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Early ABI Testing May Decrease Risk of Amputation for Patients With Lower Extremity Ulcers

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Abstract

Background: Patients with lower extremity wounds from diabetes mellitus or peripheral artery disease (PAD) have a risk of amputation as high as 25%. In patients with arterial disease, revascularization decreases the risk of amputation. We aimed to determine if the early assessment of arterial perfusion correlates with the risk of amputation.

Methods: We retrospectively reviewed patients referred to the vascular clinic over 18 months with Rutherford Grade 5 and 6 chronic limb-threatening ischemia to determine if patients had a pulse exam done at the time the wound was identified and when ankle brachial index (ABI) testing to evaluate perfusion was performed. Kaplan Meier analysis was used to determine if the timing of ABI testing affected the time to revascularization, wound healing, and risk of amputation.

Results: Ninety-three patients with lower extremity wounds were identified. Of these, 59 patients (63%) did not have a pulse exam performed by their primary care provider when the wound was identified. Patients were classified by when they underwent ankle brachial index testing to assess arterial perfusion. Twenty-four had early ABI (< 30 days) testing, with the remaining 69 patients having late ABI testing. Patients in the early ABI group were more likely to have a pulse exam done by their PCP than those in the late group, 12 (50%) vs. 22 (32%), $P = 0.03$. Early ABI patients had a quicker time to vascular referral (13 days vs. 91 days, $P < 0.001$). Early ABI patients also had quicker times to wound healing than those in the late group (117 days vs. 287 days, $P < 0.001$). Finally, patients that underwent early ABI were less likely to require amputation (Fig. 1), although this did not reach statistical significance ($P = 0.07$).

Conclusions: Early ABI testing expedites specialty referral and time to revascularization. It can decrease the time to wound healing. Larger cohort studies are needed to determine the overall effect of early ABI testing to decrease amputation rates.

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INTRODUCTION

The rate of major amputation for patients with lower extremity wounds from diabetes mellitus (DM) and/or peripheral artery disease (PAD) ranges from 6–28% per year depending on patient comorbidities.[1] The United States Preventive Task Force does not recommend screening for PAD in asymptomatic patients; [2] however, the American Diabetes Association (ADA) recommends that patients with diabetes have an annual evaluation for both macrovascular, and microvascular disease.[3] In addition, the American Heart Association (AHA) recommends screening for PAD with a resting ankle brachial index (ABI) measurement test in patients with atherosclerotic risk factors or those >65 years old.[4] When evaluating patients with a lower extremity ulcer, the Society for Vascular Surgery, the Society of Vascular Medicine, the American Podiatric Medicine Society, and the Wound Ostomy and Continence Nurses Society all have guidelines recommending a full assessment of arterial perfusion by pulse exam and ABI testing.[5-7] Despite these guidelines, as much as 45% of patients have no objective testing of their arterial perfusion prior to major amputation.[8] This is alarming given that for patients with arterial insufficiency, revascularization clearly decreases the risk of major amputation.[9]

The reasons patients do not get an arterial assessment is difficult to understand. Palpation of the pedal pulses has been shown to have good diagnostic accuracy in diagnosing PAD with a 93% specificity.[10 , 11] PCPs today, however, find themselves being asked to see more patients with less time, which can take away time from the physical exam. Even the annual Medicare Wellness exam for patients does not include a physical exam component.[10-12] A second reason arterial perfusion testing is not done may be due to unfamiliarity with specialty guidelines. It is well known that lack of dissemination, especially in rural areas, is a reason providers are less familiar regarding guidelines.[13] Finally, many PCPs have not been taught how to work up lower extremity ulcers in a systematic way, and feel that there are no adequate courses or resources to teach them how.[14]

When a patient presents with a lower extremity ulcer, the timely ability to identify the right diagnosis and the right treatment may mean the difference between limb-salvage and amputation. Currently, it is unknown what percentage of patients get an appropriate pulse exam when they present with a lower extremity ulcer, nor is there an understanding of whether the timing of arterial perfusion assessment affects amputation outcomes. We aimed to determine what proportion of patients with lower extremity ulcers had a pulse exam performed by their PCP and if early ABI testing correlated with amputation risk.

