiency	43 (9.3)	88 (24.4)	**<.001***
End-stage renal disease	6 (1.3)	45 (12.5)	**<.001***
Hypertension	433 (93.3)	316 (87.5)	**0.004**
Hyperlipidemia	370 (79.9)	218 (60.4)	**<.001***
Coronary artery disease	280 (60.2)	165 (45.8)	**<.001***

Congestive heart failure	46 (9.9)	70 (19.4)	**<.001***
Stroke	48 (10.3)	44 (12.2)	0.404
Hypercoagulable disorder	2 (0.4)	2 (0.6)	1.000
History of cancer	69 (14.8)	56 (15.5)	0.789
Prior endovascular intervention	146 (31.4)	53 (14.7)	**<.001***
Prior open surgery	62 (13.3)	48 (13.3)	0.988
Serum creatinine (Mean ± SD)	1.0 ± 0.7	1.7 ± 1.9	**<.001***
Medications			
Aspirin	388 (83.6)	229 (63.8)	**<.001***
P2Y12 inhibitor	208 (44.7)	103 (28.9)	**<.001***
Anticoagulation	58 (12.5)	68 (18.8)	0.012
Statins	360 (77.4)	236 (65.6)	**<.001***
Pre-procedure ABI	0.68 ± 0.15	.060 ± 0.21	**<.001***

SD: Standard deviation

P* values in bold reflect a significant value.

Procedures

The majority of patients underwent endovascular LER. Patients with CLTI were more likely to undergo open LER compared to patients with claudication (12.5% vs 6%, P=.005). In patients with CLTI and claudication undergoing endovascular procedures, stenting was more frequently used in patients with claudication than patients with CLTI (50% vs 33.8%, P<.001). In terms of location of endovascular treatment, claudicants were more likely to undergo revascularization of isolated femoropopliteal vessels (60.1% vs 31.3%, P <.001) while patients with CLTI were more likely to receive multilevel revascularization (27.2% vs 13.8%, P <.001). (**Table II**)

Table II. Procedural characteristics of patients with claudication and CLTI undergoing lower extremity revascularization.

Procedural Characteristics	**Claudication (N = 465), N(%)**	**CLTI (N = 361),N (%)**	**P-value**
Initial Procedure			**.005***
Open	28 (6.0)	45 (12.5)	
Endo	424 (91.2)	305 (84.5)	
Hybrid	13 (2.8)	11 (3.1)	
Endovascular Procedure			**<.001***
Balloon angioplasty	109 (25.1)	154 (49.0)	
Stent	217 (50.0)	106 (33.8)	
Atherectomy	69 (15.9)	39 (12.4)	
Stent + Atherectomy	39 (9.0)	15 (4.8)	
Endovascular Anatomical Location			**<.001***
Aortoiliac	104 (23.9)	35 (11.2)	
Femoropopliteal	262 (60.1)	98 (31.3)	
Tibial	10 (2.3)	95 (30.4)	
Multilevel	60 (13.8)	85 (27.2)	

Open Procedure			
Suprainguinal bypass	5 (1.1)	9 (2.5)	0.117
Axillary to femoral bypass	1(20.0)	5(55.6)	
Aorta/iliac artery bypass	4(80.0)	4(44.4)	
Infrainguinal bypass	20 (4.0)	37 (10.3)	**0.009***
Common Femoral endarterectomy	16 (3.4)	23 (6.4)	**0.049***

P* values in bold reflect a significant value.

Perioperative Outcomes

LER for CLTI were associated with higher rate of bleeding (8.8% vs 2.0%, P < .001), wound infection (7.4% vs 0.9%, P < .001), acute renal failure (5.4% vs 0.2%, P < .001), and return to the OR (14.2% vs 4.9%, P < .001). There was significantly higher perioperative major amputation in LER for CLTI compared to claudication (3.7% vs .2%, P <.001). There was a trend toward higher mortality of 1.4% in the CLTI cohort compared to .2% in the cohort treated for claudication that did not reach statistical significance (P = .092). (**Table III**)

Table III. Perioperative outcomes of patients with claudication and CLTI undergoing lower extremity revascularization.

Perioperative Outcomes	Claudication (N = 465), N (%)	CLTI (N = 361), N (%)	P-value
Hematoma	6 (1.3)	8 (2.3)	0.307
Pseudoaneurysm	10 (2.2)	4 (1.1)	0.288
Bleeding	9 (2.0)	31 (8.8)	**<.001***
Wound infection	4 (0.9)	26 (7.4)	**<.001***
Pneumonia	2 (0.4)	4 (1.1)	0.413
Urinary tract infection	4 (0.9)	4 (1.1)	0.734
Arterial thrombosis	3 (0.7)	4 (1.1)	0.705
Deep venous thrombosis	2 (0.4)	8 (2.3)	0.025
Stroke	0 (0.0)	1 (0.3)	0.438
Acute renal failure	1 (0.2)	19 (5.4)	**<.001***
Acute/new hemodialysis	1 (0.2)	5 (1.4)	0.092
Return to operating Room	22 (4.9)	50 (14.2)	**<.001***
Major amputation	1 (0.2)	13 (3.7)	**<.001***
Any complication	38 (8.2)	93 (25.8)	**<.001***
Mortality	1 (0.2)	5 (1.4)	0.092

P* values in bold reflect a significant value.

