Predictors of Change in Walking Distance in Patients with Peripheral Arterial Disease Undergoing Endovascular Intervention

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ABSTRACT

Background: Endovascular treatment of peripheral artery disease is becoming frequent, yet the clinical factors which predict ambulatory outcomes are not known.

Hypothesis: To identify predictors of change in walking distance in patients who underwent endovascular intervention for their lower extremity peripheral arterial disease (PAD).

Methods: A total of 134 patients underwent lower extremity peripheral arterial intervention, 52 patients were contacted via phone between 1 and 36 months (a mean of 22 mo) after their initial procedure. The remaining 82 patients were excluded due to the following reasons: death (n = 13), contact information was not available (n = 50), and refusal to participate in the follow-up (n = 19).

Results: The patients were 63±12 years old (mean±standard deviation [SD]), 46% were male, 47% were diabetics, 49% had coronary artery disease, of whom 29% had prior revascularization, and 22% had coronary artery bypass grafts (CABG). The disease severity described by Fontaine classification were as follows: 44.2% were in stage II, 15.4% were in stage III, and 40.4% were in stage IV. Walking distance was improved in 21% of patients, worsened in 73% of patients, and unchanged in 6% of patients. Stepwise multiple regression demonstrated that patients who started to walk or exercise ($R = 0.372$, $P<0.012$) and who had a prior history of CABG ($R = 0.467$, $P<0.006$) were the only independent predictors of the change in walking distance at follow-up. Those who started to walk reported worse walking distance at follow-up, while those with a history of CABG reported better walking distance at follow-up.

Conclusion: CABG prior to endovascular intervention is predictive of favorable change in walking distance in patients with PAD at follow-up. Therefore, post-CABG patients are good candidates for exercise rehabilitation and risk factor modification.

Introduction

Estimates of prevalence of peripheral arterial disease (PAD) in the general population range from 3% to 30% in the United States.[1] The major cause of lower extremity PAD is atherosclerosis. Risk factors for atherosclerosis such as cigarette smoking, diabetes, dyslipidemia, hypertension, and hyperhomocysteinemia increase the likelihood of developing lower extremity PAD, as well as other manifestations of atherosclerosis.[2,3] Symptomatic PAD carries at least a 30% risk of death within 5 years and almost 50% within 10 years, due to myocardial infarction (60%) and stroke (12%).[4]

Until recently, surgery was the only widely accepted treatment option in PAD.[5] Pioneering endovascular techniques were first proposed in the late 1960s[6] as a minimally invasive alternative to surgery, but were initially viewed with skepticism. However, the relentless refinement of these techniques and constant expansion of their applications, coupled with advances in device technology and vascular biology have virtually redefined the paradigm of managing PAD.

However for endovascular interventions, late clinical failure remains an important concern. For instance with percutaneous transluminal angioplasty of the superficial femoral artery (SFA) may result in restenosis in 40% to 60% of treated segments in 1 year, and even greater than 70% in lesions greater than 100 mm in length. Cumulative primary patency for all lesions and all indications ranges from 26% to 45% at 5 years.[7–9] The use of self-expanding nitinol stents have improved the outcome and patency rates of long SFA lesions.[10–12] Many studies have examined amputation free survival[13] between different modalities (angioplasty vs stent placement), different endovascular interventions (angioplasty vs open surgical bypass), and with regards to the patency and complications of stents. However, no study

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has assessed ambulatory outcomes following endovascular intervention, and whether baseline comorbid conditions affect ambulation after intervention. This information is important in considering the timing of intervention as well as in risk factor modification.[14] Therefore, the purpose of our study is to identify baseline predictors of walking ability at follow-up in patients with PAD undergoing endovascular intervention.

Methods

Subjects

In this retrospective study, we reviewed details of all patients who presented to cardiac catheterization laboratories for lower extremity endovascular intervention between January 2005 and June 2007. We limited our study group to patients who had infra-inguinal disease. Patients presenting with acute limb ischemia due to embolism were excluded. Letters were sent by U.S. Mail in order to seek permission to contact them, and those who agreed were contacted via follow-up telephone call. The procedures used in this study were approved by the Institutional Review Board at the University of Oklahoma Health Sciences Center.

A total of 134 consecutive patients had (infra-inguinal) lower extremity endovascular intervention performed 1 or more times during the study period. Of these patients, 13 died before the follow-up, 19 patients refused to participate by notifying us in response to our letter, 50 patients could not be located as their contact information had changed since the procedure, and the remaining 52 patients were contacted at follow-up and therefore comprise the sample for this study.

