

EPIDEMIOLOGY

Clinical Findings in Patients Submitted to Cardiac Catheterization and Coronary Angiography at the Cardiovascular Center of Puerto Rico and the Caribbean: A Pilot Study.

CYNTHIA M. PÉREZ-CARDONA, MS, PhD*, MANUEL GUZMÁN-SERRANO, MD†, RAFAEL A. COX-ROSARIO, MD†.

Objective. This study examined the demographic characteristics, cardiac risk factors, angiographic findings, and complications of patients undergoing coronary angiography.

Background. There is growing evidence of coronary angiography safety, however, limited data is available concerning the value of this procedure in the Puerto Rican population.

Methods. We retrospectively reviewed the medical records of 322 patients submitted to this procedure at the Cardiovascular Center of Puerto Rico and the Caribbean over a three-month period during 1995. Comparisons of means were based on Student's t-test; comparisons of proportions were based on Pearson's Chi-Square test.

Results. Mean age was 60.4 ± 10.6 years (Range: 20-86); 57.1% were males. Stable angina ($p < 0.001$) and atypical chest pain ($p = 0.014$) were more frequent in females. Smoking history ($p < 0.0001$), left ventricular dysfunction ($p = 0.003$), angina post-myocardial infarction ($p < 0.001$), and myocardial infarction ($p < 0.025$) were more frequent in males. The

most frequent angiographic findings were two-vessel disease (24.2%), normal coronary angiogram (21.2%), and non-obstructive disease (16.9%). In patients with angiographic evidence of coronary artery disease, hypertension (69.8%), diabetes mellitus (41.3%), and hypercholesterolemia (37%) were the predominant risk factors. Thirty-four percent of patients had left ventricular dysfunction. The majority of patients (86%) met American College of Cardiology/American Heart Association Class I or II indications for coronary angiography. The only major complication recorded was ventricular arrhythmia requiring defibrillation (0.6%).

Conclusions. Thirty-eight percent of patients submitted to this procedure did not have significant coronary artery stenosis, a slightly higher estimate than reported elsewhere. In addition, the frequency of major procedural-related complications as currently practiced in this institution was low.
Keywords: Catheterization, Coronary angiography, Coronary artery disease, Puerto Rico

Cardiovascular disease constitutes the leading cause of morbidity and mortality in Puerto Rico, accounting for 8,530 (29.9%) of all deaths reported in

1993 (1). Coronary artery disease (CAD) represented over half (58%) of the cardiovascular deaths in that report. The definite diagnosis and subsequent management of CAD is primarily dependent on three cardiovascular procedures: cardiac catheterization and coronary angiography, percutaneous transluminal coronary angioplasty, and coronary artery bypass graft surgery. The practice of cardiac catheterization and coronary angiography has evolved from merely a diagnostic procedure for the evaluation of candidates for surgery to a more sophisticated catheter-based, non-surgical interventional therapeutic modality (2,3).

In light of the increased demand for cardiac catheterization and coronary angiography, questions have been raised concerning the appropriateness in the use of

From the Department of Biostatistics and Epidemiology, Graduate School of Public Health*, and the Cardiology Section, Department of Medicine†, Medical Sciences Campus, University of Puerto Rico.

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Address for correspondence: Cynthia M. Pérez-Cardona, PhD, Department of Biostatistics and Epidemiology, Graduate School of Public Health, University of Puerto Rico, Medical Sciences Campus, P.O. Box 365067, San Juan, Puerto Rico 00936-5067. Tel. 758-2525 x. 1470, Fax: 759-6719. E-mail: cy_perez@rcmaca.upr.edu

these procedures (4-8). Established criteria for cardiac catheterization and coronary angiography include stable and unstable angina pectoris, atypical chest pain, positive stress test, previous history of myocardial infarction, significant congestive heart failure or valvular heart disease, ventricular and supraventricular arrhythmias (2,3). In spite of the ample dissemination of the American College of Cardiology/American Heart Association (ACC/AHA) screening criteria for cardiac catheterization and coronary angiography (2,3), a significant number of patients undergoing these procedures do not have the appropriate indications (4-8).