Long-term Outcomes

Reinterventions

There was a significant difference in the mean follow-up time between the two groups. The mean follow up was 3.7 ± 1.5 years in patients treated for claudication compared to 2.6 ± 1.8 years in patients treated for CLTI (P <.001). There was no significant difference in the ipsilateral reintervention rate between the two groups or the mean number of reinterventions. However, after accounting for follow up time, patients with CLTI had significantly higher ipsilateral mean number of reinterventions per year compared to patients with claudication (1.4 vs .6 reintervention per year, P <.001). There was no difference in the overall reintervention (ipsilateral or contralateral lower extremity) rate between the two groups (claudication: 60.2% vs CLTI: 53.7%, P <.065) or the mean overall number of reinterventions even after accounting for follow up time. (**Table IV**)

Table IV. Long-term outcomes of patients with claudication and CLTI undergoing lower extremity revascularization.

Long-term Outcomes	Claudication (N = 465), N (%)	CLTI (N = 361), N (%)	P-value
Follow-up time (years) (Mean ± SD)	3.7 ± 1.5	2.6 ± 1.8	**<.001***
Ipsilateral reintervention rate	184 (39.6)	154 (42.7)	0.370
Ipsilateral mean number of reinterventions (Mean ± SD)	2.0 ± 1.6	2.0 ± 1.7	0.778
Ipsilateral mean number of reinterventions per year (Mean ± SD)	0.6 ± 0.7	1.4 ± 2.2	**<.001***
Reintervention rate (any leg)	280 (60.2)	194 (53.8)	0.065
Mean number of reinterventions (Mean ± SD)	2.6 ± 2.1	2.5 ± 2.1	0.770
Mean number of reinterventions per year (Mean ± SD)	1.3 ± 5.7	1.6 ± 2.3	0.443
Major ipsilateral amputation	6 (1.3)	56 (15.5)	**<.001***
Mortality	84 (18.1)	134 (37.1)	**<.001***

SD: Standard deviation

P* values in bold reflect a significant value.

Major Amputation and Mortality

Patients with CLTI had higher rates of major amputation (15.5% vs 1.3%, P < .001) and mortality (37.1% vs 18.1%, P < .001) compared to patients with claudication. Kaplan Meier analysis demonstrated that freedom from ipsilateral amputation at 1 and 4 years was 87.8% and 83.6% for patients with CLTI compared to 99.6% and 98.5% for patients with claudication, respectively (P<.001). (**Figure I**) Overall survival at one year (96.3% vs 83.6%, P<.001) and four years (84.7% vs 63.2%, P<.001) was significantly higher for patients undergoing LER for claudication compared to CLTI. (**Figure II**)

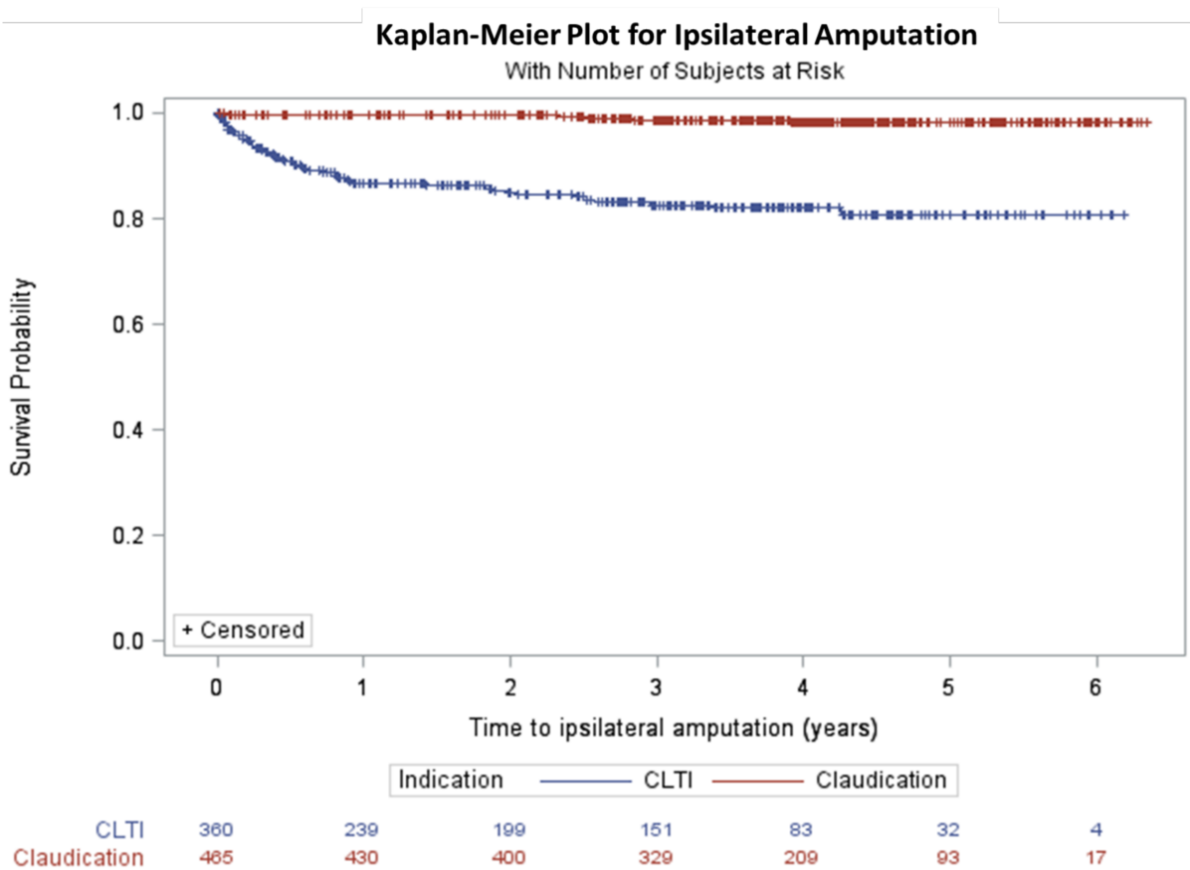

Figure I. Kaplan-Meier Plot for ipsilateral amputation after lower extremity revascularization in patients treated for chronic limb threatening ischemia (CLTI) vs claudication.

