Black-White Differences in Severity of Coronary Artery Disease Among Individuals with Acute Coronary Syndromes

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OBJECTIVE: To determine whether the extent of coronary obstructive disease is similar among black and white patients with acute coronary syndromes.

DESIGN: Retrospective chart review.

PATIENTS: We used administrative discharge data to identify white and black male patients, 30 years of age or older, who were discharged between October 1, 1989 and September 30, 1995 from 1 of 6 Department of Veterans Affairs (VA) hospitals with a primary diagnosis of acute myocardial infarction (AMI) or unstable angina (UnA) and who underwent coronary angiography during the admission. We excluded patients if they did not meet standard clinical criteria for AMI or UnA or if they had had prior percutaneous transluminal coronary angioplasty or coronary artery bypass grafting.

MEASUREMENTS AND MAIN RESULTS: Physician reviewers classified the degree of coronary obstruction from blinded coronary angiography reports. Obstruction was considered significant if there was at least 50% obstruction of the left main coronary artery, or if there was 70% obstruction in 1 of the 3 major epicardial vessels or their main branches. Of the 628 eligible patients, 300 (48%) had AMI. Among patients with AMI, blacks were more likely than whites to have no significant coronary obstructions (28/145, or 19%, vs 10/155 or 7%, $P = .001$). Similarly, among patients with UnA, 33% (56/168) of blacks but just 17% (27/160) of whites had no significant stenoses ($P = .012$). There were no racial differences in severity of coronary disease among veterans with at least 1 significant obstruction. Racial differences in coronary obstructions remained after correcting for coronary disease risk factors and characteristics of the AMI.

CONCLUSIONS: Black veterans who present with acute coronary insufficiency are less likely than whites to have significant coronary obstruction. Current understanding of coronary disease does not provide an explanation for these differences.

KEY WORDS: coronary atherosclerosis; race; acute myocardial infarction; unstable angina; acute coronary syndromes.

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African Americans (blacks) do not appear to have shared equally in recent declines in age-adjusted mortality rates due to coronary artery disease (CAD). Whereas there is some evidence that black males had lower coronary artery disease mortality than white men during the 1950s and 1960s,¹⁻³ more recent data suggest that mortality rates among blacks now exceed those for whites among old and young women, and among men under 65 years of age.³⁻⁵ The reasons for these different trends in mortality rates are unclear. Certain coronary risk factors, including diabetes, obesity, and tobacco use are more prevalent among blacks than whites.⁶⁻⁹ Alternatively, less extensive use of advanced treatment for coronary artery disease in the black population may contribute to poorer outcomes. This has been most convincingly demonstrated for revascularization procedures.¹⁰⁻¹⁴

Despite the high rates of coronary artery disease mortality in the black population, coronary angiographic studies since the 1970s have repeatedly suggested lower rates of obstructive coronary artery disease among blacks than among otherwise similar whites.¹⁵⁻¹⁷ However, in these studies, the indications for coronary angiography frequently differed between the whites and blacks. Thus, it is not clear whether the lower rate of obstructive coronary disease in blacks simply reflects differences in clinical situation at the time of coronary angiography, or if it reflects true differences in obstructive coronary disease. We therefore used data from a study of use of revascularization procedures in black and white patients with similar indications for coronary angiography to address this issue. We asked the question, do black and white patients with acute coronary syndromes have differences in their extent of coronary obstruction?

METHODS

We performed a retrospective cohort study of black and white veterans admitted to 1 of 6 Department of Veterans Affairs (VA) hospitals with acute coronary syndromes and who had undergone coronary angiography during the hospital stay. The design of the study has been reported previously.¹⁸

Study Population

We identified potentially eligible patients using the Department of Veterans Affairs Patient Treatment File (PTF). The PTF contains administrative data including