METHODS

Study Setting

All patients referred to the outpatient clinic of a tertiary vascular referral center for lower extremity pathology from January of 2018 to June 2019 were reviewed. The Institutional Review Board approved the review of patients' charts and this study.

Patient Cohort

Patients with arterial disease were classified by Rutherford grade. Only patients referred for Rutherford grade 5 or 6 Chronic Limb Threatening Ischemia (CLTI) were considered for this study. For each patient, data regarding the sex, age, race, insurance status, and comorbidities, were collected. Data was also collected regarding current smoking status and current medications.

First Visit Data

Clinic notes from the date the wound was first brought to the primary care provider's (PCP) attention and the day of the first visit with the PCP were reviewed. Based on this note, the date the wound occurred was determined. If there was no documented information about how long the wound had been present in the PCP note, then the date of the PCP visit was considered the date the wound was identified. All time to event outcomes were determined from this date.

Assessment of Arterial Flow

The physical exam portion of the first documented PCP note was reviewed to determine if the patient had a pulse exam performed at the time the wound was identified. The pulse exam was categorized as complete if there was a documented femoral and pedal pulse exam for both lower extremities. The pulse exam was considered limited if there was only examination of the pulses on the same leg as the wound was located on, but no examination of the femoral pulse or the pulses of the contralateral leg. When there was no mention of the pedal or femoral pulses on the leg the wound was located on, this was considered no pulse exam. The date of any objective ankle brachial index (ABI) or arterial duplex testing of the leg with the wound was also recorded. Patients were considered to have early ABI testing if the ABI was performed within 30 days from when the wound occurred. Patients who had an ABI test after 30 days were placed in the late ABI group.

Outcomes

The primary outcome was time to any amputation (minor or major). This time was determined from the date the wound occurred to the date of the first amputation. Time to major amputation was also collected.

Time to Event

The date the referral was placed from the PCP's office was recorded as well as the date of the vascular clinic visit. If the patient was referred to a wound care center, the date of the referral, and evaluation by the wound care center was also recorded. The time to referral/evaluation was calculated by subtracting the date of the event from the date the wound was identified. For patients that underwent a vascular intervention, the date of the intervention was recorded. In order to account for patients that underwent diagnostic angiography then a surgical or hybrid endovascular intervention, a category of time to first intervention, and time to the definitive intervention was created. Both dates were recorded and the time to event was determined by subtracting the date from the date the wound was identified. Finally, the time to wound healing was recorded.

Statistics

Continuous variables were reported as mean and standard deviation when parametric. In cases where data were skewed, the median, and interquartile range was reported. Student t-test was used to compare parametric continuous variables and the Wilcoxon rank test when data were nonparametric. Categorical variables were reported as absolute numbers with percentages and compared with X^2 testing or Fisher exact testing. Amputation rates were compared using Kaplan Meier analysis and compared by the log-rank test. Cox Proportional Hazards modeling was used to determine factors associated with amputation. A two-sided *P* value of ≤0.05 was considered statistically significant. All statistical analyses were completed in R Programming for Statistical Analysis (R Foundation for Statistical Computing) version 3.6.3.

RESULTS

Ninety-three patients with wounds due to chronic limb-threatening ischemia were seen over the study period. The mean age of the cohort was 68 years old (sd ± 12 years). Sixty of the patients were men. There was a high prevalence of diabetes (n=65, 70%) in the entire cohort. Renal failure was a comorbidity in 38 (41%) of patients and 56 (60%) patients were current smokers. Only 72 (77%) of patients were on an antiplatelet agent and 70 (75%) patients were on a statin agent.

Pulse Exam at the of Initial Visit

We first analyzed the data based on if a pulse exam was done by the PCP at the time the wound was identified. Of the 93 patients, 59 patients (63%) did not have a pulse exam performed by their primary care provider at the visit when the wound was identified (Table I). Patients that did not have a pulse exam were less likely to be on an antiplatelet agent (73% vs. 85% p= 0.32) or a statin (69% vs. 85%, *P* = 0.18), although this did not reach statistical significance. Interestingly, patients who had a pulse exam performed by their PCP at the initial wound visit had a longer time to vascular surgery referral (36 vs. 61 days), revascularization (82 vs. 145 days), and wound healing (172 vs. 300 days) than those that did not have pulse exam.

