Original Article

Peripheral Arterial Disease in Coronary Artery Bypass Graft Candidates: Prevalence, Risk Factors and Functional Mobility

Kamontip Harnphadungkit,[1] Wilawan Thirapatarapong,[1] Vareerat Wanichagorn,[1] Thitima Chanawises[1] and Pansak Laksanabunsong[2]

[1]Department of Rehabilitation Medicine; [2] Department of Surgery
Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

ABSTRACT

Objectives: To determine the prevalence of peripheral arterial disease (PAD) among coronary artery bypass graft (CABG) candidates during the preoperative period of their surgical admission using the ankle brachial index (ABI) screening method and to evaluate risk factors, quality of life, and functional mobility.

Study design: Cross-sectional study.

Setting: Siriraj Hospital.

Subjects: Coronary artery bypass candidates.

Methods: Ankle brachial index (ABI) ≤ 0.9 was used to diagnose PAD. The four-meter walk test (4MWT) was used to evaluate functional mobility and the 36-Item Short Form Survey (SF-36) was used to evaluate quality of life.

Results: Of 192 candidates, 143 (74.5%) were male and 49 (25.5%) were female. Mean age was 64 years (SD 10). The prevalence of PAD identified by ABI screening was 12.5%. However, only 4.2% had a history of PAD. Age was the only risk factor significantly correlated with coexisting PAD in the CABG candidates. PAD risk was higher in patients of advanced age. There were no statistically significant differences between the PAD and non-PAD groups in calf pain or claudication symptoms, congestive heart failure, foot ulcers, end-stage renal disease (ESRD) or osteoarthritis of knee (OA knee). However, left ventricular ejection fraction (LVEF) was lower in the PAD group (mean 46.0, SD 20.9) than the non-PAD group (mean 55.95, SD 17.19) (p = 0.031). Time needed to complete the 4MWT was significantly higher in the PAD group (mean 6.6, SD 2.6 seconds) than non-PAD group (mean 4.9, SD 1.8 seconds) (p = 0.01). SF-36 revealed that the PAD group had a lower quality of life in the physical domain (p = 0.007).

Conclusions: PAD was identified in 12.5% of the CABG candidates. However, most cases were unrecognized. The PAD group had lower LVEF, functional mobility, physical health domain of quality of life than the non-PAD group.

Keywords: prevalence, peripheral arterial disease (PAD), coronary artery bypass, ankle brachial index (ABI), mobility, quality of life

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Introduction

Atherosclerosis is a common pathological condition of blood vessels that expresses in many important diseases such as coronary artery disease (CAD), peripheral arterial disease (PAD), and stroke[1] which share links to many of the same predisposing risk factors, e.g., age, smoking, diabetes and dyslipidemia. CAD and PAD can occur independently or can coexist in the same patient. The PARTNERS study suggested that 16% of outpatients at moderate risk of atherosclerosis have both PAD and cardiovascular disease.[2] CAD is the leading cause of death worldwide, including Thailand.[3,4] Treatments include education, lifestyle modification, medication, percutaneous coronary intervention, surgical correction and cardiac rehabilitation. Coronary artery bypass graft (CABG) is the surgical procedure used with CAD patients to relieve clinical symptoms and to increase longevity.

Cardiac rehabilitation is one of the treatments for CAD patients. Walking is an easy exercise/activity recommended for cardiac rehabilitation. However, the main clinical symptom of PAD is intermittent claudication that can limit walking or make walking difficult due to calf pain or claudication symptoms. CAD patients usually have impaired cardiac function leading to limited activity, including walking which can obfuscate a clinical diagnosis of PAD. However, PAD can now be diagnosed by non-invasive ankle brachial index (ABI) measurement.[5] Prevalence of PAD in the middle-class urban Thai population as measured by ABI was 5.2%.[6] The prevalence was much higher in patients with previous coronary or cerebrovascular events[7] as well as in hospitalized CAD patients.[8]

Hospital rehabilitation departments usually provide rehabilitation programs to improve the functional outcome of cardiac patients. A recent study of PAD patients undergoing outpatient cardiac rehabilitation had similar benefit but higher dropout rates than other patients.[9] Additionally, PAD has been demonstrated to be an independent predictor of poor long-term survival among patients undergoing CABG surgery[10]