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demographic information, International Classification of Diseases – Ninth Revision – Clinical Modification (ICD-9-CM) diagnosis and procedure codes, and treatment site for all patients discharged from VA hospitals. We identified all black and white males, 30 years of age or older, who underwent coronary angiography (ICD-9-CM 37.22–37.23, 88.55–88.57) during an admission for an acute myocardial infarction (AMI) (ICD-9-CM codes 410–410.92) or unstable angina (UnA) (ICD-9-CM codes 411.1–411.89). We studied patients discharged between October 1, 1989 and September 30, 1995 from 1 of 6 Department of Veterans Affairs Medical Centers (VAMCs) representing the 4 original VA administrative regions (East, Central, South, West) as they were defined in 1995. These sites included the VAMCs in Birmingham, Ala, Milwaukee, Wis, New York, NY, Philadelphia, Pa, Pittsburgh, Pa, and West Los Angeles, Calif. The sites vary in the proportion of the patient population that is black and in the proportion of patients with AMI or UnA who undergo coronary angiography, indicating a spectrum of practice patterns.

We selected all eligible black patients. We stratified our white patients by age, VAMC, primary diagnosis and year of discharge, then selected as many white patients as there were black patients with each set of characteristics. For example, if there were three 60- to 69-year-old black patients who were admitted to a study site with unstable angina during 1993–1994, we sampled three white patients with those characteristics. Thus, our sampling strategy did not lead to a set of matched pairs, since the white patients were not individually matched to black patients. Rather, our sampling strategy simply made it very likely that blacks and whites would be similar in terms of age, primary diagnosis, year of admission and study site. Because prior revascularization identifies a population that has or had significant stenosis, we excluded patients who had undergone prior percutaneous transluminal coronary angioplasty or coronary artery bypass grafting since they would obscure racial differences in the presence of stenosis. We also excluded patients who were admitted for a medical illness other than ischemic heart disease and developed acute coronary insufficiency while in the hospital. We included patients originally classified as AMI who turned out to have UnA (and vice versa) on physician review of the initial data. These patients were classified as having the diagnosis assigned by the physician reviewer.

Data Collection

Each participating hospital's institutional review board approved the study. Patient consent was not required because the study involved blinded chart review. We provided each site with a list of selected patients. Study personnel at each participating VAMC retrieved eligible charts, photocopied them, and placed a unique study identifier on each page of the copy. In addition, they confirmed that any mention of race in the chart corresponded to the race that had been designated. Thus, our

designation of race reflects the treating clinicians' perception of patient race, which we believe was generally formed without asking the patient. The study personnel then removed all references to the patient's name, social security number and race before sending the blinded copy to the coordinating center in Pittsburgh.

A board-certified internist (DSM) reviewed each record to confirm that the clinical criteria for acute myocardial infarction or unstable angina were present. The diagnosis of acute myocardial infarction required 2 out of the following 3 criteria: 1) chest pain; 2) characteristic electrocardiogram changes; and 3) elevation of creatine phosphokinase, MB fraction or total creatine phosphokinase with a characteristic rise and fall. The diagnosis of unstable angina required one of the following: 1) in patients with previously stable angina, an increase in intensity, duration, or frequency, or angina occurring at rest; or 2) in patients without previous history of angina, an initial episode occurring at rest, or new onset exertional angina unrelieved by rest. We relied on the clinicians' impressions to determine when angina was present. Thus, if a patient had chest pain deemed to be atypical, we did not consider it angina, nor did we try to second guess a clinician's diagnosis of angina by relying on the chart description of the chest pain.

A registered nurse abstracted clinical data regarding each patient, including specified comorbid medical conditions and features of the clinical presentation. We summarized the overall burden of comorbidity using the method of Charlson et al.¹⁹ to assign a comorbidity score on an ordinal scale (0, 1, 2, or 3) based on the number and severity of comorbid conditions. We also gathered data regarding the presence of hypertension, past or current tobacco use, and past or current recreational drug use. We considered alcohol abuse to be present if the social or past medical history documented alcohol abuse, tolerance, dependence, heavy alcohol use, alcoholism, or any medical conditions referred to as alcoholic or secondary to alcohol use. Additionally we considered alcohol abuse to be present if alcohol consumption was more than 12 drinks per week. In addition, we gathered data regarding features of the acute coronary syndrome. Specifically, if the patient had an AMI, we gathered infarct location (anterior, inferior, other) and whether the patient developed Q waves. For all patients, we determined whether the patient had a history of congestive heart failure or a previous AMI.