Timing of Ankle Brachial Index

The overall median time to ABI testing in patients was 55 days (IQR 30–104 days) Patients were then classified by when they underwent ankle brachial index testing. Early ABI testing (< 30 days) was performed in 24 patients, with the remaining 69 patients having late ABI testing. Patients in the early ABI group were more likely to have a pulse exam done by their PCP than those in the late group, 12 (50%) vs. 22 (32%), *P* = 0.03, which may indicate the PCP recognized limited perfusion to the lower extremity. Early ABI patients had a quicker time to vascular referral (13 days vs. 71 days, *P* < *0.*001) and revascularization (99 days vs. 144 days, *P* = *0.*04). Finally, early patients also had quicker times to wound healing than those in the late group (117 days vs. 287 days, *P* < *0.*001).

Wound Center Referral

Within this cohort, only 31 (33%) patients were referred by their primary care provider to a wound care center at the time of the initial wound evaluation. Patients that did not have a pulse exam performed by their PCP were less likely to be referred to a wound care center for treatment (47% vs. 25%, $P = 0.04$). There was no difference in the median time to ABI testing for patients who were referred to a wound care center (69 days) compared to those who were not referred to a wound care center (50 days, $P = 0.11$). Patients referred to a wound care center had a longer time to vascular referral than patients that were not initially treated at a wound care center (56 days vs. 29 days, p= 0.002), but there was no difference in time to definitive revascularization (no wound care center = 90 days vs. wound care center = 97 days, $P = 0.71$) or wound healing (no wound care center = 177 days vs. wound care center = 210 days, $P = 0.56$) (Table II).

Risk of Amputation

Twenty-two patients (24%) underwent an amputation, 5 (5%) of which were major amputations. Only 2 (8%) patients in the early ABI group required amputation, with one being a major amputation. In contrast, 20 (30%) patients in the late ABI group required an amputation, with 4 of those being a major amputation. When adjusted for age, sex, and comorbidities, patients that underwent early ABI were less likely to require any amputation (Fig. 1), although this did not reach statistical significance ($P = 0.07$).

DISCUSSION

This study of patients with chronic limb-threatening ischemia shows that the majority of patients do not get an appropriate pulse exam at the time the wound is identified and that many of these patients are immediately referred to a wound care center. We also showed that performing ABI testing within 30 days of wound diagnosis results in a quicker time to vascular referral, definitive revascularization, and wound healing. In addition, early ABI testing may decrease the risk of amputation.

In this study, 63% of patients with a lower extremity wound did not have any documented pulse exam of the affected extremity by their primary care provider. In the no pulse exam group, patients were also less likely to be on a statin or antiplatelet agent. Multiple societies, including the Society for Vascular Surgery (SVS), and wound care organizations have dedicated guidelines all of which recommend a complete pulse exam when a patient presents with a lower extremity wound.[5, 7, 15, 16] In 2016 the Association of American Family Physicians promoted the dissemination of the SVS guidelines as well.[17] Promoting the adoption of Clinical Practice Guidelines can be challenging. However, despite efforts at dissemination, specialty guidelines are often poorly adopted by primary care providers due to lack of time to review them and the fact that they are published in specialty journals.[18, 19] Adherence to guidelines can be even more limited in rural areas.[20] At this point, the impetus should be on specialist organizations to create partnerships with primary care societies to increase awareness and develop programs to ensure that patients are getting better care. In the US, this means the SVS development of in-depth training programs for PCPs which

provide continuing medical education credit and help them understand the management of patients with lower extremity wounds.

We found that patients who underwent early ABI testing had a faster time to referral, definitive revascularization, and wound healing. ABI is currently the most widely used method to assess perfusion in patients with lower extremity wounds.[21] Unfortunately, as much as 45% of patients with CLTI undergo revascularization without an ABI prior to treatment.[22] While there is substantial debate about the optimal ABI threshold for diagnosing PAD, it is clear that ABI testing provides valuable prognostic information for patients with wounds. There is no recommendation for the timing of ABI, but the assessment of perfusion is part of all evidence-based guidelines for the treatment of patients with lower extremity ulcers.[4, 5, 15, 17] Our study suggests that there is a decreased risk of amputation when the ABI is done within 30 days of wound identification, and because of that we believe the timing of ABI testing should be a metric for treating patients with CLTI and/or diabetic foot infections.

