



Published in final edited form as:

Am J Cardiol. 2012 September 1; 110(5): 736–740. doi:10.1016/j.amjcard.2012.04.059.

Frequency of Coronary Artery Disease in Patients Undergoing Peripheral Artery Disease Surgery

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Abstract

The prevalence of coronary artery disease (CAD) in patients with peripheral arterial disease (PAD) varies widely in published reports. This is likely due, at least in part, to significant differences in how PAD and CAD were both defined and diagnosed. We describe 78 patients with PAD who underwent pre-operative coronary angiography prior to elective peripheral revascularization and provide a review of published case series. In our patients the number with concomitant CAD varied from 55% in those with lower extremity stenoses to as high as 80% in those with carotid artery disease. The number of coronary arteries narrowed by 50% in our patients was 1 in 28%, 2 in 24% and 3 in 19%; 28% did not have any angiographic evidence of CAD. Our review of the literature resulted in identification of 19 case series in which a total of 3969 patients underwent pre-operative coronary angiography prior to elective PAD surgery; in the 2687 that were described according to the location of the PAD, 55% had at least one epicardial coronary artery with 70% diameter narrowing. The highest prevalence of concomitant CAD was in patients with severe carotid artery disease (64%). In conclusion, despite sharing similar risk factors the prevalence of obstructive CAD in patients with PAD ranges widely, and appears to differ across PAD locations. Thus, the decision to perform coronary angiography should be based on indications independent of the planned PAD surgery.

Keywords

peripheral vascular; coronary artery

INTRODUCTION

The co-existence of coronary artery disease (CAD) and peripheral arterial disease (PAD) was described nearly 50 years ago¹. Complications of CAD are the leading causes of post-operative morbidity and mortality in patients undergoing PAD surgery². Therefore, pre-operative coronary angiography in patients thought to be at increased risk has become

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There are no conflicts of interest

standard clinical practice³. While it is generally assumed that patients with severe PAD have concomitant severe CAD, the prevalence of significant CAD in patients with severe PAD varies widely from 28%⁴ to 94%⁵ in published reports. This variability is in part attributable to differences in how CAD was defined (50% or 70% diameter stenosis) and diagnosed (on history alone, electrocardiogram, stress testing, or diagnostic coronary angiography), and the location of PAD. When last reviewed in 1994⁶, there were 3 published case series of patients with PAD undergoing pre-operative coronary angiography: Since then, an additional 16 articles addressing this subject have been published. In light of the fact that it is commonly assumed that patients with severe PAD also have severe CAD, the inconsistent prevalence estimates across published studies, and the additional information available since last reviewed, we present our own case series of 78 patients undergoing pre-operative coronary angiography prior to PAD surgery and provide an updated review of the previously published reports.

METHODS

After receiving approval from our Institutional Review Board, we searched the cardiac catheterization laboratory database at the University of Virginia, Charlottesville, Virginia, for patients with known severe PAD undergoing revascularization surgery who were referred for coronary angiography as part of the pre-operative work-up from January 1, 2006 to January 1, 2011. We collected demographic, and clinical information including past medical history, laboratory values, body mass index, the peripheral vascular territory to be revascularized and coronary angiographic data. The data was obtained from the electronic medical record and the cardiac catheterization laboratory database. The presence of significant CAD was defined as a 70% luminal diameter narrowing of a major epicardial artery, or 50% narrowing of the left main coronary artery. We defined PAD as disease documented by a vascular imaging study (including CT scan, ultrasound, peripheral angiography, and MRI) that was significant enough for the patient to be referred for elective vascular surgery.

We searched the literature for reported case series of pre-operative coronary angiography prior to peripheral arterial disease revascularization. We reviewed the MEDLINE database (National Library of Medicine, Bethesda, MD) and the Cochrane database (The Cochrane Library, Wiley InterScience, Chichester, UK): from January 1, 1960 to January 1, 2012. The following key words were used in the search: peripheral vascular disease, PAD, CAD, concomitant, revascularization, vasculopath, prevalence, pre-operative, and coronary angiography. The articles reviewed were limited to those written in English. Only case series where patients were scheduled for peripheral arterial surgery on the basis of a vascular imaging study and underwent coronary angiography as part of their pre-operative work-up were included. In articles where the authors included a review of the literature, only information from their own primary case series was collected for this review.

