Disparity in Frequency of Normal Coronary Artery in Black and White Patients Undergoing Cardiac Catheterization

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Background: Normal epicardial coronary arteries (NCA) based on angiography have been reported to occur more frequently in Blacks than in Whites, but these studies have suffered from the limitation of being retrospective, reporting on relatively small numbers of subjects, or lacking a systematic angiogram interpretation.

Methods and Results: Angiograms of 560 consecutive patients (226 Black and 334 White) enrolled in the Harlem-Bassett Study were reviewed. The presence of coronary artery disease risk factors was documented. A coronary artery was defined as normal if no segment contained a luminal diameter stenosis >24%. Overall, NCA were found in 39.1% of patients (Blacks 42.9% and Whites 36.5%) and were present most frequently in White women (53.7%). Black men were two times more likely than White men to have NCA (odds ratio [OR] 2.09, $P<.002$). More Blacks than Whites with NCA were hypertensive (OR 3.30, $P<.001$) and cigarette smokers (OR 5.18, $P<.001$), whereas more Whites had hypercholesterolemia (OR .29, $P<.001$).

Conclusion: Significant racial differences exist between the Black and White populations in regard to the presence of NCA. The traditional risk factors of age, diabetes, cigarette smoking, and hypercholesterolemia are present in both groups. However, a racial disparity exists in the frequency of some risk factors (hypertension, cigarette smoking, hypercholesterolemia) in patients with NCA. (*Ethn Dis*. 2006;16:370–374)

Key Words: Coronary Angiography, Coronary Artery Disease, Race, Risk Factors

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INTRODUCTION

Several published studies have indicated racial differences in the anatomic location and severity of coronary artery disease (CAD)[1–3] as well as in the occurrence of CAD risk factors[4–6] between the Black and White populations. Data on racial differences in the frequency of normal epicardial coronary arteries (NCA) in patients undergoing coronary angiography for suspected coronary artery disease are scanty. NCA based on angiography have been reported to occur more frequently in Blacks than in Whites,[1–3] but these studies have suffered from the limitations of being retrospective, reporting on relatively small number of subjects, lacking a clear definition for normal coronary arteries, and not including White patients for comparison.[3] Also, differences in risk factors for CAD have not been well defined in patients with normal coronary angiogram. We analyzed the clinical data and angiographic findings in Black and White patients undergoing coronary angiography who were enrolled in the Harlem-Bassett Study, which was designed to determine the effect of lipoprotein(a) on race-related differences in the development of atherosclerosis. The objectives of our study were to evaluate for racial differences in the presence of angiographically normal coronary arteries in our patient population and to determine the distribution of CAD risk factors in patients with normal coronary angiograms.

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METHOD

Overview

The Harlem-Bassett Study was a National Institute of Health-sponsored cross-sectional investigation designed to examine the race-related differences in the development of coronary atherosclerosis, with particular emphasis on the role of lipoprotein(a). Patients were <70 years of age and underwent diagnostic cardiac catheterization for suspected coronary artery disease between 1991 and 1994 in accordance with Harlem-Bassett study protocol. Recruit-

Table 1. Characteristics of study population

	Black (*n*=226)	White (*n*=334)	*P* value
Mean age (years)	54.6 ± 9.4	56.7 ± 10.2	.01
Male *n* (%)	127 (56)	213 (64)	
Mean BMI (kg/m)	28.5 ± 6.1	29.6 ± 6.0	.05
Hypertension *n* (%)	175 (75)	197 (59)	.001
Diabetes *n* (%)	68 (29)	64 (21)	.02
Hypercholesterolemia *n* (%)	66 (28)	176 (53)	.001
Smoking *n* (%)	98 (42)	58 (17)	.001
Prevalence of NCA	97 (42.9)	122 (36.5)	NS

Results are given as mean ± SD (age and BMI) or *n* (%).
BMI=body mass index.

ment took place at two institutions, Harlem Hospital Center in New York City, which serves a predominantly urban Black population, and Mary Imogene Bassett Hospital in Cooperstown, New York, which serves a primarily rural or suburban White population. Exclusion criteria for the Harlem-Bassett Study were inability to give informed consent, age ≥70 years, recent myocardial infarction, coronary artery thrombolysis, angioplasty or stents, major surgery such as coronary artery bypass surgery, communicable diseases such as hepatitis, or the use of lipid-lowering medications.