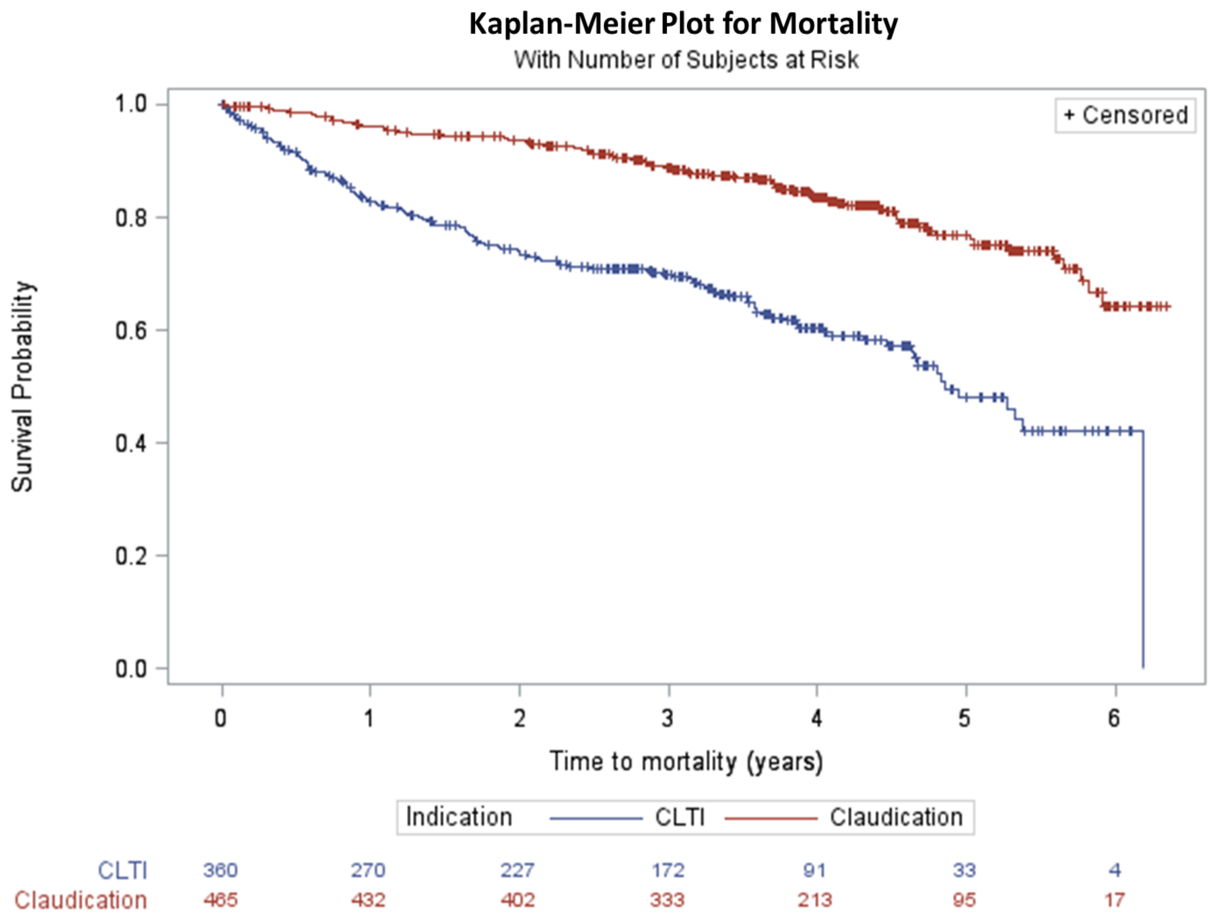

Figure II. Kaplan-Meier Plot for overall survival after lower extremity revascularization in patients treated for chronic limb threatening ischemia (CLTI) vs claudication.

Risk factors Associated with Ipsilateral Reintervention

On multivariable analysis, open surgery (including hybrid procedures) was associated with decreased ipsilateral reintervention compared to endovascular LER (OR= 0.46 [0.28-0.76]) while a history of prior endovascular LER was associated with increased reinterventions (OR = 1.82 [1.27-2.59]). On the other hand, hypertension (OR= 0.56 [0.33-0.94]) was associated with decreased likelihood of reintervention. The indication for LER was not associated with reintervention in this model. (**Table V**)

Table V. Multivariable regression analysis of independent factors associated with reintervention

Variable	Odds Ratio [95% CI]
Indication	
CLTI vs Claudication	1.38 [0.98-1.93]
Smoking	
Former vs non-smoker	1.04 [0.69-1.57]
Current vs non-smoker	1.30 [0.82-2.05]
Race	
African American vs White	1.05 [0.67-1.66]
Other vs White	1.42 [0.85-2.38]
Age	0.98 [0.97-1.00]
Body Mass Index	0.98 [0.95-1.00]

Comorbidities	
Diabetes	0.87 [0.63-1.20]
Congestive heart failure	0.89 [0.57-1.39]
End-stage renal disease	1.25 [0.66-2.37]
Hypertension	**0.56 [0.33-0.94]***
Hyperlipidemia	0.90 [0.63-1.27]
Coronary artery disease	1.07 [0.77-1.49]
Prior Endovascular Procedure	**1.82 [1.27-2.59]***
Medications	
Aspirin	1.17 [0.81-1.69]
ADP receptor/P2Y12 inhibitors	1.34 [0.97-1.85]
Anticoagulant	1.08 [0.71-1.64]
Statins	0.73 [0.51-1.02]
Procedure	
Open/hybrid vs Endovascular	**0.46 [0.28-0.76]***

CI: Confidence Interval, CLTI: chronic limb threatening ischemia

P* values in bold reflect a significant value.