RESULTS

From January 1, 2006, to January 1, 2011, 10,696 patients underwent coronary angiography at the University of Virginia cardiac catheterization laboratory. Of these, 78 (0.73%) were referred for the sole purpose of pre-operative assessment of coronary anatomy prior to planned PAD surgery. The majority of patients were European-American, and interestingly, there were more women than men (Table 1). The rates of hypertension and hyperlipidemia were high (88% and 86%, respectively). While only 35% were current smokers, 72% of the patients had a prior history of smoking. The most common peripheral vascular territory involved was the abdominal aorta in 50% of the patients (Table 2), and 45% of the patients had significant disease in more than one peripheral arterial territory (Table 2). Angiographic

evidence of obstructive coronary artery disease (70% lesion) was seen in 72% of the patients (Table 3).

Out of a total of 58 publications reviewed, 19 fulfilled our search restrictions^{4,5,7-23}. The remaining 38 papers were not included for the following reasons: a) the prevalence of PAD was reported in patients with known CAD; b) pre-operative coronary angiography in patients referred for urgent, not elective, PAD surgery; c) no definition of CAD was provided; d) CAD was defined as >50% luminal diameter narrowing, not 70% luminal diameter narrowing of a major epicardial artery; e) PAD surgery was not planned; f) the strategy of pre-operative cardiac testing was not based on coronary angiography; and g) the paper consisted of a subset of patients from a larger, previously published database. These articles were reviewed by two of the authors (D.J.H. and E.C.K.) and pertinent information including year the case series was published, number of patients, gender, age, cardiac risk factors, peripheral vascular territory involved, and coronary angiographic data were collected and tabulated (Table 4). The 19 case series included patients undergoing elective surgery for abdominal aortic aneurysms^{4,7,9,10,15,17,18,20,21,23}, lower extremity arterial lesions¹², a combination of abdominal aortic aneurysm and lower extremity arterial lesions^{8,11,22}, a combination of abdominal and thoracic aortic aneurysms¹⁶, carotid artery disease^{5,14}, a combination of abdominal aortic aneurysm and aortoiliac disease¹⁹, and a combination of all territories including other areas such as renal and mesenteric arterial disease¹³ (Table 4). Except for one series⁴ that reported a predominance of women similar to ours, the vast majority of patients in the remaining 19 case series were men. Even when restricting the definition of CAD to the presence of a 70% lesion in at least one major epicardial coronary artery, the number of patients with concomitant CAD in these case series varied from as low as 28% in patients with abdominal aortic aneurysms⁴ to as high as 94% in patients with obstructive carotid artery disease⁵.

We determined if there was a difference in the prevalence of CAD depending on the diseased peripheral arterial territory (Table 5). All studies except three^{11,16,19} specified the number of patients with significant CAD according to each PAD subgroup included in their series. Excluding those three studies, we found that concomitant CAD was diagnosed angiographically in 50% of all sub-groups of peripheral vascular disease territories (abdominal aorta, lower extremity, carotid and other locations including the subclavian, mesenteric and renal arteries) (Table 5). The highest prevalence of concomitant CAD was seen in patients undergoing surgery for severe carotid artery disease (64%).

DISCUSSION

In our case series of 78 patients we found that 72% of the patients with severe PAD undergoing pre-operative coronary angiography had obstructive CAD. We also found that in patients referred for coronary angiography, the abdominal aorta was involved in half of the cases, and 45% of patients had involvement of more than one peripheral vascular territory (similar findings have been reported by others²⁴). Moreover, we found a difference in the prevalence of CAD according to the location of PAD in both our case series and our review of the literature: For example, patients with severe carotid artery disease had concomitant severe CAD in 72% of patients in our series and 64% of patients described in previous reports.

Results of published reports regarding the prevalence of concomitant CAD in patients with PAD are highly variable. Since many of these studies did not use definite imaging data for the diagnosis of CAD and PAD, and others defined CAD as >50% luminal diameter narrowing, not 70% which is considered to be flow-limiting, it is not surprising that together these factors could overestimate of the prevalence of obstructive CAD in this

population. One strength of our case series and review of the literature is that all patients underwent a definitive imaging study that documented the presence and severity of both coronary and peripheral arterial disease, and all patients were being referred for pre-operative coronary angiography in preparation for upcoming PAD surgery. Despite this focus, rates of angiographically- detectable severe CAD ranged from 28% to 94%, appearing to depend, at least in part, to PAD location. It is important to note, however, that angiographic detection of CAD has limitations and this point is underscored by pathologic studies showing that the vast majority of patients with PAD also have severe CAD: specifically, 85% of patients with abdominal aortic aneurysms ²⁵, and 92% of patients with severe lower extremity disease requiring amputation ²⁶ had one or more coronary arteries narrowed >75% in cross-sectional area by plaque at necropsy.