The nurse identified all reports of echocardiography, Multi-gated Acquisition (MUGA) Scan, and left heart catheterization. These were reviewed by study physicians (JW, JC, CBG). Ejection fraction (EF) was categorized as <35%, 35% to 49%, or >49%, using the results of contrast ventriculography, MUGA, or echocardiography performed during the admission. If more than 1 of these was performed, they were used in that order. If none of these had been performed, the EF was considered normal. We defined coronary anatomy using the official signed cardiac catheterization report. If it could not be located, we used

the postcatheterization note recorded by the most senior cardiologist who recorded a note. We used the method of RAND^{19,20} to classify coronary disease. Using this method, a patient is considered to have no significant coronary disease if no vessel has at least 70% stenosis and the left main coronary artery (LMCA) does not have $\geq 50\%$ stenosis. Physician reviewers classified coronary angiography reports as showing no coronary obstruction $>70\%$, 1 to 2 vessels with $>70\%$ obstruction but without proximal left anterior descending obstruction (PLAD), 1 to 2 vessels with PLAD, 3-vessel disease, or LMCA $>50\%$ obstructed.

Analysis

The plan of analysis was to first assess black-white differences in coronary disease among veterans with an admitting diagnosis of AMI or UnA at 6 VA centers. Second, we determined whether these differences remained after controlling for potential confounders with multivariable analysis. Pearson χ^2 tests were used to compare coronary disease and risk factors for coronary disease in black and white veterans. Multivariate logistic regressions were used to assess independent associations of race and risk factors and coronary disease. Separate analyses were completed on the patients with AMI and UnA. For the AMI patients, information about the type and location of the myocardial infarction (MI) was included in the modeling. We also repeated the analysis for the subset of patients presenting with their first AMI who had no current or past recreational drug abuse.

We used 2-sided *P* values of $<.05$ to indicate significance and report *P* values not corrected for multiple comparisons. SPSS version 8 (SPSS Inc., Chicago, Ill) was used for the analyses.

RESULTS

We identified 3,137 potentially eligible patients, 535 of which were black. We received 414 of the 535 (77%) charts we requested for black patients and 517 of the 710 (73%) charts we requested for white patients. (We requested more charts of white than black patients because when a chart was not available for a white patient we could request the chart for a replacement white patient with similar age,

primary diagnosis, year of discharge, and study site.) There was no racial difference in the proportion of charts received (77% black vs 73% white). We excluded 303 patients for the reasons stated in Table 1. Patients whose charts were unavailable or who were ineligible were similar to those whose charts were retrieved and eligible in terms of race, age and diagnosis. Our final study population included 628 veterans, 313 of whom were black. Because of our sampling strategy, age, admitting diagnosis, fiscal year of admission, and admitting hospital were similar for black and white patients in the study. As shown in Table 2, black patients were more likely to have a history of diabetes, hypertension, or intravenous drug use. Among AMI patients, blacks were more likely to be reported to have previous or current alcohol abuse. Among UnA patients, whites were more likely to have a history of congestive heart failure.

Black patients were more likely than white patients to have no significant stenosis, both among patients with AMI and among those with UnA. After patients with no significant disease were removed, there was no difference between black and white patients in the degree of stenosis (Table 2). We therefore present the results of our analyses focused on the dichotomous outcome variable, presence or absence of at least 1 significant stenosis.

In univariate analysis, patients with a diagnosis of AMI were more likely to have at least 1 significant stenosis than those having a diagnosis of UnA (87% vs 75%). Results are presented separately for these groups. As might be expected in a population undergoing coronary angiography, risk factors such as diabetes mellitus, peripheral vascular disease, hypertension, congestive heart failure, and smoking history were not related to the presence of significant coronary obstructions, since these are likely considered in the decision to perform the procedure. Among patients with AMI, each of the following characteristics was associated with significant coronary obstruction: age (mean age 59.0 vs 55.7 years old), ejection fraction $<50\%$ (present in 50% of those with obstruction versus 32% of those without), and anterior (31% vs 21%) or inferior (34% vs 16%) location of MI. In contrast, past history of alcohol abuse (41% vs 71%) was less likely in patients with significant coronary obstruction. Among unstable angina patients, those with significant coronary obstructions were