Review of the Literature

Results

From a total of 1462 identified unique articles, 96 were selected meeting the inclusion and exclusion criteria.

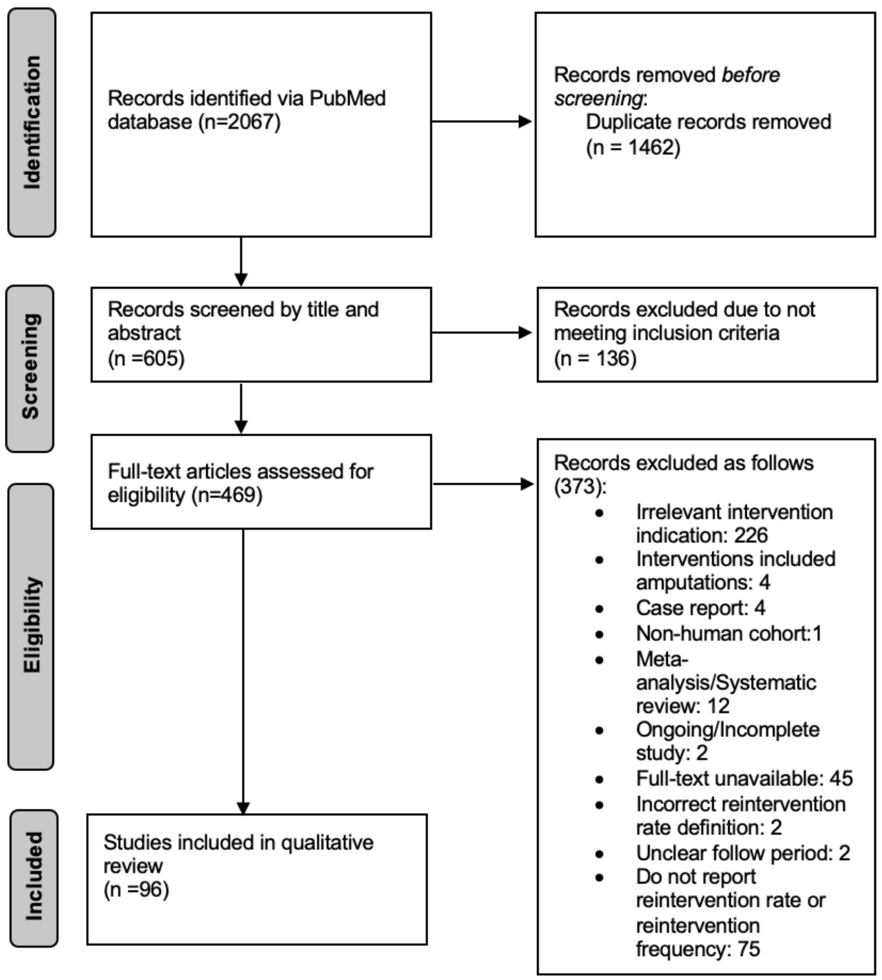

Figure III. Flowchart Diagram of Study Selection Process

The selected studies included 18 prospective studies, four of which were randomized controlled trials. Retrospective review was undertaken in the remaining 78 articles. Study publication dates spanned 1998 to 2021. Study population sizes ranged from 10 patients to 16,800 patients. The overall mean follow up duration ranged from 30 days to 18.2 years. In CLTI patient populations, mean age ranged from 61.7 to 82.1. In claudication studies, mean age ranged from 53 to 75.9. In mixed studies, the mean age range was 62.2 to 74. The majority (66/96) of studies were composed of CLTI patients as the primary study cohort. Comorbidities were consistent with this current study, with the most prevalent being diabetes, chronic renal insufficiency, end-stage renal disease (ESRD) (hemodialysis (HD)/renal transplant)), hypertension, hyperlipidemia, coronary artery disease, smoking status, and history of cancer.

Several studies included patients with prior endovascular and open procedures. Study index procedures included various combinations of endovascular, open, and hybrid procedures. 14 studies compared results of endovascular versus open procedures in a variety of cohorts including those with infrainguinal disease, smokers, insulin-dependent diabetics, and patients on dialysis. Several studies assessed endovascular or bypass interventions in specific diseased target vessels including iliac disease, infrapopliteal disease, femoropopliteal disease, and aortoiliac occlusive disease. Several studies compared those with and without diabetes. Three studies involved endarterectomy with or without concomitant procedures. Three studies investigated percutaneous deep vein arterialization in no-option CLTI patients.

Tables **VI** and **VII** compare the results of this study with those of previous original studies concerning reintervention rate in the population of individuals with PAD. Tables VI and VII specifically report reintervention rates explicitly addressed in the literature, for claudicants and CLTI patients respectively. Studies within which claudication and CLTI patients are mixed are reported based on the indication of the larger subgroup. Table **VIII** reports the 23 articles from which frequency of reintervention can be determined based on reported reintervention rate, number of reinterventions, and mean follow-up. Upon comparison to our study's patients with claudication, few studies had similar duration follow up and a study cohort greater than 100 patients with claudication. In 2018, Qato et al reported a reintervention rate of 39% in a cohort of 402 patients followed over the course of 33.1 months.[11] This is very much in accordance to the current study's reported rate of 39.6%. On the other hand, Schlieder et al reported a 41.3% reintervention rate in a cohort of 138 patients followed over 3.6 years. This observed lower rate of reintervention may be due to several reasons including the composition of the patient population including 65.9% nonsmokers.[12] This is significantly higher than the percentage observed in our claudication population (10.6%). Similar reasoning may be attributed to the low rates of reintervention observed in Dorigo et al's study.[13] Additionally, as the authors note, there were fewer patients of nonwhite race which is associated with higher risk of reintervention.