The issue regarding pre-operative coronary angiography with prophylactic coronary revascularization prior to elective PAD surgery remains controversial: it has been shown to improve survival in two studies, one in patients diagnosed with unprotected severe left main disease ¹¹, and another in patients deemed to be medium-high risk for surgery ¹⁹. Other studies, however, have not found a benefit to pre-operative coronary revascularization in patients undergoing PAD surgery ²⁷⁻²⁹. It has been suggested, therefore, that the decision to perform coronary angiography should be based on indications independent of the planned peripheral surgery ^{15,29-30}.

Acknowledgments

Funding: This work was supported by the National Institutes of Health [HL97074 to E.C.K.]

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TABLE 1**Baseline Characteristics of Patients with Severe Peripheral Arterial Disease Referred for Pre-operative Coronary Angiography**

Variable	N=78
Age (yr) (mean +/- SD)	67 ± 10
Men	35 (45%)
European-American	69 (88%)
African-American	7 (9%)
Hispanic	2 (3%)
Body mass index (kg/m ²) (median [IQR])	27.2 [24.3–30.1]
Diabetes mellitus	26 (33%)
Hypertension *	69 (88%)
Hyperlipidemia †	67 (86%)
Current smoker	27 (35%)
Former smoker	56 (72%)
Hemoglobin A _{1c} (%) (median [IQR])	5.4 [0–6.0]
Low density lipoprotein (mg/dL) (median [IQR])	91 [66–111]

Data are expressed as number (percentage), mean ± standard deviation (SD), and median [25%–75% interquartile (IQR) range]

* patients treated with antihypertensive medication, and untreated patients with known systolic blood pressure ≥ 140mmHg or diastolic blood pressure ≥ 90mmHg

† patients with total cholesterol level >200mg/dl, or current use of lipid-lowering drugs

TABLE 2

Indication for Peripheral Vascular Surgery (N=78)

Diseased peripheral vascular territory	N (%)
Abdominal aortic aneurysm	39 (50%)
Subclavian artery	7 (9%)
Femoral artery	18 (23%)
Carotid artery	25 (32%)
Iliac artery	29 (37%)
Renal artery	13 (17%)
Involvement of more than one territory	35 (45%)

TABLE 3

Pre-operative Coronary Angiographic Data (N=78)

Number of coronary arteries narrowed 50% in diameter	
1	22 (28%)
2	19 (24%)*
3	15 (19%)*
0	22 (28%)

* three patients with 2-vessel disease, and two patients with 3-vessel disease had involvement of the left main coronary artery (50% stenosis)

TABLE 4
Clinical Features and Coronary Angiographic Data of Patients with Peripheral Vascular Disease Referred for Pre-Operative Coronary Angiography as Reported in the Literature