Correspondence to: Kamontip Harnphadungkit, MD, FRCPhysiatrT, Department of Rehabilitation Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Prannok Road, Bangkoknoi, Bangkok, Thailand 10700, E-mail: kamontip.har@mahidol.ac.th; kamontip.har@gmail.com

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and was identified as an independent risk factor only for late mortality in patients undergoing isolated CABG surgery.[11] This finding emphasizes the importance of coexisting PAD. However, the prevalence of PAD in CABG candidates in Thailand has never been determined. To fill that void, we performed a cross-sectional study to determine the prevalence of PAD among CABG candidates during the preoperative period of their surgical admission using the ankle brachial index (ABI) screening method to explore the size of the population with a coexisting PAD condition. Potential risk factors and their correlation with functional mobility were also evaluated.

Methods

This cross-sectional descriptive study was conducted at Siriraj Hospital, a university-based hospital in Bangkok, Thailand. The protocol for this study was approved by the Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University (553/2551(EC1)).

Participants

Inpatient coronary bypass candidates were invited to participate in the study during their preoperative period. All participants provided informed consent before joining the study which was conducted between January 2009 and December 2011. Patients with severe systemic illness that would have hindered assessment, those unable to communicate or unable to walk and patients who were blind were excluded.

Basic demographic and other characteristics were collected. All subjects underwent ABI screening using a non-invasive automatic device (Colin VP-2000). A diagnosis of PAD was made when ABI was ≤ 0.9.[5] Calf pain or claudication symptoms defined by the Edinburgh claudication questionnaire (ECQ)[12] were used to detect PAD. The four meter-walk test (4MWT) was performed to evaluate functional mobility. The test was performed by having patients walk at their usual pace using gait aids if needed. The better of two trials was used for analysis. Rate of perceived exertion (RPE) on a scale of 6-20 was also recorded. The self-reported short form 36-item health questionnaire (SF-36)[13] was used to evaluate quality of life.

Sample size was calculated based on the 16% PAD prevalence reported in the Hirsch AT study[2] with a 95% confidence interval and 5.5% allowable error. The calculated sample size was 171, with a 5% oversample of 180. The actual sample size in the study was 192.

Statistical analysis

PASW Statistics version 18 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Descriptive statistics were used for subject characteristics. The independent t-test was used to compare quantitative data, e.g., age and body mass index. The Chi-square test was used to compare qualitative data, e.g., gender and specific disease(s). Time for the 4MWT (in seconds) between the PAD and non-PAD group was analysed for cut-off values using the Receiver Operating Characteristic (ROC) curve. Statistical significance was accepted at $p < 0.05$.

Results

Table 1 shows the characteristics of the participants. A total of 192 participants were evaluated. The average age was 63.7 years (SD 10.2, range 27-87). There were 143 males (74.5%) and 49 females (25.5%). The prevalence of PAD determined by ABI screening (≤ 0.9) was 12.5% (95% CI, 8.5% to 17.9%). Only 4.2% of the patients had a previous history of PAD. The risk factors studied were age, sex, body mass index (BMI), smoking, diabetes mellitus, dyslipidemia, and family history of CAD. Age was the only risk factor found to be significantly correlated with coexisting PAD in the CABG candidates. PAD risk was higher in patients of advanced age (Table 2). The odds ratio in the age group over 70 years was 5.33 (95% CI, 1.62 to 17.51).

There were no statistically significant differences between PAD and non-PAD groups in congestive heart failure, foot ulcer, end-stage renal disease (ESRD) and osteoarthritis of knee (OA knee). However, the PAD group was found to have lower LVEF (mean 46.0, SD 20.9) than the non-PAD group (mean 55.95, SD 17.19) ($p = 0.031$).