With respect to patients with CLTI, there are similarly few studies reporting comparable data. Iida et al and Dosluoglu et al reported similar reintervention rates to this study.[14,15] However, both Biagioni et al and Qato et al reported a lower rate at 23%.[11,16] In the case of Qato et al, this difference may be due to the lower proportion of CLTI patients with femoropopliteal disease in the current study. Indeed, while our study included 31.3% femoropopliteal, 30.4% tibial and 27.2% multilevel, Qato et al's study included solely femoropopliteal interventions. It has been previously shown in the literature that interventions in the tibial region yield lower patency rates than femoropopliteal.[17]

Comparatively, Davies et al reported a higher rate at 57.9% over 2.5 years. This higher rate is consistent with the patient population studied which appears to be sicker with higher rates of CHF, diabetes, hypertension, chronic renal insufficiency, hypercoagulability, and cerebrovascular disease.[18]

Table VI. Population and outcomes of studies addressing reintervention rate of patients with claudication in the literature

	N (total study patients)	% Claudication	Reintervention Rate	Mean Follow-up
Assadian et al (2015)[19]	117	84.7	12.8%*	12 months
AbuRahma et al (2019)[5]	228	40	16.5%	12.2 months
Azema et al (2011)[20]	36	70	11%*	12 months
Baker et al (2015)[21]	20	45	0%	4.3 months
Bodewes et al (2017)[8]	7302	27.7%**	2.9%**	30 days
Bodewes et al (2017)[8]	7302	25.5%***	5%***	30 days

Boulitrop et al (2020)[22]	59	78%	25%*	34 months
Chen et al (2017)[3]	4706	44.4%**	3%**	30 days
Chen et al (2017)[3]	4706	65.3%***	2.4%***	30 days
Dave et al (2009)[23]	65	100%	23.1%	1 year
DeRubertis et al (2007)[24]	730	46.3%	17%	9.9 months
Dorigo et al (2017)[13]	210	76%**	11%**	38 months
Dorigo et al (2017)[13]	210	65%***	6%***	38 months
Ferranti et al (2015)[25]	3338	57%	7%	12 months
Fokkenrood et al (2014)[26]	4954	100%	35%	3 months
Gifford et al (2016)[27]	566	46%	.88%	17 months
Jamsen et al (2002)[28]	173	100%	32.6%	104 months
Jones et al (2015)[29]	236	100%	25.8%	28 months
Karathanos et al (2015)[30]	12	75%	58%*	50 months
Kiguchi et al (2013)[31]	165	67.9%	36.5%*	25.1 months
Klonaris et al (2008)[32]	12	50%	0%*	18.3 months
Larsen et al (2017)[33]	242	100%	14%	18 months
Lumsden et al (2015)[34]	293	72.4%	43.6%	12 months
Mazari et al (2017)[35]	111	100%	35.9%	5.2 years
McKinsey et al (2008)[36]	275	36.7%	25.3%	12.5 months
Naiem et al (2021)[37]	74	100%	21.2%	2 years
Perou et al (2018)[38]	129	65%	5.6%*	12 months
Piffaretti et al (2018)[39]	364	55%	3%*	28 months
Piffaretti et al (2019)[40]	713	57%	5.5%*	11 months

Powell et al (2000)[41]	87	60%	29%*	27 months
Prince et al (2013)[42]	34	100%	18%	10 months
Qato et al (2018)[11]	402	79%	39%	33.1 months
Qato et al (2021)[43]	341	44.8%	15.8%*	13 months
Saraidaridis et al (2017)[44]	515	100%	21.8%	5 years
Schillinger et al (2007)[45]	98	91%	45.9%*	2 years
Schlieder et al (2019)[12]	138	100%	41.3%	3.6 years
Schwindt et al (2011)[46]	52	82.7%	19%*	39.4 months
Shammas et al (2017)[47]	1906	62.7%	15.9%	12 months
Soga et al (2021)[48]	1824	69.2%	30.2%	5 years
Stavroulakis et al (2017)[49]	72	81%	15.3%*	12 months
Steiner et al (2016)[50]	248	38.6%	20%	9 months
Tetteroo et al (1998)[51]	279	100%	5.7%	9.3 months
Van Vugt et al (2010)[52]	157	60.5%	14%*	18.2 years
Vogel et al (2007)[4]	1718	51.9%	2.8%	30 days

***Reintervention rate of entire mixed study population (CLTI and Claudication).**

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Table VII. Population and outcomes of studies addressing reintervention rate of patients with CLTI in the literature

	N (total study patients)	% CLTI	Reintervention Rate	Mean Follow-up
Abdelhamid et al (2010)[53]	39	100	5%	15.4 months
Abualhin et al (2019)[54]	117	100	16.2%	30 days
AbuRahma et al (2019)[5]	228	60	26%	12.2 months
Atar et al (2009)[55]	17	100	43.7%	12 months
Baker et al (2015)[21]	20	55	27%	4.3 months
Berceli et al (2007)[56]	313	100%	35%**	151 days
Berceli et al (2007)[56]	313	100%	23%***	193 days
Biagioni et al (2019)[57]	91	100%	11%	3 years
Biagioni et al (2020)[16]	108	100%	23%**	3 years
Biagioni et al (2020)[16]	108	100%	11.6%***	3 years
Bischoff et al (2018)[58]	563	100%	27.3%	14.6 months
Bodewes et al (2017)[8]	7302	72.3%**	4.9%**	30 days
Bodewes et al (2017)[8]	7302	74.5%***	7.8%***	30 days
Bosiers et al (2005)[59]	48	100%	9.5%	6 months
Chang et al (2008)[60]	171	54%	24%*	24 months
Chen et al (2017)[3]	4706	55.6%**	6.8%**	30 days
Chen et al (2017)[3]	4706	34.7%***	6.5%***	30 days
Clair et al (2021)[61]	32	100%	52%	12 months
Cotroneo et al (2010)[62]	18	55.6%	37%*	9.4 months
Darling et al (2018)[63]	580	100%	58%**	5 years
Darling et al (2018)[63]	580	100%	47%	5 years
Davies et al (2015)[18]	728	100%	57.9%	2.5 years
Dayama et al (2019)[64]	1355	100%	3%**	30 days