Revascularization

In the 52 study participants, angioplasty followed by stent placement were the most common methods of intervention noted. The methods of intervention are described as follows: balloon angioplasty 41/52 patients (78%), stent placement 29/52 (55%), atherectomy 18/52 (34%), cryoplasty 8/52 (15%), and laser catheter 2/52 (4%). Complications noted in our review included 2 cases of dissection, in which 1 was self-limiting and the other was treated with stent placement, 1 pseudoaneurysm, and 1 case of retroperitoneal hematoma.

Measurements

Prior to and soon after revascularization, age, height, weight, current medical problems, current medications, type of procedure, angiogram details prior and after the procedure, and any complications related to procedure were recorded. During a telephone call at follow-up (mean duration of 22 mo; range = 1–36 months), subjects were asked to assess whether their walking ability had improved, remained the same, or worsened prior to revascularization. Additionally, subjects reported the number of blocks walked during the past week, the number of flights of stairs climbed during the past week, and whether they had initiated an exercise program since revascularization. To assess current level of physical activity, the Baltimore Activity Scale for Intermittent Claudication questionnaire was administered.[15]

Statistical Analysis

The primary endpoint was walking ability at follow-up. To identify the determinants of improvement in walking distance after the endovascular intervention, a stepwise multivariable linear regression analysis was performed. The following variables were included in the analyses: age, sex, race, weight, body mass index (BMI), Fontaine classification, diabetes, coronary artery disease, hypertension, renal insufficiency, congestive heart failure, prior revascularization, history of CABG, smoking status and number of pack years, Trans Atlantic Inter-Society Consensus (TASC) lesion,[16] repeat intervention, smoking cessation after the procedure, started walking/exercising, and taking medications regularly. Correlation coefficients and descriptive statistics were also performed using the SPSS version 15.0 statistical package (SPSS Inc., Chicago, IL).

Results

The baseline characteristics of patients who underwent endovascular intervention are displayed in Table 1. Mean age of patients in our study was 63 years, and 46% of the sample was male. A total of 50% were active smokers at the time of intervention; two-thirds of patients had hypertension and had hypercholesterolemia. More than 40% of patients had coronary artery disease, diabetes, with only 13% of patients having congestive heart failure. Renal insufficiency was present in 33% of patients and 22% of patients had a history of CABG. The disease severity described by the Fontaine classification were as follows, 44.2% were in stage II, 15.4% were in stage III, and 40.4% were in stage IV and similarly 42% of patients had TASC D lesions on angiogram.

The correlation coefficients between walking ability at follow-up and baseline medical problems are listed in Table 2. Walking ability was positively correlated with statins ($P = 0.026$), repeat intervention ($P = 0.018$), and history of CABG ($P = 0.028$) and negatively correlated with started walking or exercising ($P = 0.006$). Table 3 shows results of stepwise multiple regression analysis. Walking ability at follow-up was predicted by history of CABG ($P < 0.006$) and when patient started to walk and exercise. After CABG and started walking/exercising entered into the model, none of the other variables including coronary artery disease, diabetes mellitus, or congestive heart failure, were statistically significant in predicting walking ability at follow-up. In Table 4, we have included characteristics of patients who underwent amputation. It was noted that only 1 of these amputations was performed at our institution.

Discussion

The majority of patients in this study were treated with angioplasty and stent placement of the involved vessel

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Table 1. Baseline Characteristics of Patients with Peripheral Arterial Disease Who were Treated Endovascularly, Along with any Intervention or Amputation on Follow-up

Variables	Mean (±SD)
Age (years)	63±12.4
Sex (% males)	46
Race (% white)	57
Body mass index	28.8±6
Smokers (% active)	50
Fontaine classification (% class IV)	40
TASC lesion (% type D)	42
Diabetes %	47
Coronary artery disease %	49
Hypertension %	78
Hypercholesterolemia %	67
Renal insufficiency %	33
Congestive heart failure %	11
Prior CABG %	22
History of prior revascularization %	29
Repeat intervention % (on follow-up)	21
Amputation % (on follow-up)	7
Follow-up duration (d)	661±220

Values are means (SD) or percentages. Abbreviations: CABG, coronary artery bypass grafting; SD, standard deviation; TASC, TransAtlantic Intersociety Consensus.