Data Collection

Black and White patients in the Harlem-Bassett study who had complete angiographic, laboratory, and clinical data available were included in this substudy. Historical information concerning hypertension, diabetes, and cigarette smoking were obtained. Hypertension was determined to be present if a patient has been told more than once by his or her doctor or healthcare provider that he or she had high blood pressure or he or she was taking medication to control blood pressure. Any patient who had ever been told by a health professional that he or she was diabetic was deemed diabetic. Cigarette smoking was deemed present if the patient was a current smoker or if he or she had quit smoking less than a year before angiography. Total cholesterol was determined by a protocol-specific method. Hypercholesterolemia was defined as serum total cholesterol >240 mg/dL. Race, height, and weight were recorded, and body mass index was calculated. Race was determined by self-report. Each coronary angiogram was reviewed by two investigators who were unaware of the patient's history and the clinician's interpretation of the test. Visual estimation of the maximum luminal diameter stenosis present in each of 15 segments of the epicardial coronary arteries was recorded. Normal epicardial coronary arteries (NCA) was arbitrarily defined as luminal diameter stenosis <25% in all 15 segments.

Statistical Analysis

The data values were entered into the SAS System (SAS Institute, Cary, NC). Descriptive statistics were calculated on all variables, and distributions were examined for normality. Continuous variables are summarized with means and standard deviations, while categorical variables are summarized as counts and percentages. Test of significance were performed by using the *t* test of analysis of variance for continuous variables and odds ratio (OR) with 95% confidence interval (CI) for categorical variables. The Cochran-Mantel-Haenszel summary OR was used when controlling for a third variable, and the chi-square test was used when more than two levels of risk were assessed. A *P* value ≤.05 was considered significant.

RESULTS

Of 567 patients in the study group, 7 were excluded because of incomplete angiographic data, which left 560 patients; 226 were Black and 334 were White. Characteristics of the study population are shown in Table 1. Fifty-six percent of Blacks and 64% of Whites were men. Mean age for Blacks was 54.6 ± 9.4 years and 56.7 ± 10.2 years for Whites (*P*=.01). The mean body mass index (kg/m²) was 28.5 ± 6.1 for Blacks and 29.6 ± 6.0 for Whites (*P*=.01). Most patients (67%) were referred for cardiac catheterization because of chest pain, 11% were referred because of congestive heart failure, and 22.2% were referred for other reasons including arrhythmias and valvular heart disease.

Normal coronary angiograms were found in 39.1% (Table 2). Although the Black population was more likely to have NCA (42.9% vs 36.5%, OR 1.3, CI .93–1.85, *P*<.13), Black men were

Table 2. Prevalence of normal coronary angiogram

	Total *n* (%)	Black *n* (%)	White *n* (%)	OR for Black vs White (95% CI)	*P* value
Men	112 (32.9)	55 (43.3)	57 (26.8)	2.09 (1.31–3.22)	.002
Women	107 (48.6)	42 (42.4)	65 (53.7)	.63 (.37–1.08)	.10
Total	219 (39.1)	97 (42.9)	122 (36.5)	1.31 (.93–1.85)	NS

OR=odds ratio; CI=confidence interval; NS=not significant.

Table 3. Race and sex differences in mean age and body mass index in patients with NCA and CAD

		NCA			CAD		
		Black	**White**	***P***	**Black**	**White**	***P***
Mean age (years)	Men	50.7 ± 9.1	49.6 ± 11.4	NS	57.3 ± 9.0	58.9 ± 8.1	NS
	Women	52.2 ± 9.7	53.2 ± 10.2	NS	56.6 ± 8.7	60.3 ± 9.4	NS
BMI (kg/m)	Men	26.6 ± 5.1	28.8 ± 5.4	.05	27.5 ± 5.4	29.7 ± 5.7	.01
	Women	32.2 ± 7.0	30.4 ± 6.8	NS	29.1 ± 6.2	29.4 ± 7.1	NS

Results are given as mean ± SD.
NCA=normal epicardial coronary arteries; CAD=coronary artery disease; BMI=body mass index; NS=not significant.

