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Yield of elective coronary angiography; gender differences, patient history, risk factors and angiographic findings in a primary care population

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ABSTRACT

Objective: To assess yield of elective coronary angiography and gender differences in primary care patients suspected to have stable coronary artery disease (SCAD).

Design: Information was gathered from an angiography registry, referral texts of the general practitioners and medical records made by the cardiologists in secondary care.

Setting: Angiography registry data analyses of the Turku University Hospital, Finland, in the year 2011.

Subjects: Two hundred forty-six patients who were referred from primary care to secondary care and underwent coronary angiography for suspected SCAD symptoms.

Main outcome measures: Gender differences and diagnostic yield of coronary angiography for obstructive CAD.

Results: Obstructive CAD was identified in 73%, more often in males than in females (51% vs. 84%, $p < 0.001$). Thirteen per cent of the patients were over 80 years of age, and 94% of them had obstructive CAD. The prevalence of hypertension was 60%, treatment goal was achieved by 25%.

Conclusion: The diagnostic yield of elective coronary angiography was low in women compared to men although there were no substantial differences in evidence-based medication, risk factors or anticipated angina symptoms between genders.

KEY POINTS

- Coronary artery disease (CAD) is the leading cause of death globally. Invasive cardiology has expanded rapidly since the 1990s.
- Among symptomatic primary care patients who underwent elective coronary angiography in secondary care, obstructive CAD was identified in 73%
- Diagnostic yield of coronary angiography was low in women compared to men.
- GPs treat their male and female patients suspected of having stable CAD equitably regarding evidence-based medication.

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Coronary artery disease; elective coronary angiography; stable coronary artery disease symptoms; primary care; pre-test probability

Introduction

Although cardiovascular disease mortality has decreased in many developed countries in the past few decades, coronary artery disease (CAD) is still the leading cause of all health loss globally [1]. In Finland, from 1970s to 2012, CAD mortality has decreased by 82% in men and 84% in women [2]. Two-thirds of the reduction in the 2000s is a result of the decline in population levels of three risk factors (smoking prevalence, serum cholesterol, and systolic blood pressure), and the remaining third by other factors such as

improved secondary prevention and improved treatment of acute cardiac events [2]. Invasive cardiology has expanded rapidly since the 1990s. In Finland, age-standardized prevalence of revascularization procedures (bypass operation or percutaneous coronary intervention) among patients with CAD was 54% in men and 34% in women in 2011, compared with 33% and 12% in 2000, respectively [3]. Nonetheless, CAD is the leading cause of mortality in Finland accounting for one in five deaths both in men and women [4].

Stable CAD (SCAD) is the most prevalent manifestation of CAD. Although expensive and involving the

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risk of complications, invasive coronary angiography remains the 'gold standard' in diagnosing CAD. It is also possible to make a quite confident diagnosis of SCAD based on the patient's history, since the symptoms of CAD are well-defined. Identification of patients presenting with symptoms of possible SCAD that requires further evaluation and the management of patients with SCAD are important tasks for primary care physicians. However, in women, symptoms of CAD tend to be nonspecific and highly variable, and diagnosing CAD remains a challenge for clinicians [5]. Thus, clinicians and patients seeking a definitive diagnosis have relied on further testing, usually starting with noninvasive imaging and progressing to invasive coronary angiography for patients thought to be at a high risk of cardiac events. This progressive testing sometimes leads to the overuse of diagnostic tests and unnecessary exposure to procedural risks particularly in female patients [6,7]. Moreover, the Euro Heart Survey revealed that women with known SCAD are less likely to receive secondary preventive therapies, and less likely to be referred for revascularization [8].

The present study aims to assess the diagnostic yield of elective coronary angiography and gender differences among patients having suspected SCAD symptoms and referred from primary care to the secondary care unit of cardiology.

Methods

The angiography registry of the Heart Centre of Turku University Hospital captures prospectively clinical and procedural data on all patients undergoing coronary

angiography in the Hospital District of Southwest Finland. In 2011, the district consisted of 29 member municipalities with a total of 465 000 residents, to whom public primary care services were provided by 24 municipal health centers [9]. In Finland, approximately 90% of the GPs work in municipal health centres. A GP cannot refer patients directly to invasive coronary angiography. Instead, referrals are addressed to a secondary care cardiologist who makes the decision about further examinations.