Table 1. Patients Excluded after Chart Review

	Black (N = 101)*	White (N = 202)*
Previous revascularization, n (%)		
Coronary artery bypass graft	38 (38)	101 (50)
Percutaneous transluminal coronary angioplasty	20 (20)	35 (17)
Diagnosis other than acute myocardial infarction or unstable angina, n (%)	29 (29)	42 (21)
No catheterization done, n (%)	0 (0)	3 (2)
Patient transferred for revascularization because of known CAD [†] , n (%)	12 (12)	14 (7)
Records incomplete, n (%)	0 (0)	5 (3)
Race other than black or white, n (%)	2 (2)	2 (1)

* Percentages do not add up to 100% due to rounding.

[†] CAD, coronary artery disease.

Table 2. Characteristics of the Study Population (N = 628)

Patient Characteristic	Acute Myocardial Infarction			Unstable Angina		
	Whites (N = 155)	Blacks (N = 145)	P Value	Whites (N = 160)	Blacks (N = 168)	P Value
Mean age, y (median)	58.6 (60)	58.6 (58)	1.0*	62.2 (63)	61.9 (63)	.8*
Comorbidities and cardiac disease risk factors, n (%)						
Current smoker	72 (47)	77 (53)	.2	64 (40)	73 (44)	.6
Current or past alcohol abuse	59 (38)	76 (52)	.02	57 (36)	72 (43)	.2
Current or past drug abuse	9 (6)	28 (18)	.001	4 (3)	14 (8)	.02
Diabetes mellitus	29 (19)	44 (30)	.02	25 (16)	44 (26)	.02
Hypertension	72 (47)	107 (74)	.000	91 (57)	125 (74)	.000
Peripheral vascular disease	12 (8)	9 (6)	.6	19 (12)	15 (9)	.5
Prior myocardial infarction	40 (26)	33 (23)	.6	53 (33)	49 (29)	.5
Prior congestive heart failure	5 (3)	7 (5)	.6	7 (4)	18 (11)	.03
Ejection fraction <50%	78 (50)	65 (45)	.6	36 (23)	42 (25)	.3
Coronary stenosis severity, n (%)						
No disease	10 (7)	28 (19)		27 (17)	56 (33)	
1,2-vessel disease, no PLAD	72 (47)	66 (46)		60 (38)	57 (34)	
1,2-vessel disease with PLAD	24 (16)	9 (6)	.001	17 (11)	12 (7)	.012
3-vessel disease	44 (28)	40 (28)		45 (28)	33 (20)	
Left main disease	5 (3)	2 (1)		11 (7)	10 (6)	

* P value is based on t test for difference in means.

PLAD, proximal left anterior descending artery stenosis.

older (mean age 63.1 vs 58.8 years old) and more likely to have prior MI (36% vs 17%). In contrast to the population with AMI, a history of alcohol abuse was not related to the presence of stenosis, but there was a trend for patients with significant coronary stenosis to be less likely to have current or past drug abuse than those without (4% vs 10%).

The results of the multivariable analyses are presented in Table 3. Both among patients with AMI and those with UnA, black race was independently predictive of having no significant obstructive coronary lesions. Among patients with AMI, other factors associated with having at least 1 significant stenosis included age >50 and location of the MI

Table 3. Multivariable Odds Ratios of Significant Stenosis

	Odds Ratio*	95% CI of Odds Ratio
All acute myocardial infarction (N = 300)		
Black	0.27	0.12 to 0.63
Age, y		
50-60	4.77	1.65 to 13.78
>60	2.75	1.11 to 6.76
Past or current alcohol abuse	0.33	0.15 to 0.73
Myocardial infarction in anterior region	3.43	1.32 to 8.91
Myocardial infarction in inferior region	5.60	2.10 to 17.09
Ejection fraction <50%†	2.04	0.95 to 4.37
New acute myocardial infarction without current or prior drug use (N = 201)		
Black	0.15	0.05 to 0.46
Age, y		
50-60	6.55	1.67 to 25.65
>60	3.50	1.09 to 11.23
Myocardial infarction in anterior region	5.33	1.52 to 18.72
Myocardial infarction in inferior region	8.90	2.47 to 32.80
Ejection fraction <50%	3.17	1.10 to 9.17
All unstable angina (N = 328)		
Black	0.40	0.23 to 0.70
Age, y		
50-60	1.64	0.74 to 3.67
>60	3.22	1.55 to 6.67
History of prior myocardial infarction	2.77	1.4 to 5.32