Regarding calf pain or claudication as defined by ECQ, there was no statistically significant difference between the PAD and non-PAD groups. The concordance between ECQ and ABI in PAD screening was poor at only 0.163. As to functional mobility, 180 participants (93.75%) completed the 4MWT (Table 3). The mean RPE for the 4MWT of the PAD and non-PAD groups were 11.2 (SD1.4) and 10.9 (SD 1.0), respectively. There was no statistically significant difference in RPE between the groups ($p = 0.209$). During the 4MWT, the PAD group walked significantly slower (mean 6.6, SD 2.6 seconds) than the non-PAD group (mean 4.9, SD 1.8 seconds) ($p = 0.01$). Receiver operating characteristic (ROC) curve analysis revealed that the cut-off point of 6 seconds gave an odds ratio (OR) of 4.33 (95% CI, 1.62 to 11.53). However, when combined with age-adjusted analysis, the OR decreased to 3.2.

Quality of life studied using the self-reporting SF-36 revealed that the PAD group had a lower physical health domain ($p = 0.007$) but there was no significant difference in the mental health domain ($p = 0.928$) (Table1).

Discussion

The prevalence of PAD in CABG candidates was 12.5% which is similar to the prevalence of PAD in patients undergoing percutaneous coronary intervention[14] and those undergoing isolated CABG,[11] but higher than in the general population.[6,15,16] The prevalence was within the 6-14.4% range reported in diabetic patients.[17,18] Although there was relatively high prevalence of PAD identified by ABI screening, only 4.2% of the patients had been diagnosed as PAD. This sug-

Table 1. Characteristics of participants

Characteristics	Total (n = 192)	PAD (n = 24)	non-PAD (n = 168)	*p*-value
Gender[1]				
• Male	143 (74.5)	16 (66.7)	127 (75.6)	0.491
• Female	49 (25.5)	8 (25.5)	41 (24.4)	
Age (years)[2]	63.7 (10.2)	69.3 (9.8)	62.9 (10.1)	0.004*
Body mass index (kg/m^2)[2]	25.2 (4.0)	25.0 (3.8)	25.2 (4.0)	0.768
Left ventricular ejection fraction (%)[2,#]	54.8 (17.9)	46.0 (20.9)	56.0 (17.2)	0.031*
Parameters				
• History of smoking[1]	99 (51.6)	12 (50)	87 (51.8)	0.950
• Family history of CAD[1]	46 (24)	5 (20.8)	41 (24.4)	0.898
• Known history of PAD[1]	1 (0.5)	1 (4.2)	0 (0)	0.125
• Diabetes mellitus[1]	78 (40.6)	13 (54.2)	65 (38.7)	0.222
• Hypertension[1]	143 (74.5)	20 (83.3)	123 (73.2)	0.416
• Dyslipidemia[1]	162 (84.4)	22 (91.7)	140 (83.3)	0.381
• Congestive heart failure[1]	25 (13)	3 (12.5)	22 (13.1)	1.000
• Foot ulcer[1]	4 (2.1)	1 (4.2)	3 (1.8)	0.416
• End-stage renal disease[1]	2 (1)	0 (0)	2 (1.2)	1.000
• Osteoarthritis knee[1]	18 (9.4)	4 (16.7)	14 (8.3)	0.251
Claudication detected by ECQ				
• Yes[1]	26 (13.5)	6 (25.0)	20 (11.9)	0.105
• No[1]	166 (86.5)	18 (75.0)	148 (88.1)	
SF-36				
• Physical health[2]	55.6 (23.1)	43.7 (23.6)	57.2 (22.6)	0.007*
• Mental health[2]	71.3 (20.7)	70.9 (21.5)	71.3 (20.6)	0.928

[1]Number (%); [2]mean (SD); *$p < 0.05$ indicates statistical significance; #, missing data (n = 149/17/132)

CAD, coronary artery disease; PAD, peripheral arterial disease; ECQ, Edinburgh claudication questionnaire; SF-36, short form 36-health questionnaire

Table 2. Age and odds ratios of peripheral arterial disease (PAD) and non-PAD groups

Age (years)	PAD (n = 24)	non-PAD (n = 168)	Odds Ratio	*p*-value
≤ 60	4 (5.9)	64 (94.1)	1	0.002*
60-70	7 (9.7)	65 (90.3)	1.72 (0.48-6.17)	
> 70	13 (25)	39 (75)	5.33 (1.62-17.51)	