Information on the patients ($n=246$) who were referred from the health centers to the Heart Centre of Turku University Hospital and underwent coronary angiography for suspected SCAD symptoms between 1 January 2011 and 31 December 2011 were identified using the angiography registry. Comorbidities and medication use (Table 1), cardiovascular risk factors (Table 2), non-invasive cardiac testing, and the symptoms of the patients at the time of angiography (Table 3) were gathered from the referral texts made by the GPs and from the medical records made by the cardiologists.

Typical chest pain was defined as having (i) substernal chest pain or discomfort, that is (ii) provoked by exertion or emotional stress, and (iii) relieved by rest and/or nitroglycerine. Atypical chest pain was defined as having two of the criteria of typical chest pain. Non-specific chest pain was defined as having one or none of the criteria [10].

The presence of obstructive CAD was defined as one or more vessels with $\geq 50\%$ lumen diameter reduction on coronary angiography.

Table 1. Characteristics of the patients.

	All $n = 246$	Males $n = 162$	Females $n = 84$	p Value*
Age, years, mean (SD)	69 (10)	68 (10)	70 (10)	0.10
Medical history, n (%)				
Coronary artery disease	106 (43)	80 (49)	26 (31)	0.006
Peripheral artery disease	12 (5)	9 (6)	3 (4)	0.49
Cerebrovascular disease	19 (8)	11 (7)	8 (10)	0.45
Diabetes mellitus	71 (29)	51 (32)	20 (24)	0.23
Atrial fibrillation	40 (16)	25 (16)	15 (18)	0.64
Hypertension	153 (62)	100 (62)	53 (63)	0.83
Depression	17 (7)	9 (6)	8 (10)	0.26
Rheumatoid arthritis	45 (18)	21 (13)	24 (27)	0.003
Obstructive sleep apnoea	28 (11)	20 (12)	8 (10)	0.51
Familiar hypercholesterolemia	1 (0.4)	0	1 (1)	0.16
Chest irradiation	5 (2)	0	5 (6)	0.002
Current Medication, n (%)				
Statin	184 (75)	124 (77)	60 (71)	0.35
Beta-blocker	179 (73)	114 (70)	65 (77)	0.24
Calcium antagonist	58 (24)	46 (28)	12 (14)	0.046
ACE inhibitor or angiotensin-receptor antagonist	137 (56)	93 (57)	44 (52)	0.30
Diuretics	79 (32)	44 (27)	35 (42)	0.021
Nitrates	159 (65)	100 (62)	59 (70)	0.13
Aspirin	169 (69)	115 (71)	54 (64)	0.19
Other antithrombotic drug	1 (0.4)	0	1 (1)	0.16
Warfarin	33 (13)	19 (12)	14 (17)	0.28

* P -value between males and females.

Table 2. Cardiovascular risk factors levels according to gender.

	All n = 246	Males n = 162	Females n = 84	P-value*	Data available, n (%) All
Smoking status, n (%)				0.001	236 (96)
Current smoker	34 (14)	24 (15)	9 (11)		
Ex-smoker	80 (33)	64 (41)	16 (20)		
Family history of CAD, n (%)	99 (49)	57 (44)	42 (60)	0.026	201 (82)
Body mass index, kg/m ² , mean (SD)	28.6 (5.1)	28.3 (5.1)	29.1 (5.1)	0.38	156 (63)
Office blood pressure, mmHg, mean (SD)					144 (59)
Systolic	148 (20)	147 (19)	151 (23)	0.31	
Diastolic	83 (11)	83 (10)	83 (12)	0.79	
Total cholesterol, mmol/l, mean (SD)	4.6 (1.1)	4.6 (1.2)	4.7 (1.1)	0.47	198 (80)
HDL-cholesterol, mmol/l, mean (SD)	1.43 (0.47)	1.35 (0.45)	1.61 (0.48)	<0.001	197 (80)
LDL-cholesterol, mmol/l, mean (SD)	2.5 (1.0)	2.5 (1.0)	2.5 (1.0)	0.92	197 (80)
Triglycerides, mmol/l, mean (SD)	1.59 (1.17)	1.64 (1.33)	1.46 (0.63)	0.34	171 (70)
Fasting glucose, mmol/l, mean (SD)	6.3 (1.6)	6.5 (1.8)	6.0 (0.8)	0.015	162 (66)

*P-value between males and females.

Table 3. Anticipated angina symptom presentation mentioned in patient records according to gender.