* Adjusted for study site, age, smoking status, diabetes, hypertension, peripheral vascular disease, history of myocardial infarction, location of myocardial infarction, ejection fraction, alcohol abuse, and recreational drug use.

† When myocardial infarction location information is not included as a covariate.

in the anterior or inferior regions, while current or past history of alcohol abuse was associated with a lower likelihood of significant stenosis. We postulated that recreational drug use might confound the relationship between race and obstructive CAD. Therefore, we analyzed a subset of patients with AMI who had no prior MI or recreational drug use. Black race continued to be associated with no significant stenosis in this subset. Among men with UnA, age >60 and history of prior MI predicted having significant stenoses, while black race was associated with having no significant stenoses.

DISCUSSION

We have shown that black men with acute coronary syndromes are significantly less likely to have obstructive coronary lesions at the time of coronary angiography than white men. Moreover, this difference was seen even among men who had enzymatically confirmed AMI. In this group, 19% of black men had no significant stenoses, compared to 7% of white men. In contrast to previous studies showing less severe obstructive coronary disease among blacks compared to whites,^{15–17,21} we studied a cohort of men who had similar clinical syndromes. In addition, we were able to gather detailed data regarding features of the clinical presentation that are likely to predict significant stenoses. Thus, compared to prior studies, it seems less likely that our results reflect simple differences in the selection of patients for coronary angiography. Rather, we believe we have demonstrated that there are racial differences in the coronary anatomy that exists at the time blacks and whites present with unstable coronary syndromes. We emphasize that these black-white differences in coronary anatomy do not fully explain racial differences in revascularization rates.^{14,18}

Our study is consistent with the prior studies in the area. In a study of the Coronary Artery Surgery Study registry data, Maynard et al. reported that blacks were more likely than whites to have no significant stenoses, and that whites were more likely to have severe disease (i.e., involvement of the left main or parts of all 3 major epicardial vessels).¹⁵ Similarly, in a study of 6,594 patients undergoing coronary angiography at a single center, Oberman and Cutter found whites more often had multivessel disease than blacks.²¹ It may be that we found similar proportions of severe disease in blacks and whites because we restricted our sample to patients with no prior revascularization who had acute ischemia, or it may simply be that our smaller sample size did not allow us to detect a difference. More recent studies of black clinical populations have also found that blacks undergoing coronary angiography are more likely to have no significant coronary obstructions than whites, and less likely to have multivessel or left main disease.^{16,17} In contrast, the multicenter Pathologic Determinants of Atherosclerosis in Youth study of black and white men without clinical CAD has found that the number and severity of atherosclerotic lesions is similar

in whites and blacks of the same age undergoing autopsy after death due to external causes.²² This is in contrast to earlier autopsy studies suggesting that coronary atherosclerosis was less prominent in black than in white males.^{23,24}

Taken as a whole, these findings may shed light on the paradoxical finding that mortality rates due to coronary artery disease among blacks now exceed those among whites, even though many studies have demonstrated less obstructive coronary disease among blacks than among whites with clinical CAD. Both our results and this paradox are consistent with the possibility that blacks have a higher risk of acute ischemia than whites at any given level of coronary obstruction, even that not traditionally considered as “significant.” However, our study provides little insight regarding why this might occur. Previous studies have suggested that AMI in the presence of angiographically normal coronary arteries was especially likely among young smokers.²⁵ However, our black and white populations were matched on age, and smoking was similar in the 2 groups. Additionally, it is well known that cocaine abuse is associated with AMI in the presence of angiographically normal coronary arteries.²⁶ Although intravenous drug use was reported more commonly for blacks in our study, our finding was present even in the subset of patients without prior or current recreational drug use. Similarly, we found no support for the theory that prolonged hypertension and subsequent left ventricular hypertrophy made blacks more likely to have ischemic events in the absence of coronary obstruction. Although we did not have a measure of left ventricular mass, controlling for hypertension and ejection fraction did not change the importance of race (data not shown). Finally, we considered the possibility that timing of coronary angiography may have differed between blacks and whites and found that there was no difference in time to coronary angiography between the 2 groups (data not shown).