Table 2. Correlation Between Walking Ability at Follow-up and Comorbid Conditions Obtained at Baseline

Variable	Walking Ability	*P* Value
Age	0.164	0.140
Fontaine classification	−0.108	0.239
BMI	−0.133	0.191
TASC lesion	0.197	0.097
Diabetes	0.177	0.122
Coronary artery disease	−0.199	0.095
Hypertension	−0221	0.072
Renal insufficiency	−0.059	0.351
CHF	0.234	0.061
Hypercholesterolemia		0.500
Statins	0.293	0.026
CABG	0.288	0.028
Prior revascularization	0.239	0.057
Repeat intervention	0.312	0.018
Follow-up duration	−0.096	0.266

Abbreviations: BMI, body mass index; CABG, coronary artery bypass grafting; CHF, congestive heart failure; TASC, TransAtlantic Intersociety Consensus.

with resultant improvement in the stented segment and in the runoff vessels distally, as documented in the final angiogram after the procedure. The primary finding was that prior history of CABG, and whether patients started walking/exercising after the procedure were the only predictors of walking ability after a mean 22 months follow-up period in patients who underwent revascularization. Furthermore, improved walking ability at follow-up was associated with higher physical activity and more city blocks walked.

The present study is the first to report that patients with prior CABG may notice improvement in walking distance after successful intervention. There have been previous reports about physical training in cardiac surgery patients who undergo CABG or other cardiac surgeries.[17,18] In these patients, functional capacity, often measured by a 6 minute walk test, is significantly reduced shortly after cardiac surgery but improves quickly after physical training.[18,19] Exercise rehabilitation has therefore been recommended in patients undergoing CABG.[20,21] A 6 minute walk test has been proposed to assess these patients soon after CABG,[18] followed by a personalized cardiac rehabilitation program adjusted to individual needs.[22]

A supervised exercise program is beneficial in improving the walking distance by almost 150% in patients with intermittent claudication.[23,24] This improvement is considerably greater than compared to oral medications (eg, cilostazol), which increase walking distance by up to 50%.[25] Prior history of CABG having a positive effect on ambulation may be due to increased surveillance and the improved medical care they receive after surgery. Consequently, patients with a history of CABG at baseline are good candidates for exercise rehabilitation and risk factor modification following intervention as an integral part of the endovascular program. Use of statins showed a positive correlation with walking ability, and this has been shown in studies to cause improvement in walking distance.[26–28] Interestingly, patients who started to walk after the intervention reported less improvement in their walking at follow-up. This has not been previously observed in patients with PAD undergoing either endovascular intervention or open surgical procedure, and may

Table 3. Multiple Regression Analysis to Predict Walking Ability at Follow-up in Patients Who Underwent Peripheral Vascular Intervention

	R	R^2	F	β	95% CI
Started walking/exercise	0.372	0.138	6.889	−0.593[a]	−1.037 to −0.150
CABG	0.467	0.218	5.863	0.549[b]	0.015 to 1.082

[a] $P<0.012$.
[b] $P<0.006$.
Abbreviations: CABG, coronary artery bypass grafting.

Table 4. Characteristics of Patients Who Ended Up Having Amputation of the Involved Extremity after Having Endovascular Intervention

	Fontaine	TASC	Runoff Post Intervention	Stent	Angioplasty	Misc
Patient 1	4	D	1	1	1	Patient had h/o prior bypass
Patient 2	3	D	1	0	0	Angiojet of occluded fem fem bypass
Patient 3	2	D	3	1	1	Atherectomy
						Cryoplasty (this was followed by repeat intervention in 7 mo and fem pop bypass a mo after)
Patient 4	4	D	3	1	1	h/o rt leg amputation

Patients 1, 3, and 4 had amputations performed at a different hospital. Abbreviations: h/o, history of; mo, month.

indicate that their expectations of improvement in walking following the procedure were not met.

There were no significant complications noted in the perioperative phase of these procedures. Overall, 21% of patients noted improvement in walking distance after the procedure. Table 4 describes the detailed characteristics of patients who gave a history of amputation on follow-up. Interestingly, none of them had a history of CABG, but all had severe PAD as described by their TASC lesions on angiogram. Two of these patients already had surgical bypass performed, 1 had bypass later after the intervention and the last case already had amputation of the contra lateral lower extremity prior to intervention.

Limitations

This study has some limitations, most important of which is that it used a retrospective study design. The findings from this study need to be confirmed in a prospective design to establish the role of comorbid conditions having a negative impact on the walking ability of patients with peripheral arterial disease at long-term follow-up. Another limitation was lack of information on almost half of the patients, as they either refused to participate or their updated contact information was not available. Thus, our results may be biased, as those with less favorable walking ability at follow-up may not have been included in the analyses. Conversely, it is possible that the patients with the best walking ability were lost to follow-up because of resolution of their symptoms.

Another important limitation is that status of the vessel at the time of follow-up, that is, whether the vessel at the time of follow-up is patent is unknown.

Conclusion

In conclusion, CABG prior to endovascular intervention is predictive of favorable change in walking distance in patients with PAD at follow-up. Therefore, post-CABG patients are good candidates for exercise rehabilitation and risk factor modification.

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