Number (%), *$p < 0.05$ indicates statistical significance

Table 3. Four meter walk test (4MWT) and rate of perceived exertion between PAD and non-PAD group (n = 180)[#]

Characteristics	Total (n = 180)	PAD (n = 20)	non-PAD (n = 160)	*p*-value
RPE	10.9 (1.1)	11.2 (1.4)	10.9 (1.0)	0.209
Time spent (seconds)	5.1 (1.9)	6.6 (2.6)	4.9 (1.8)	0.010*

[#]only 180 subjects completed test; Mean (SD); * $p < 0.05$ indicates statistical significance

gests that PAD had been previously overlooked in this group of patients.[2] The study also found no statistically significant difference in claudication pain based on ECQ between patients with PAD and the non-PAD patients. The concordance between ECQ and ABI in PAD screening was poor. This may be due to asymptomatic PAD or to some patients having low functional mobility or being unable to walk, making it difficult to accurately evaluate symptoms. ECQ has been previously reported to be insufficiently sensitive in detecting PAD.[19,20] Therefore, diagnoses that rely primarily on history taking, especially claudication pain, might fail to detect the presence of PAD. The majority of individuals seen in the cardiac rehabilitation unit were post-CABG patients.[21] These findings suggest that early PAD detection screening should be provided in cardiac rehabilitation programs to achieve better outcomes.

Age was the only risk factor found to be related to the coexistence of PAD with CAD, a situation which might be due to CAD and PAD having the same risk factors. Age is one of the non-modifiable risk factors of PAD and advanced age was found to be associated with increased risk of PAD. The prevalence of PAD increased with age.[15,22] In this study, the risk increased every decade beginning at age 60. This should remind health care providers to look for PAD in advanced age patients.

Lower LVEF, which might suggest greater cardiac impairment severity, was found in the PAD group. This is in concordance with a prior study which reported that concomitant PAD is associated with the angiographic severity of coronary atherosclerosis.[23]

Candidates who were able to perform the 4MWT reported an average RPE of about 11, which is described as fairly light, suggesting that the 4MWT can be performed safely by CABG candidates. The PAD group needed more time to complete 4MWT, an indication that they had less functional mobility. The effects of PAD or poor LVEF might be the reason for poorer 4MWT results because there were no significant differences in congestive heart failure, foot ulcer, end-stage renal disease and osteoarthritis of knee. However, the study did not collect data on other causes that could potentially impair functional mobility, e.g., peripheral neuropathy and lumbosacral radiculopathy. In cases where no ABI measurements are available, 4MWT may have a role in screening for PAD as well as monitoring for the development of PAD when times exceed 6 seconds. Abnormal 4MWT findings may also be used to help determine the need for further evaluation using other means of investigation to diagnose PAD. However, further study is needed to evaluate this suggestion.

Regarding quality of life, the PAD group had lower physical health QOL which might be due to impaired mobility. Considering the high dropout rate of PAD patients from rehabilitation programs in a previous report,[9] a focus on adherence to the program should be emphasized. The majority of patients appearing at our cardiac rehabilitation unit were in the post CABG patient group.[21] Attention should be paid to providing rehabilitation programs to improve the QOL of patients especially the ones with coexisting PAD.

This study has some limitations. As the duration of the preoperative period was limited, not all potential candidate patients could be invited to participate. Additionally, the study recruited only patients who were able to walk and to complete the self-report SF-36 and the validity and reliability of the ECQ used had not been previously evaluated. Other diseases which could potentially affect walking ability should be studied to identify additional factors related to functional mobility.

Conclusions

PAD coexisted in 12.5% of the CABG candidates. The prevalence of PAD increased with age, the only statistically significant coexistence-related risk factor. Significant issues identified included unrecognized diagnosis, lower LVEF, greater impairment in lower limb function and/or mobility and poorer physical domain of QOL. ABI screening and identification of PAD as well as methods of improving rehabilitation program adherence which could increase function and QOL in this group of patients are needed.

Disclosure

The authors report no conflicts of interest.

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