Only 33% of patients in this study were referred to a wound care center. It is also concerning that 47% of those referred did not have a pulse exam by their primary care provider at the time the wound was identified and there was a significantly longer time to vascular referral for patients initially referred to a wound care center. There are also no multidisciplinary wound care centers in the area surrounding our tertiary referral center where all these patients live. Patients with CLTI have high rates of treatment failure, which is mostly related to wound breakdown, vascular disease, or recurrent amputation.[23, 24] Despite this, research has clearly shown that patients with CLTI treated in a multidisciplinary fashion have decreased risk of amputation and better survival.[25] Moreover, treatment at multidisciplinary wound care centers increases the likelihood that vascular insufficiency is diagnosed and patients get appropriate debridement and offloading.[26, 27] Multidisciplinary care also improves patient-reported outcomes of pain and quality of life.[27] Vascular providers throughout the country should make focused efforts to develop partnerships with local wound care centers in their surrounding area and create multidisciplinary collaborations either by simplification of referrals, improved communication, or use of telemedicine/telementoring networks.

There are several limitations to this work. First and foremost, it is retrospective, which introduces a number of biases about treatment, and delays in treatment. Second, we reviewed exam notes by the PCP to determine if the patient had a pulse exam documented. It is possible that a pulse exam was done, and the PCP just did not document this in their note. This would still be concerning as the provider is not revealing their true thought process behind the nature of the wound. We did not separate patients that had Rutherford grade 5 disease from those that had Grade 6 disease. It is very possible that patients who presented with Grade 6 disease were going to require amputation no matter when their ABI testing was performed. Finally, because of the small sample size, there is likely a Type 2 error which does not show the true effect timing of ABI testing has on reducing amputation risk. In addition, it is clear that a very large sample size would be needed to demonstrate a decreased risk for major amputation risk.

CONCLUSIONS

Early ABI testing, rather than a complete pulse exam by the PCP at the initial wound visit, expedites specialty referral ,and time to revascularization. It can also decrease the time to wound healing. Larger cohort studies are needed to determine the overall effect of early ABI testing to decrease amputation rates.

Acknowledgments

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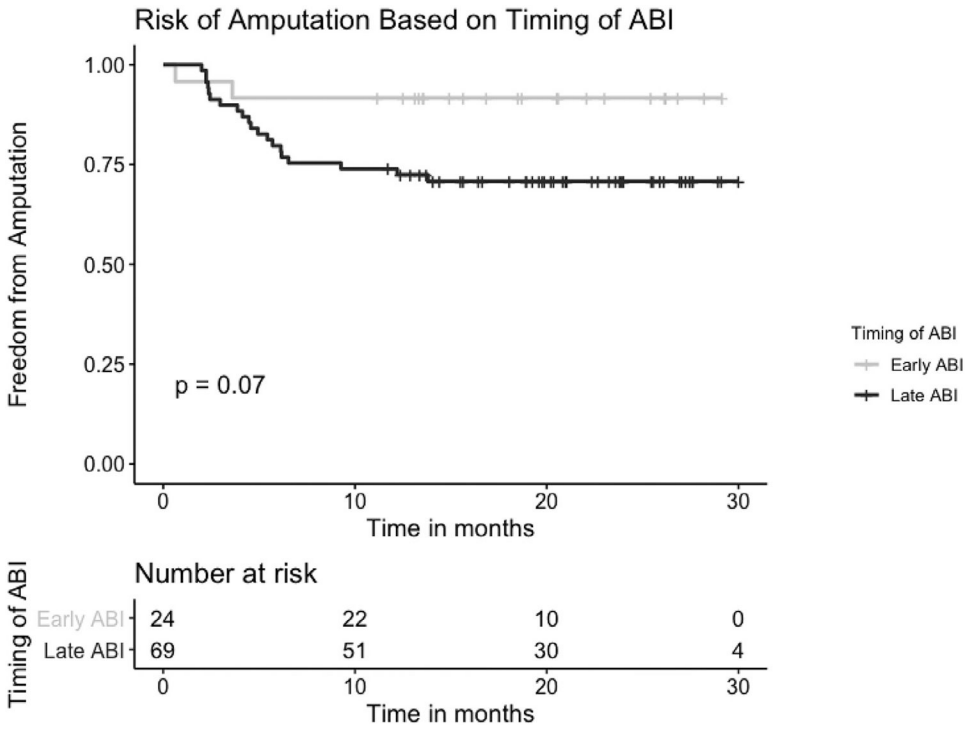