Dayama et al (2019)[64]	1355	100%	4.3%***	30 days
De Athayde Soares et al (2018)[65]	46	79.5%	15.9%*	1200 days
De Athayde Soares et al (2018)[65]	69	76.6%	17.4%*	2500 days
DeRubertis et al (2007)[24]	730	52.7%	16.6%	9.9 months
Domenick et al (2012)[66]	201	100%	53%	12 months
Dosluoglu et al (2012)[15]	433	100%	44.9%**	28.4 months
Dosluoglu et al (2012)[15]	433	100%	33%***	28.4 months
Fernandez et al (2010)[67]	111	100%	29.7%	6.8 months
Fernandez et al (2011)[68]	123	100%	31.7%	12.6 months
Ferranti et al (2015)[25]	3338	43%	13.1%	12 months
Fisker et al (2020)[69]	363	100%	23%	65 months
Gandini et al (2013)[70]	119	100%	26.6%	6 months
Gifford et al (2016)[27]	566	54%	1.23%	17 months
Gilmore et al (2014)[71]	28	100%	43%	29.9 months
Guevara-Noriega et al (2019)[72]	149	100%	24.8%	5 years
Iida et al (2012)[73]	63	100%	48%	12 months
Iida et al (2012)[74]	406	100%	61%	3 years
Iida et al (2021)[14]	425	100%	36.3%	3 years
Iida et al (2013)[75]	314	100%	34%	12 months
Keeling et al (2007)[76]	60	67.1%	13.3%	6.1 months
Klaphake et al (2018)[77]	263	100%	32%	2.4 years
Klonaris et al (2008)[32]	12	50%	0%	18.3 months
Kumada et al (2015)[78]	226	100%	12.4%	28 months
Labed et al (2021)[79]	64	76.6%	26.1%*	12 months

Latz et al (2021)[80]	10783	100%	4.4%**	30 days
Latz et al (2021)[80]	10783	100%	5.3%***	30 days
Leithead et al (2018)[81]	172	100%	30.1%	6 months
Lin et al (2019)[82]	16800	100%	37%	80 months
Lindgren et al (2012)[83]	112	75%	16.1%*	12 months
Lumsden et al (2015)[34]	203	27.6%	52.3%	12 months
McKinsey et al (2008)[36]	275	63.3%	30.1%	12.5 months
Meecham et al (2019)[84]	311	100%	34%**	43.6 months
Meecham et al (2019)[84]	311	100%	19%***	46.2 months
Mendiz et al (2011)[85]	78	100%	4.2%	22.4 months
Muir et al (2017)[86]	116	100%	33.3%	983 days
Mustapha et al (2019)[87]	10	100%	30%	6 months
Palena et al (2018)[88]	21	100%	16.2%	356 days
Perlander et al (2020)[89]	190	100%	39%**	2 years
Perlander et al (2020)[89]	190	100%	38%***	2 years
Qato (2018)[11]	402	21%	23%	33.1 months
Qato (2021)[43]	341	55.2%	15.8%*	13 months
Ramanan et al (2019)[90]	535	100%	4.28%**	30 days
Ramanan et al (2019)[90]	535	100%	4.44%***	30 days
Saratzis et al (2019)[91]	296	68%	23%*	2 years
Schmidt et al (2020)[92]	32	100%	32%	34 months
Schmieder et al (2010)[93]	482	62.2%	25%*	8.6 months
Scott et al (2007)[94]	104	62.9%	20.2%*	23.4 months
Shammas et al (2017)[47]	1906	37.3%	19.2%	12 months
Steiner et al (2016)[50]	248	61.4%	24.4%	9 months
Tewksbury et al (2014)[95]	74	100%	23%	15 months

Vergnaud et al (2018)[96]	656	100%	35.1%	2 years
Vierthaler et al (2015)[97]	1244	100%	8%	1 year
Wu et al (2020)[98]	151	100%	32%	678 days
Xiao et al (2012)[99]	139	81.3%	33.8%*	26.3 months
Zlatanovic et al (2021)[100]	470	100%	44.7%**	61 months
Zlatanovic et al (2021)[100]	470	100%	22.1%	61 months

***Reintervention rate of entire mixed study population (CLTI and Claudication).**

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Table VIII. Population and outcomes of studies addressing mean number of reinterventions and follow-up duration.