Table 4. Coronary artery disease risk factors in patients with normal coronary angiogram

	Total	**Black *n* (%)**	**White *n* (%)**	**OR (95% CI)**	***P***
Hypertension	123	71 (73.2)	52 (42.6)	3.30 (1.85–5.91)	<.001
Diabetes	25	14 (14.4)	11 (9.0)	1.59 (0.69–3.70)	NS
Hypercholesterolemia	66	17 (17.5)	49 (40.2)	.29 (.15–.54)	<.0001
Smoking	58	41 (42.3)	17 (14.8)	4.22 (2.20–8.13)	<.0001

Results are given as *n* (%).
OR=odds ratio; CI=confidence interval; NS=not significant.

two times more likely than White men to have NCA (OR 2.09, CI 1.31–3.32, *P*<.002) and Black women had a lower prevalence of NCA compared to White women (OR .63, CI .37–1.09, *P*<.10). The difference in the prevalence of NCA between Black men and Black women was not significant (43.3% vs 42.4%, OR 1.04, CI 0.61–1.76). On the other hand, White men were significantly less likely than White women to have NCA (26.8% vs 53.7%, OR .32, CI .20–.50, *P*<.0001). No significant difference was seen in the mean age of Black men and women with NCA compared to their White counterparts. Black men with NCA weighed significantly less compared to White men. The difference in BMI between Black and White women was not significant (Table 3).

Hypertension, diabetes, and cigarette smoking occurred more frequently in Blacks compared to Whites, while hypercholesterolemia was more frequent in Whites. Likewise in the subgroup with NCA shown in Table 4, hypertension, diabetes, and smoking were more frequent in Blacks (OR 3.30, CI 1.85–5.91, *P*<.001; OR 1.59, .69–3.70, *P*=NS; and OR 4.22, CI 2.20–8.13, *P*<.0001. When men and women within each race were compared, no significant difference in the occurrence CAD risk factor was seen (Table 5). In the subgroup of patients with CAD, significant differences between Blacks and Whites were present for all the CAD risk factors (Table 6). The magnitude of the Black-White difference with regard to CAD risk factors did not differ significantly between the

NCA and CAD groups as shown in Table 7.

DISCUSSION

In this observational study, normal coronary angiograms were found in 39.1% of patients referred for cardiac catheterization, 42.9% in Blacks and 36.5% in Whites. The prevalence of NCA was highest for White women (53.7%). No significant difference was observed between White women and Black women. However, Black men were two times more likely than White men to have NCA. We did not observe any significant sex difference in the prevalence of NCA in Blacks, but White men were significantly less likely than White women to have NCA. The main

Table 5. Race and sex differences in coronary artery disease risk factors in patients with normal coronary angiogram

	Black Men *n* (%)	**Black Women *n* (%)**	***P***	**White Men *n* (%)**	**White Women *n* (%)**	***P***
Hypertension	39 (70.9)	32 (76.2)	NS	23 (42.6)	29 (47.5)	NS
Diabetes	5 (9.1)	9 (21.4)	NS	5 (9.3)	6 (9.8)	NS
Hypercholesterolemia	7 (12.7)	10 (23.8)	NS	23 (42.6)	26 (42.6)	NS
Smoking	26 (47.3)	15 (35.7)	NS	9 (16.7)	8 (13.1)	NS

NS=not significant.

Table 6. Coronary artery disease risk factors in patients with coronary artery disease

	Total	Black *n* (%)	White *n* (%)	OR (95% CI)	*P* value
Hypertension	240	99 (76.7)	141 (66.8)	1.64 (.99–2.70)	NS
Diabetes	107	52 (40.3)	55 (26.1)	1.92 (1.20–3.06)	<.01
Hypercholesterolemia	170	46 (35.7)	124 (58.8)	.39 (.25–.62)	<.0001
Smoking	93	52 (40.3)	41 (19.4)	2.80 (1.72–4.57)	<.0001

Results given as *n* (%).
OR=odds ratio; CI=confidence interval.