Numerous studies have documented the safety of diagnostic cardiac catheterization and coronary angiography (9-17). Nevertheless, there exists a small risk of adverse events associated with these invasive procedures. Included among major complications of cardiac catheterization and coronary angiography are: death, myocardial infarction, neurologic events, need for emergency coronary artery bypass graft surgery, cardiac perforation, ventricular arrhythmia requiring countershock, excessive bleeding, renal failure, and vascular complications requiring treatment or surgical repair (9-17). Previous reports have shown that older age (>60 years), New York Heart Association functional class III or IV, left main CAD, valvular disease combined with CAD, left ventricular ejection fraction <30%, renal insufficiency, insulin-dependent diabetes mellitus, advanced cerebrovascular and/or peripheral vascular disease, and severe pulmonary insufficiency appear to increase the risk of procedural-related mortality (9,10,12,16).

Various studies have addressed the topic of differences in clinical characteristics by gender. Bernstein et al. (8) have reported that women have on average a greater number of risk factors than men (1.8 vs. 1.5) at the time of coronary angiography. In addition, women more frequently present unstable angina, while men more commonly are asymptomatic. Furthermore, more women undergoing this procedure are found to have normal angiograms or non-obstructive disease as compared to men. Johnson et al. (9) found that females are more prone to develop arrhythmias and hemorrhage than males.

Although there is ample evidence of the safety and efficacy of diagnostic cardiac catheterization and coronary angiography in the medical literature, limited data is available concerning the value of these procedures in the Puerto Rican population, a largely understudied ethnic group. The present pilot study was conducted to review cardiac catheterization and coronary angiography data of patients with suspected CAD who underwent these procedures at the Cardiovascular Center of Puerto Rico

and the Caribbean over a three-month period. The specific aims of this study were to: 1) describe the baseline clinical characteristics of patients undergoing these procedures, 2) assess the risk factors in patients with documented CAD, 3) determine the percent of patients with appropriate indications for the procedure, 4) describe their angiographic findings, 5) describe the in-hospital procedural-related complications, 6) describe recommended subsequent management, and 7) determine whether clinical and demographic characteristics differed by gender.

Methods

We retrospectively reviewed all clinical charts and procedure reports of patients who underwent cardiac catheterization and coronary angiography at the Cardiovascular Center of Puerto Rico and the Caribbean between March and May 1995. Patients with previous coronary artery bypass graft surgery, previous percutaneous transluminal coronary angioplasty, congenital heart disease or serious valvular heart disease were excluded from the study.

Data obtained from each patient's chart included demographic characteristics, cardiac clinical diagnoses, cardiac risk factors, medications prior to admission, indications for the procedure, left ventricular ejection fraction, coronary angiographic findings, cardiac catheterization technique, procedural-related complications and recommended management. Significant coronary artery stenosis was defined as a reduction of 50% or more in luminal diameter. Left ventricular function was classified according to the ejection fraction (EF) determined by contrast ventriculography: EF > 50%, EF 30%-49% and EF < 30%. Procedural-related complications were defined as any adverse event occurring within a 24-hour period of the procedure. Whenever necessary, films were reviewed for further evaluation of the extent of CAD.

Continuous variables were expressed as mean \pm standard deviation. Continuous variables were compared by means of Student's t test; categorical variables were compared by the Pearson's Chi-Square test or Fisher's Exact test, when appropriate. Odds ratios (OR) and test-based 95% confidence intervals (95% CI) were computed to determine the magnitude of associations between categorical variables (18). To adjust for the effect of potential confounders, the Mantel-Haenszel technique was used to obtain adjusted odds ratios (OR_{MH}) (18). All statistical tests were two-sided. Data entry was done using Epi-Info (CDC, Atlanta, GA) (19) and analyzed with the Statistical Analysis System (SAS Institute, Cary, NC) (20).

Results

Demographic and clinical characteristics of patients. A total of 322 consecutive patients underwent cardiac catheterization and coronary angiography between March and May 1995. The mean age of all patients was 60.4 ± 10.6 years (range: 20 to 86), and more than half (57.1%) of patients were males. Table 1 shows the medical history of patients at the time of admission for the procedure. Hypertension (69.3%) was the predominant cardiac risk factor, followed by hypercholesterolemia (37.0%) and diabetes mellitus (34.8%). The most common cardiac clinical diagnosis was stable angina (44.1%). In

Table 1. Medical History of 322 Patients Who Underwent Cardiac Catheterization and Coronary Angiography.