	All n = 246	Males n = 162	Females n = 84	p Value*
Chest pain or discomfort, n (%)				
Substernal	194 (79)	127 (78)	67 (81)	0.67
Provoked by exertion or emotional stress	188 (76)	128 (79)	60 (71)	0.18
Relieved by rest and/or nitroglycerine	193 (78)	129 (80)	64 (77)	0.65
Classification of angina symptoms, n (%)				0.73
Typical	168 (68)	113 (70)	55 (66)	
Atypical	28 (11)	18 (11)	10 (12)	
Non-specific	50 (20)	31 (19)	19 (23)	
Radiating pain, n (%)	84 (34)	50 (31)	34 (41)	0.14
Physical exhaustion, n (%)	19 (8)	11 (7)	8 (10)	0.44
Nausea, n (%)	9 (4)	4 (3)	5 (6)	0.17
Palpitation, n (%)	15 (6)	6 (4)	9 (11)	0.028
Sweating, n (%)	11 (4)	7 (4)	4 (5)	0.86
Shortness of breath, n (%)	108 (44)	64 (40)	44 (52)	0.54

*P-value between males and females.

The institutional review board of the Hospital District of Southwest Finland gave authorization for this register-based study.

Statistical analysis

Data were recorded to SPSS for Windows 15.0 database. Using the database descriptive analyses were done. Statistical significances between groups were calculated using cross-tabulation and a chi-square test or comparing means by using a t-test.

Results

During the year 2011, 246 symptomatic primary care patients underwent elective coronary angiography after an evaluation at the secondary care cardiac clinic in the Hospital District of Southwest Finland. The mean age of the patients was 69 years (SD 10, range 28–89 years), and 34% of the study cohort were women.

Table 1 displays the comorbid conditions and the current cardiovascular medication prescribed at the

time of the cardiologist's appointment. Males had higher prevalence of previously diagnosed CAD whereas the women more often had rheumatoid arthritis. Five of the 84 (6%) female patients had a history of chest irradiation due to breast cancer. Seventy-five percent of the patients used statin at the time of the angiography. Antithrombotic therapy was used by 69% and anticoagulant therapy by 13% of the patients. Men used calcium-channel blocker therapy more often than women who more commonly used diuretics, otherwise, there was no difference in cardiovascular medical therapy between genders.

Of the risk factors available in the medical records, women more often had a family history of CAD than men and a higher HDL cholesterol level. Male patients were more likely to be current or ex-smokers and they had a higher fasting plasma glucose level than females (Table 2).

The blood pressure treatment goal (<140/90 mmHg measured at office or <135/85 mmHg measured at home) was achieved by only 25% of the patients.

The presence of anticipated symptoms caused by SCAD are reported in Table 3 as mentioned in the

Table 4. Angiographic findings and the age distribution of the patients.

Age group, years	No CAD n = 66		1 vessel disease n = 80		2 vessel disease n = 44		3 vessel disease n = 55	
	Males n = 26	Females n = 40	Males n = 62	Females n = 18	Males n = 28	Females n = 16	Males n = 46	Females n = 9
<30	1							
30–39			1					
40–49	1	1	3	1	1		1	
50–59	3	9	8		7		2	1
60–69	11	14	19	7	12	6	16	
70–79	9	15	24	6	8	4	17	5
≥80	1	1	7	4		6	10	3
All	39%	61%	78%	22%	64%	36%	84%	16%

patient records. Women felt palpitations more often than men, otherwise there was no gender difference in angina symptom presentation.

Non-invasive testing was performed in 144 (59%) of the patients before the angiography. Of the 102 patients in whom non-invasive testing was not applied, 57 (56%) had previously been diagnosed with CAD.

Obstructive CAD was identified in 179/246 (73%) patients, 136/162 (84%) in males and 43/84 (51%) in females ($p < 0.001$). The number of diseased vessels and age distribution of the patients are displayed in Table 4. There were 10/246 (4%) patients under 50 years of age, and 6 (60%) of them had obstructive CAD. At the other extreme, 32/246 (13%) of the patients were over 80 years of age with 30 (94%) having obstructive CAD.

Women who had obstructive CAD were older (73 vs 67 years, $p = 0.002$), had more often previously diagnosed CAD (46% vs 15%, $p = 0.003$) and typical angina symptoms (82% vs 48%, $p = 0.003$) than women who were not diagnosed with CAD. Men with obstructive CAD were characterized by having more often typical angina symptoms (77% vs 39%, $p = 0.001$) and family history of CAD (48% vs 25%, $p = 0.043$) than men without CAD.

Discussion

This study shows that although there were no substantial differences in evidence-based medical therapy, risk factors or anticipated angina symptoms between male and female patients, the diagnostic yield in women was low compared to men (51% vs. 84%).