finding of this study contradicts previous studies that have reported a higher prevalence of NCA in both Black men and women compared to their White counterparts undergoing coronary angiography for suspected coronary artery disease.[1–3] Maynard et al[1] reported the prevalence of NCA in Blacks as 47.0% for men and 67.3% for women, compared to 19.7% for White men and 54.5% for White women in the Coronary Artery Surgery Study (CASS). Other studies in Black patients undergoing coronary angiography have also reported relatively high prevalence of NCA.[2,3] The varying prevalence of NCA from one study to another may be partly related to differences in the indications for coronary angiography. In our study, chest pain was the indication for cardiac catheterization in 67% of the study population, while in CASS >80% of patients were referred

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for coronary angiography because of chest pain. In addition, in CASS only 2.4% of the study population was Black, which would make drawing conclusions with respect to Black patients difficult. These and other selection biases for coronary angiography, such as differences in provider referral pattern, may partly account for the ethnic and sex differences observed.[7] Another factor in this study that may be largely responsible for the different prevalence of NCA observed compared to other studies is the definition of NCA as luminal diameter narrowing <25%. This angiographic definition of NCA is stricter and better reflects NCA compared to luminal diameter narrowing <50% used in the other studies referenced.

The focus in angiographic studies has been generally on patients with coronary artery disease, as these individuals often account for greater cardiovascular morbidity, mortality, and use of health resources.[8,9] Much less data exist on patients with NCA. Data from intravascular ultrasound studies have shown considerable atherosclerotic disease burden in these patients.[10–14]

This study describes the NCA population in terms of CAD risk factors, race, and sex. Previous studies reporting the prevalence of NCA did not provide information on CAD risk factors. Hypertension was the most frequent CAD risk factor in patients with NCA and occurred disproportionately more in Blacks compared to Whites. The leading role of hypertension as a CAD risk factor is confirmed in our study.[8]

This study was not randomized, and therefore a selection bias is possible. This limitation should be taken into account in interpreting the results. The use of two experienced investigators to interpret the angiogram was intended to reduce the chance of misclassification of coronary angiogram. The inherent limitations of coronary angiography as a diagnostic tool are well known and were not the subject of our study.[11–14] The two institutions in which the study was performed had similar capabilities in terms of cardiovascular care; hence the spectra of cardiac patients treated in both institutions were comparable, which eliminates a potential source of bias. Each had a cardiac catheterization laboratory and performed diagnostic

Table 7. Black-White differences in distribution of CAD risk factors in patients with NCA and CAD

Risk factor	NCA OR for B vs W	CAD OR for B vs W	Mantel-Haenszel Odds Ratio	*P* value
Hypertension	3.30	1.63	2.20 (1.52–3.20)	NS
Diabetes	1.59	1.92	1.83 (1.22–2.75)	NS
Hypercholesterolemia	.29	0.39	.35 (.24–.50)	NS
Smoking	5.18	4.31	4.62 (2.97–7.18)	NS

Results are given as odds ratio.
NCA=normal epicardial coronary arteries; CAD=coronary artery disease; OR=odds ratio; B=Black; W=White.

cardiac catheterization but not revascularization procedures or coronary artery bypass surgery. However, this study does not resolve a possible rural-urban difference that may exist in the frequency of normal coronary angiogram and distribution of CAD risk factors. Data on the question of rural-urban difference in the frequency of normal coronary angiogram is lacking, although data exist on cardiovascular disease mortality.[15] We did not provide data on the socioeconomic background of the study population; however, most of the study cohort appear to be in the low income category of the United States population by virtue of were they resided. We also did not evaluate for the variation in referral pattern in this study, a factor that has been well documented in clinical practice as a cause for selection bias.[7] Our study included a significant number of women of both races. Studies have shown that women are less likely to be referred for cardiac procedures in general and cardiac catheterization in particular.[7,16] The exclusion of patients ≥70 years of age and with previous myocardial infarction or coronary intervention would reduce the number of patients with CAD because it occurs more commonly in the elderly compared to the younger patients.

As far as we are aware, our study is the largest systematic analysis in a prospective cohort of Black and White patients that uses a cutoff of 25% luminal diameter narrowing as definition for normal coronary angiogram. In CASS, only 2.4% of the study population was Black. The study by Mathew et al[2] from Cook County hospital in Chicago was retrospective, used a luminal diameter narrowing <50% as the definition of NCA, and lacked a comparator White group. In conclusion,

a disparity exists in frequency of normal coronary angiogram in Blacks and Whites undergoing coronary angiography for suspected coronary artery disease. This disparity is not explained by race.

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