Characteristic	Percentage
Medical history	
Hypertension	69.3
Hypercholesterolemia	37.0
Diabetes mellitus	34.8
Cigarette smoking	23.6
Family history of premature CAD*	11.5
Cardiac clinical diagnosis	
Stable angina	44.1
Angina post-myocardial infarction	20.8
Q wave myocardial infarction	19.6
Non-Q wave myocardial infarction	14.6
Unstable angina	12.1
Congestive heart failure	9.3
Atypical chest pain	7.5
Peripheral vascular disease	4.0
Supraventricular/ventricular arrhythmia	3.1
Renal insufficiency	1.9
Medications	
Nitrates	64.9
Aspirin	44.1
Calcium channel blockers	41.3
ACE inhibitors	34.2
Beta blockers	31.4
Diuretics	15.5
Lipid lowering drugs	12.1
Digoxin	7.1
Warfarin	2.2

*Coronary Artery Disease
Angiotensin Converting Enzyme

patients with angiographically documented CAD, the most commonly reported risk factors were hypertension (69.7%), diabetes mellitus (40.4%) and hypercholesterolemia (36.4%) (data not shown). The most commonly used medications prior to admission were nitrates (64.9%), aspirin (44.1%), and calcium channel blockers (41.3%). However, beta blockers were the least commonly used anti-anginal medication (31.4%).

Eighty-six percent of patients met ACC/AHA Class I or Class II indications for cardiac catheterization and coronary angiography (data not shown).

Angiographic findings. Ten (10.4%) percent of patients had severe left ventricular dysfunction (ejection fraction <30%) and 24.2% had moderate left ventricular dysfunction (ejection fraction 30% to 49%) (Table 2).

Table 2. Ventriculogram and Angiogram Findings, Procedural-Related Complications, and Management Recommended to Patients Who Underwent Cardiac Catheterization and Coronary Angiography.

Characteristic	Percentage
Left ventricular ejection fraction	
>50 %	65.4
30-49 %	24.2
<30 %	10.4
Technique	
Standard femoral approach	98.4
Brachial approach	1.6
Angiographic findings	
Normal angiogram	21.1
Non-obstructive disease	17.4
Single vessel disease	17.1
Two vessel disease	24.2
Three vessel disease	17.1
Left main coronary artery stenosis	3.1
Complications	
Vasovagal reaction	2.8
Coronary vasospasm	1.9
Non-surgical hematoma	1.6
Excessive bleeding at puncture area	0.9
Ventricular arrhythmia requiring defibrillation	0.6
Transient left bundle branch block	0.3
Recommended management	
Medical therapy	50.9
Percutaneous transluminal coronary angioplasty	14.9
Coronary artery bypass graft surgery	27.6
Unknown	6.6

The vast majority (98.4%) of the procedures were performed using the standard femoral approach. Normal coronary angiograms were observed in 21.1% of patients, whereas non-obstructive disease was observed in 17.4%. Three vessel disease and left main CAD were found in 17.1% and 3.1% of the patients, respectively.

Procedural-related complications and patients' disposition. Minor complications including vasovagal reactions, coronary vasospasm, non-surgical hematomas, excessive bleeding at puncture area and transient left bundle branch block were developed in 24 (7.5%) patients. The only major complication was the development of ventricular arrhythmia requiring defibrillation in two patients (0.6%) (Table 2). No deaths were reported among the 322 patients studied.

After coronary angiography evaluation, medical therapy was recommended for the majority of patients (50.9%). Percutaneous transluminal coronary angioplasty and coronary artery bypass graft surgery were recommended in nearly 43% of patients.