	N (total study patients)	% CLTI/%Claudication	Mean No. of Reinterventions	Mean Follow-up	Mean No. of Reinterventions per year
AbuRahma et al (2019)[5]	228	60%/40%	1.5	12.2 months	1.47
Boulitrop et al (2020)[22]	59	22%/78%	1	34 months	.35
Darling et al (2018)[101]	580	100%/0%	.59**	5 years	.51**
Darling et al (2018)[101]	580	100%/0%	.47***	5 years	.39***
Davies et al (2015)[18]	728	100%/0%	2.5		

De Athayde Soares et al (2018)[65]	69	76.6%/23.4%	1	2500 days (6.85 yrs)	.15
Fisker et al (2020)[69]	363	100%/0%	1.5	65 months	.28
Iida et al (2021)[14]	425	100%/0%	-	3 years	.82** .56***
Jones et al (2015)[29]	236	0%/100%	1.35(<80) 1(>80)	28 months	.59(<80) .43(>80)
Karathanos et al (2015)[30]	12	75%/25%	1.4	50 months	.34
Labed et al (2021)[79]	64	76.6%/23.4%	1.1	27 months	.48
Meecham et al (2019)[84]	311	100%/0%	.74** 1.58***	46.2 months 43.6 months	.2** .41***
Mustapha et al (2019)[87]	10	100%/0%	1.33	6 months	2.7
Powell et al (2000)[41]	87	40%/60%	1.2	27 months	.53
Qato et al (2018)[11]	402	21%/79%	1.95	-	-
Saqib et al (2013)[102]	210	100%/0%	3	-	-
Schillinger et al (2007)[45]	98	9%/91%	1	2 years	.5
Schmieder et al (2010)[93]	482	62.2%/37.8%	1.5	8.6 months	2
Schwindt et al (2011)[46]	52	17.3%/82.7%	1.11	3.28	.34

Scott et al (2007)[94]	104	62.9%/37.1%	1.1	23.4 months	.56
Stavroulakis et al (2017)[49]	72	19%/81%	1.18	12 months	1.18
Sultan et al (2009)[103]	190**	100%/0%	-	5 years	1.45**
Sultan et al (2009)[103]	119***	100%/0%	-	5 years	1.74***
Tewksbury et al (2014)[95]	74	100%/0%	1.06	15 months	.89

**** Endovascular**

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DISCUSSION:

As demonstrated in our study and in the literature, PAD continues to be a disease plaguing those of early elderly age, and with a male predilection.[7,9,104,105] This study reveals that patients with CLTI had higher rates of major amputation and mortality at both the short-term 30-day period and at long-term outcomes. Although it initially seemed that ipsilateral reinterventions were not significantly different between CLTI patients and claudicants, patients with CLTI underwent twice the frequency of ipsilateral reinterventions as patients with claudication when adjusting for mean follow up time. The findings of this study are consistent with published literature suggesting that patients treated for claudication and CLTI have significant differences in vascular outcomes, such as major amputations and other perioperative complications, and overall prognosis.[104,106]

Numerous studies on reintervention after LER are limited by short follow up. Of the 66 articles studying primarily CLTI patients, 21 studies reported a mean follow up duration less than one year. Five of these studies, within a duration of 30 days, reported an endovascular reintervention rate between 3% - 7%.[3,8,64,80,90] In studying reinterventions after subintimal angioplasty, Schmieder et al reported a 25% reintervention rate in a group of 482 patients with predominantly CLTI (60%).[93] This reintervention rate is lower than our current study likely due to shorter mean follow up period of 8.6 months (range 0-34 months). However, the mean number of reinterventions was 1.5 ± 0.8, similar to our CLTI group (1.4 ± 2.2). Similarly, in their 2018 study evaluating 563 CLTI patients, Bischoff et al reported a 27.3% reintervention rate over a mean follow up of 14.6 months.[58] It is however notable that 26.3% of this study cohort underwent open index procedures which could contribute to the lower reintervention rate as this is a greater proportion compared to the 12.5% open index procedures in our study CLTI cohort.[107] In studies describing predominantly patients with claudication, 12 out of the 30 studies reported mean follow up duration at around or less than one year. McKinsey et al described atherectomy in 275 patients and reported a reintervention rate of 30.1% for CLTI patients and 25.3% in claudicants after a mean follow-up period of 12.5 months (range, 0.5-48.2).[36] While it is notable that the use of atherectomy in the present study was low (approximately 20%), it is unlikely that atherectomy garners a superior method of intervention that potentially reduces need for reintervention. In fact, multiple studies have demonstrated that atherectomy does not particularly impact reintervention compared to balloon angioplasty and/or stenting.[108-110] Indeed, when compared to another study with similar follow up duration by Dave et al, the reintervention rate remained fairly consistent at 23.1% in claudicants.[23]

Longer follow-up has been reported in other publications. In a study looking at endovascular LER for CLTI in patients older than 70 years of age, the reintervention rate was reported at 32% after 2.4 years of follow up. However, it is notable that patients included in this study were older than 70 with the mean age of the study population being 79 years, which is 10 years older than our group of patients with CLTI. A less aggressive approach to limb salvage adopted in this older population could explain the higher ipsilateral reintervention rate of 42.7% in our study despite similar mean follow up period (2.6 ± 1.8 years).[77] Also, the older patients in that study had higher rates of amputation (25%) and mortality (41%). Thus, it is possible that due to the combination of less aggressive intervention and increased morbidity and mortality, there would be lower rates of reintervention as those patients are then deceased or limbless, thus rendering the need for reintervention moot and explaining further the difference with our current report. Other studies support the curtailed benefit of LER as patients get increasingly older because of limited survival.[111] Conversely, Darling et al compared open and endovascular initial LER in diabetic patients with CLTI. After 3 years, the reintervention rate was approximately 50% after initial endovascular LER and 40% after open LER, comparable to our findings in a group of patients predominantly treated with endovascular surgery. However, the mean reintervention was 0.5 per year after open or endovascular LER and lower than the frequency in our study (1.5). The decreased frequency of reintervention could be related to higher major amputation rate at 30% related to a totally diabetic patient population and higher overall comorbidities.[112] Davies et al and Schmidt et al highlighted similar reintervention rates to the current study in similar follow up: Davies et al (57.9%, 30 months), Schmidt et al (59.4%, 34 months).[18,92]