We acknowledge several limitations of the current study. Most importantly, the study population, although carefully selected to be representative of patients with AMI who underwent coronary angiography, did not include all patients who had AMI at the study hospitals. Rather, the group that had coronary angiography was selected by the clinicians caring for them. There is little reason to expect that this process would lead to racial differences in the severity of CAD, unless the criteria that clinicians use to select patients for coronary angiography is predictive of disease in whites but not blacks. We are unable to directly test that hypothesis, since we don't know the disease status of the patients who did not undergo coronary angiography. However, our findings are consistent with an emerging body of evidence from studies using electron beam computed tomography (EBCT). Because it is noninvasive, EBCT can be carried out in representative populations, even those without symptoms of coronary artery disease.²⁷ Early studies suggest that the amount of coronary artery calcium is higher in whites than in similarly aged blacks,

even when controlling for the presence of clinical cardiovascular disease and risk factors.²⁸ Nonetheless, until similar studies are done in a clinical population, one can hypothesize that some of the difference that we observed is because clinicians are less able to select patients who are likely to have severe obstructive disease when they are black than when they are white.

Second, although the 6 academic VA medical centers in the study were selected to represent the 4 VA regions (East, Southeast, Midwest and West), the population treated at these centers is not necessarily representative of all patients with acute coronary insufficiency. Most obviously, there were no women in the study. Additionally, individuals using VA hospitals for medical care are less affluent on average than the overall U.S. population. Further, the practice pattern at VA medical centers tends to be somewhat less aggressive than at non-VA facilities, in that a smaller proportion of patients with AMI undergo coronary angiography.²⁹

Third, we relied on coronary angiography reports, rather than actual review of coronary angiography, for our analysis. It is possible that the apparent racial differences in anatomy instead reflect differences in the interpretation of angiograms from black and white patients. If there is a tendency to avoid revascularization in black patients, it may be that the interpretation is subtly altered to justify that non-use. The consistency of our findings across sites makes this interpretation of the data less likely, since it would require the same bias be present in each of 6 sites.

Finally, our study tells us nothing of why these differences exist. It is possible that blacks and whites receive different treatments for cardiac risk factors or symptoms of coronary disease, and that these differences in therapy lead to these differences in anatomy. Similarly, it is possible that blacks were more likely to have resolved coronary thrombus by the time that coronary angiography occurred. Thus, the apparent higher prevalence of obstruction in whites may reflect more thrombus present at the time of coronary angiography, rather than more atherosclerotic disease. However, the time from symptom onset to angiography was similar in blacks and whites. Although it is possible that racial differences in regular use of antiplatelet agents influenced this finding, we did not examine use of medications prior to hospitalization.

These limitations notwithstanding, we believe that this report clearly indicates that further research is required regarding the mechanisms whereby acute ischemia occurs, particularly in the black population. Previous research has clearly demonstrated that acute ischemic events occur because of thrombus formation at the site of plaque, not necessarily at the most significant stenosis in a given patient.³⁰ It is not surprising that this occurs among both blacks and whites. However, we are not aware of data indicating why this would occur more frequently in black than white patients without coronary artery disease. However, studies of cardiovascular reactivity have

suggested that blacks may have greater cardiovascular reactivity than whites.^{31,32} This may be associated with increased risk of vascular events. Unfortunately, our own study did not collect data regarding the presence of thrombus in the coronary arteries, so we could not address this question directly.

It is interesting that blacks are also more likely to suffer thrombotic cerebrovascular events than whites, despite being less likely to have obstructive large vessel extracranial disease.³³ We believe that research into the genesis of these racial differences in ischemic syndromes will almost certainly shed important light into the mechanisms of thrombosis among blacks and whites.

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