Gender-specific comparisons. Table 3 shows comparisons of selected clinical characteristics by gender. Men were significantly more likely than women to have smoked or to be smoking at the time of the procedure (OR=4.54, 95% CI: 2.41-8.55, $p<0.0001$). Considering medical history upon admission, men more commonly presented with angina post-myocardial infarction (OR=3.23, 95% CI: 1.73-6.03, $p<0.001$), Q wave myocardial infarction (OR=3.19, 95% CI: 1.68-6.06,

$p<0.001$), and non-Q wave myocardial infarction (OR=2.18, 95% CI: 1.10-4.31, $p=0.023$). On the other hand, men less commonly presented with stable angina (OR=0.43, 95% CI: 0.28-0.68, $p<0.001$) and atypical chest pain (OR=0.34, 95% CI: 0.14-0.83, $p=0.014$). No significant differences ($p>0.05$) were noted between genders with regards to age, history of hypertension, diabetes mellitus, family history of premature CAD and hypercholesterolemia.

Men were less likely to be using calcium channel blockers (OR=0.53, 95% CI: 0.33-0.84, $p=0.006$) and more likely to be receiving aspirin (OR=1.64, 95% CI: 1.04 - 2.59, $p=0.034$) than women. In addition, men were more likely to have left ventricular dysfunction (OR=2.19, 95% CI: 1.35-3.57, $p=0.003$) than women. Analysis of coronary angiograms showed that men were less likely to have angiographically normal coronary arteries (OR=0.48, 95% CI: 0.28-0.82, $p=0.007$) than women. Although the association was marginally significant, men were less likely to have non-obstructive disease (OR=0.59, 95% CI: 0.33-1.06, $p=0.075$) than women. The distribution of coronary lesions did not vary significantly with age or gender. Men were less likely to develop procedural-related complications than women (OR=0.34, 95% CI: 0.14-0.83, $p=0.014$) even after adjusting for angiographic findings (OR_{MH}=0.39, 95% CI: 0.17-0.92, $p=0.03$). Men were less frequently recommended for medical therapy than women (OR=0.55, 95% CI: 0.35-0.86, $p=0.008$).

Table 3. Comparison of Selected Clinical Characteristics by Gender* in 322 Patients who Underwent Cardiac Catheterization and Coronary Angiography.

Characteristic	OR	95% CI	P value
History of smoking	4.54	2.41-8.55	<0.0001
Angina post-myocardial infarction	3.23	1.73-6.03	<0.001
Q wave myocardial infarction	3.19	1.68-6.06	<0.001
Left ventricular dysfunction	2.19	1.35-3.57	0.003
Non-Q wave myocardial infarction	2.18	1.10-4.31	0.023
Aspirin use	1.64	1.04-2.59	0.034
Non-obstructive disease	0.59	0.33-1.06	0.075
Medical therapy recommended	0.55	0.35-0.86	0.008
Calcium channel blockers' use	0.53	0.33-0.84	0.006
Normal coronary angiogram	0.48	0.28-0.82	0.007
Stable angina	0.43	0.28-0.68	<0.001
Atypical chest pain	0.34	0.14-0.83	0.014
Procedural-related complication	0.34	0.14-0.83	0.014

OR = Odds ratio, CI = Confidence interval
 * Reference category: Females

Discussion

This pilot study evaluated the clinical characteristics, angiographic findings, and procedural-related complications in a sample of patients undergoing cardiac catheterization and coronary angiography at the Cardiovascular Center of Puerto Rico and the Caribbean over a three-month period. After evaluation of medical history, arterial hypertension was the predominant cardiac risk factor in these patients. A history of cigarette smoking was significantly more frequent in men than in women; however, there were no differences by gender with regards to age, arterial hypertension, diabetes mellitus, family history of premature CAD, and hypercholesterolemia.

The clinical presentation observed in our series of patients was different in men and women; stable angina and atypical chest pain were the most frequent clinical diagnoses in female patients whereas angina post-myocardial infarction and prior myocardial infarction were more frequent in male patients. Furthermore, more than one-third of patients exhibited left ventricular dysfunction, with men having significantly more dysfunction than women. These observations suggest that men experience more coronary events prior to invasive diagnostic procedures. Additional explanations may include a delay in referral of men to tertiary care medical centers or that women seek health care services earlier than men avoiding recurring events that may deteriorate their left ventricular function.

Despite the documented benefits of beta blockers and aspirin use in patients with CAD, there was a low frequency of use of these medications in patients referred for coronary angiography suspecting significant CAD. An increased effort by physicians to improve their awareness regarding the protective effects of these drugs on patients with suspected or documented CAD is warranted.