Upon evaluating the current literature for mean number of reinterventions and frequency of reinterventions over time, there result 22 unique studies. In the 2009 study by Sultan et al evaluating five-year results in 309 CLTI patients with TASC II type C/D lesions, the reintervention frequency over time for those undergoing subintimal angioplasty was 1.45 per patient per year.[103] This is very comparable to the findings in the current study. The minimal discrepancy in our study may be attributed to the inclusion of open LER and hybrid LER in our CLTI cohort. Comparatively, Iida et al, in assessing 425 CLTI patients undergoing endovascular therapy, determined a reintervention frequency over time of .82 per person-year.[14] There may be several reasons for this decreased frequency of reintervention. Firstly, their cohort had certain rates of comorbidities associated with lower risk of reintervention including decreased rate of smoking (59% vs 71%). Further, they had increased population of ESRD patients on dialysis (53% vs 12.5%). As Meyer et al found in their 2016 study assessing endovascular reintervention in ESRD vs non-ESRD patients, ESRD is associated with increased odds of amputation and death, logically resulting in decreased overall reinterventions.[113] Additionally, Iida's study cohort had older mean age which may account for the decreased reintervention risk as aforementioned. Turning to frequency in claudication majority cohorts, Schillinger et al, Powell et al, and Jones et al all reported similar frequencies to this study.[29,41,45] However, Boulitrop et al , Schwindt et al, and Karathanos et al reported lower frequencies at .34-.35. In the cases of Boulitrop et al and Karathanos et al, this may be due to the employment of endarterectomy and hybrid interventions, respectively, as the interventions of choice.[22,30,46]

The optimal method to measure and compare reinterventions has not been well characterized. Even though the reintervention rate is a valuable indicator of the proportion of patients that require additional therapy, it does not provide information on the frequency of repeated interventions. Thus, it can be misleading as it does not differentiate between a patient that requires a single reintervention after 3 years and another patient that underwent 3 reinterventions in the first year after LER. Moreover, the reintervention rate does not typically incorporate time which was crucial in the current analysis. This paper builds on our prior work defining the reintervention index as the frequency of reinterventions. In that initial analysis comparing open and endovascular LER, there was no difference in follow up duration and we used the absolute number of reinterventions for comparison. Certainly, accounting for time to follow up is crucial to avoid selection bias related to the duration of patient monitoring. Therefore, we suggest incorporating time (in years) in the derivation of the reintervention index.[114] The significant difference in follow up period between the two patient populations in this study is likely related to the significantly higher mortality in patients with CLTI. Also, patients with CLTI are likely less compliant with overall follow up and treatment, and that is suggested by the lower likelihood of that group of patients to be taking antiplatelets and statins compared to patients treated for claudication. Further research pertaining to the magnitude of reinterventions (major vs minor) is ongoing.

In terms of perioperative and long-term outcomes of LER in patients with claudication and CLTI, this study is consistent with the literature. Patients undergoing LER for claudication typically have less severe comorbidities and improved outcomes. Several authors from various centers as well as using national administrative databases have demonstrated that patients with CLTI have greater complications, major amputation, and mortality after LER compared to patients treated for claudication.[4,6,115] In their population-level analysis, Vogel et al. found that out of 1718 patients, 28.1% of readmitted claudicants required reintervention, however none underwent amputation in less than 30 days.[116] This is comparable to the findings in this study wherein though there was a significantly high rate of reintervention in claudicants (39.6%, p=.370), there were few major amputations perioperatively(.2%, p<.001).

AbuRahma et al. reported no major amputations after LER for claudication compared to 13% for CLTI. In comparison, the major amputation rate in our study was 1.2% in claudication vs 15.3% in CLTI.[5] In an application of the BASIL survival prediction model for patients with PAD after LER, Moxey et al. reported a 2-year survival of 73% compared to the 70% seen in the BASIL trial.[117,118] Those values concur with this study's 2-year survival rate of 74.6% in the CLTI group. Furthermore, patients with CLTI have 3x higher risk of cardiovascular mortality compared to claudicants. In fact, while patients with CLTI make up about 1% of those with PAD, the overall mortality is over 50% at 5 years.[106] Our results are similar to many findings expanding on that increased mortality rate for CLTI patients. In their study investigating 5-year survival, Nguyen et al reported differences in survival of 44% in CLTI treated with balloon angioplasty vs 83% in claudication. They also found rates of survival of 49% in CLTI treated with stent compared to 84% in claudication.[6] In the current study, the survival of patients with CLTI was 96.3% compared to 83.6% in patients treated for claudication at one year ($P<.001$).

The limitations of this study are characteristic of retrospective reviews. Reinterventions performed at outside institutions may not have been captured. Additionally, we evaluated CLTI patients as one group including those presenting with rest pain and tissue loss; however, recent literature suggests significant differences in outcomes of LER between the two groups. Indeed, in assessing outcomes of LER for rest pain compared to tissue loss, studies have reported higher rates of comorbidities, perioperative complications, morbidity, mortality and major amputation in patients with tissue loss.[119,120] However, since the majority of patients with CLTI in this study had tissue loss (85%), further stratification would have limited statistical power. This study included reinterventions with variable anatomical level and magnitude which could affect the outcomes observed. Finally, selection bias introduced by different providers, specialties, and thresholds for reintervention could not be accounted for.

CONCLUSION:

Although reintervention rates in this study were not different between patients undergoing LER for CLTI and claudication, the frequency of ipsilateral reinterventions was higher for patients with CLTI. Patients with CLTI have worse perioperative and long-term outcomes including reintervention compared to patients with claudication. Thus, the frequency of reinterventions over time may be more informative than the reintervention rate.

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