In the literature of the 2000s, we did not find other studies reporting results of coronary angiography among patients with suspected SCAD referred to a cardiology clinic by GPs. In the present era of modern non-invasive imaging and use of cardiac catheterization, Patel *et al.* reported a diagnostic yield of 60% in elective coronary angiography among patients derived

from the large American College of Cardiology National Cardiovascular Data Registry [6]. Contrary to the US data, all patients in our study population had chest pain or discomfort and thus a clear indication for further investigations. Moreover, a comparison between the US and our data is difficult due to differences in health care systems.

In a Swedish study conducted in 2010–2012, primary care patients suspected to have CAD and thus referred to exercise testing were followed-up for 6 months. Of the 865 patients, 99 (11%) were referred to a heart clinic, and 79 (9%) underwent coronary angiography. Among them, diagnostic yield of angiography was 63% [11].

According to the Swedish Coronary Angiography and Angioplasty Register, 12200 patients with stable chest pain (41% women) underwent a first-time elective coronary angiography in Sweden during the years 2006–08. The diagnostic yield for obstructive CAD (defined as $\geq 50\%$ luminal narrowing in any epicardial coronary artery) was 70% in men and 36% in women. This large study confirmed the difficulty of diagnosing CAD and underuse of aspirin in women prior to coronary angiography [12].

According to our results, Finnish GPs treat their male and female patients suspected of having SCAD equitably regarding evidence-based medication. However, there are gaps in optimising medical therapy, risk factor documentation, and management. Statins were used by 75%, and antithrombotics or anticoagulants by 83% of the patients at the time of the cardiologist's appointment. Thus, adding medication proved to prevent cardiovascular events would be important while awaiting the definite diagnosis. There were more subjects having nitrate medicines than subjects with previously diagnosed CAD (Table 1). This may reflect an effort by the GPs to treat or prevent angina symptoms while waiting for the definite diagnosis from angiography.

Hypertension was the most common medical condition with a prevalence of 60% in our patient

population. Importantly, only one in four reached the blood pressure target. This implies that GPs need to do better at improving BP control rates. New methods such as text message-based interventions might hold promise to improve patient adherence to antihypertensive therapy and healthy lifestyle choices [13].

Risk factor data documented both in the referrals made by GPs and in the medical records made by cardiologists were inadequate to calculate the total cardiovascular risk of most of the patients. This diminishes the possibility to evaluate pre-test probability of CAD which would guide GPs in decisions on the further testing and cardiologist referral. Purpose-oriented risk factor data in medical records might also serve as an instructive knowledge-base for the patients, since Finnish citizens are able to see the data recorded by the healthcare units in the electrical Patient data repository, "My Kanta" – service.

All subjects of our study population underwent coronary angiography, but only a third of them were women although the age distribution of the patients was quite equal between the genders – every other patient was at least 70 years old. Men had previously been diagnosed more often with CAD, but this hardly explains the gender difference. Delays in symptom recognition by the women themselves and suboptimal history-taking by the GPs are possible explanations for the lower utilization of diagnostic tests in women. In primary care, patients often present with the early stage of their disease and with uncharacteristic clinical findings. GPs have to rely on the history and knowledge of an individual patient to determine the clinical probability of CAD and decide whether specialist referral is indicated. Only the presence of typical angina symptoms was a common feature in men and women who had obstructive CAD. However, we cannot rule out the possibility that angina symptoms among those patients who had no evidence of obstructive CAD were caused by microvascular dysfunction. In contrast, vasospastic angina is unlikely because symptoms were exercise-related.

There are several limitations in our study. This is a retrospective, registry-based data. We did not have information regarding those patients referred by GPs and evaluated by cardiologists, but who did not undergo a coronary angiography. Because only patients who underwent a coronary angiography were evaluated, our results may not be generalized to all angina patients attending primary care. The major risk factors were poorly reported in medical records and thus, we cannot estimate the total cardiovascular risk of the patients. However, our study population can be

regarded as representative of primary care patients in communities. All coronary angiographies were performed in one laboratory. Patient selection for invasive testing had clear indications, there were no asymptomatic patients.

If we are to learn from our results, more attention should be paid to treatment of hypertension and the quality of the medical records made by physicians. Risk factor assessment and estimation of total cardiovascular risk was insufficiently described by both the GPs and the cardiologists. More weight should be given to consideration of pre-test probability in order to avoid unnecessary non-invasive testing and coronary angiography. New insights into history-taking from female patients are needed.

Ethical approval

For this register-based study, a permission was granted by the Hospital District of Southwest Finland (permission number t109/2016).

Disclosure statement

No potential conflict of interest was reported by the authors.

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