Questions regarding the appropriateness of these procedures have been raised by several investigators (4-8). In fact, the rate of inappropriateness has ranged from 4% to 17% and as high as 21% in elderly patients (4,6). The vast majority of patients (86%) in this study met the ACC/AHA Class I or Class II indications for cardiac catheterization and coronary angiography (2,3). Appropriateness for these procedures was not evaluated in 14% of medical records due to insufficient data. This suggests that the rate of inappropriateness might be as high as 14%; however, this would still represent a lower estimate than the reported in previous studies.

Other studies of patients who underwent cardiac catheterization and coronary angiography have reported normal coronary angiograms in 20% to 22.8% and non-obstructive disease in 6% to 13.6% (9, 13, 14) of cases.

The present study showed a slightly higher frequency of non-obstructive disease (17.4%) but a similar frequency of normal coronary angiograms (21.1%). The distribution of left main coronary artery stenosis (3.1%), one vessel CAD (17.1%), and three vessel CAD (17.1%) was lower to that reported by the Society for Cardiac Angiography Registry (6%, 21%, and 26%, respectively) (9). However, the frequency of two vessel disease in the study sample was slightly higher (24.2% vs. 20%) than the reported in that Registry. Previous studies have found that single vessel disease is predominant in younger patients whereas multivessel disease occurs more frequently in older patients (11,21). However, the distribution of coronary lesions was not age nor gender dependent in the sample of patients examined.

In an analysis of coronary angiograms by gender, Bernstein et al. (8) found a higher frequency of normal coronary angiograms in women compared with men. Similarly, significantly less men in this study were found to have normal coronary angiograms. This finding suggests the need for an increased effort to evaluate the clinical findings and non-invasive screening tests prior to the referral of female patients to cardiac catheterization and coronary angiography, considering the potential risk for any procedural-related complication.

The safety of cardiac catheterization and coronary angiography has been documented in numerous studies, with a low complication rate ranging from less than 1% to 3.7% (9, 12, 13, 16). The overall incidence of major complications in this study was low (0.6%), remarkably similar to that reported in prior reports. However, minor complications were developed in 7.5% of patients, most of whom were women with normal coronary angiograms or non-obstructive disease. This observation cannot be explained by differences in age, body mass index, cardiac risk factors, comorbid conditions, or extent of CAD.

One limitation of the study was the insufficient information on other significant risk factors for CAD such as lipoprotein levels and details of family history of premature CAD as well as non-invasive testing results including severity of ischemia in exercise testing, and extent of perfusion defects on nuclear studies. In addition, the present study could not examine the factors associated with the development of procedural-related complications due to the small number of major complications.

The current pilot study indicates that cardiac catheterization and coronary angiography as currently practiced in this institution is safe and fulfilled the indications according to ACC/AHA guidelines (2,3) in the majority of patients. A carefully devised computer-based national registry should be established to monitor prospectively the rate of appropriate use of these

procedures, describe the related complications, characterize the extent of CAD and evolving trends in the Puerto Rican population.

Resumen

Este estudio analizó las características demográficas, factores de riesgo, hallazgos angiográficos y complicaciones en pacientes sometidos a angiografía coronaria en el Centro Cardiovascular de Puerto Rico y del Caribe de marzo a mayo de 1995. La edad promedio fue 60.4 ± 10.6 años; 57.1% eran varones. Angina estable ($p < 0.001$) y dolor de pecho atípico ($p = 0.014$) predominaron en las mujeres, mientras que infarto al miocardio ($p < 0.025$) y angina post-infarto ($p < 0.001$) predominaron en los varones. Los hallazgos más frecuentes fueron enfermedad de dos vasos (24.2%), angiograma normal (21.2%), y enfermedad no-obstructiva (16.9%). En pacientes con enfermedad coronaria, hipertensión (69.8%), diabetes mellitus (41.3%), e hipercolesterolemia (37%) fueron los factores de riesgo predominantes. La única complicación mayor fue arritmia ventricular (0.6%). Treinta y ocho por ciento de los pacientes no tenían enfermedad significativa, un estimado mayor que lo reportado. La incidencia de complicaciones mayores en esta institución fue baja.

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