Fig. 1.

Risk of an amputation based on early versus last ankle brachial index measurement.

Table I.

Breakdown of patient characteristics by pulse exam. Normal distribution data represented by mean and standard deviation (SD). Nonparametric data represented by medial and interquartile range (IQR)

Total patients = 93	**No Pulse Exam *n* = 59 (63%)**	**Pulse Exam, *n* = 34 (37%)**	***P*-value**
Age (Mean ± SD)	68 ± 13 years	68 ± 10 years	0.80
Male Sex	35 (59%)	25 (74%)	0.25
Race			
White	37 (63%)	22 (65%)	0.29
Black	9 (15%)	2 (6%)	
Asian/Pacific Islander	3 (5%)	1 (3%)	
American Indian	2 (3%)	0	
Hispanic	8 (14%)	9 (26%)	
Comorbidities			
Diabetes	40 (68%)	25 (74%)	0.73
Coronary Artery Disease	32 (54%)	14 (41%)	0.28
COPD	9 (15%)	4 (12%)	0.88
Congestive Heart Failure	17 (29%)	9 (26%)	0.96
Renal Failure	24 (41%)	14 (41%)	0.99
Tobacco Use	37 (63%)	19 (56%)	0.64
Medication Use			
Antiplatelet therapy	43 (73%)	29 (85%)	0.32
Anticoagulation	29 (49%)	20 (59%)	0.60
Statin therapy	41 (69%)	29 (85%)	0.18
Referral to Wound Care Center	15 (25%)	16 (47%)	0.04
Median Time to Vascular Referral (IQR)	36 (15–64) days	61 (20–139) days	0.17
Median Time to Revascularization (IQR)	82 (58–183) days	145 (15–184) days	0.85
Median Time to Wound Healing (IQR)	172 (113–336) days	300 (148–432) days	0.51

Table II.

Patient characteristics by time of ABI testing. Early ABI testing = < 30 days. Normal distribution data represented by mean and standard deviation (SD). NonParametric data represented by medial and interquartile range (IQR)

Total patients = 93	**Early ABI *n* = 24 (26%)**	**Late ABI *n* = 69 (74%)**	***P*-value**
Age (Mean ± SD)	70 ± 11 years	67 ± 12 years	0.27
Male Sex	19 (79%)	41 (59%)	0.13
Race			
White	16 (67%)	43 (62%)	0.67
Black	2 (8%)	9 (13%)	
Asian/Pacific Islander	2 (8%)	2 (3%)	
American Indian	0	2 (3%)	
Hispanic	4 (17%)	13 (19%)	
Comorbidities			
Diabetes	17 (71%)	48 (70%)	0.99
Coronary Artery Disease	15 (63%)	31 (45%)	0.24
COPD	4 (17%)	9 (13%)	0.92
CHF	9 (38%)	17 (25%)	0.37
Renal failure	9 (38%)	29 (42%)	0.88
Referral to Wound Care Center	6 (25%)	25 (36%)	0.50
Pulse Exam By PCP	12 (50%)	22 (32%)	0.03
Median Time to ABI testing (IQR)	13 (8–17) days	91 (49–176) days	< 0.001
Median Time to Vascular Referral (IQR)	13 (5–25) days	71 (31–139) days	< 0.001
Median Time to Revascularization (IQR)	99 (13–221) days	144 (66–559) days	0.04
Median Time to Wound Healing (IQR)	117 (72–156) days	287 (164–440) days	< 0.001