Reference No. (Year)	No. of Patients	Men/Women	Mean age in years (range)	Smoker	Hypertension	Diabetes	Hyperlipidemia	Peripheral territory	Significant CAD [§]
22 (1972)	100	83 (83%)/17 (17%)	61 (39–81)	95 (95%)	48 (48%)	14 (14%)	36 (36%)	AAA (n=28), LE (n=72)	21/28 (75%); 34/72 (47%)
9 (1987)	84	63 (75%)/21 (25%)	66 (51–79)	53 (63%)	54 (64%)	30 (36%)	37 (44%)	AAA	30/39* (76%)
7 (1987)	42	39 (93%)/3 (7%)	67 (49–78)	NR	15 (36%)	6 (14%)	NR	AAA	36 (86%)
8 (1992)	37	33 (89%)/4 (11%)	68 (53–76)	23 (62%)	20 (54%)	14 (38%)	15 (41%)	AAA (n=16), LE (n=21)	7/16 (44%); 12/21 (57%)
13 (1984)	1000	685 (69%)/315 (31%)	64 (29–95)	NR	548 (55%)	170 (17%)	NR	AAA (n=263), carotid (n=295), LE (n=381), other (n=61) [†]	170/263 (65%); 174/295 (59%); 218/381 (57%); 36/61 (59%)
4 (1995)	125	21 (17%)/104 (83%)	64 (38–83)	NR	63 (50%)	19 (15%)	NR	AAA	35 (28%)
18 (1997)	102	82 (80%)/20 (20%)	68 (48–83)	47 (46%)	61 (60%)	10 (10%)	37 (36%)	AAA	66 (65%)
10 (1997)	283 (151 [*])	259 (92%)/24 (8%)	72 (45–92)	NR	90 (32%)	NR	NR	AAA	52 (34%)
23 (1998)	50	46 (92%)/4 (8%)	71	41 (82%)	29 (58%)	9 (18%)	21 (42%)	AAA	23 (46%)
16 (2002)	133 (84 [*])	116 (87%)/17 (13%)	66 (39–84)	NR	NR	NR	NR	TAA (n=45), AAA (n=88)	36 (43%)
17 (2002)	94	81 (86%)/13 (14%)	72	55 (94%)	68 (72%)	14 (15%)	31 (34%)	AAA	43 (46%)
21 (2002)	159 (145 [*])	132 (83%)/27 (17%)	70 (53–87)	NR	59 (41%)	15 (10%)	18 (12%)	AAA	43 (30%)
20 (2004)	100	89 (89%)/11 (11%)	71 (56–87)	58 (58%)	65 (65%)	7 (7%)	45 (45%)	AAA	47 (47%)
14 (2005)	420	276 (66%)/144 (34%)	69	54 (13%)	306 (73%)	118 (28%)	282 (67%)	carotid	258 (61%)
5 (2005)	200 (78 [*])	175 (87%)/25 (13%)	70 years [‡]	136 (68%)	153 (77%)	72 (36%)	89 (45%)	carotid	73 (94%)
12 (2008)	82	61 (74%)/21 (26%)	68 (47–88)	50 (61%)	53 (65%)	56 (68%)	24 (29%)	LE	27 (33%)
15 (2008)	122	106 (87%)/16 (13%)	73	58 (48%)	96 (79%)	15 (12%)	47 (39%)	AAA	68 (56%)
11 (2008)	1048 (823 [*])	NR	NR	NR	NR	NR	NR	AAA, LE	626 (76%)
19 (2009)	208 (105 [*])	75 (71%)/30 (29%)	74	NR	70 (67%)	39 (37%)	NR	AAA, LE	65 (62%)

* in reference #21, 145 of the 159 patients underwent coronary angiography; in reference #5, 78 of the 200 patients underwent coronary angiography; in reference #10, 151 of the 283 patients underwent coronary angiography; in reference #16, 84 of the 133 patients underwent coronary angiography; in reference #11, 823 of the 1048 patients did not have a previous CABG; in reference #19, 105 of the 208 patients underwent coronary angiography; in reference #9, data is reported for 82 patients, 70% lesion was reported in 76% of group 1 (definite clinical evidence of coronary artery disease, n=35) and group 2 (possible clinical evidence of coronary artery disease, n=4), no mention was made regarding group 3 (no clinical evidence of coronary artery disease, n=43)

⁷ renal or mesenteric artery stenosis, extremity aneurysms, false aneurysms or complications of prior vascular reconstruction

[‡] 40 patients with coronary artery disease and 65 patients without coronary artery disease were 70 years old

[§] significant CAD defined as 70% luminal diameter narrowing of a major epicardial artery, or 50% narrowing of the left main coronary artery

AAA= abdominal aortic aneurysm

CABG= coronary artery bypass graft surgery

CAD = coronary artery disease

LE = lower extremity

TAA= thoracic aortic aneurysm

NR= not reported

TABLE 5

Prevalence of Significant Coronary Artery Disease According to Location of Peripheral Vascular Disease

Location of peripheral disease	Prevalence of significant CAD in previous reports	Prevalence of significant CAD in our patients
Abdominal aortic aneurysm	641/1277 (50%)	22/39 (56%)
Lower extremity	291/556 (52%)	26/47 (55%)
Carotid	505/793 (64%)	18/25 (72%)
Other	36/61 (59%)	16/20 (80%)
Any specified by location	1473/2687 (55%)	82/131 (63%)

Other = renal or mesenteric artery stenosis, subclavian artery stenosis, extremity aneurysms or complications of prior vascular reconstruction