Coronary Artery Disease and Risk Factors in Black South Africans—A Comparative Study

M. R. Nethononda, MD; M. R. Essop, MD; A. D. Mbewu, MD; J. S. Galpin, PhD

Objective: The purpose of this study was to identify and compare coronary risk factors in different South African ethnic groups with angiographically documented significant coronary artery disease (CAD).

Design: An observational retrospective analysis.

Methods: Hospital records of 500 consecutive patients with no previous coronary interventions who underwent coronary angiography at Chris Hani Baragwanath Hospital, Soweto over a 2-year period were reviewed. Patients with significant CAD were selected for this study. Data analyzed included demographics, presenting diagnoses, coronary risk factors, number of coronary arteries significantly affected and extent of CAD, left ventricular ejection fraction (LVEF), and the main treatment modality for CAD.

Results: Of the 206 patients with significant CAD, 85 were Africans and 121 were non-Africans. There were significantly more females in the African group (31% vs 12%, $P=.0023$) and hypertension was more prevalent in the same group (78% vs 55%, $P=.0006$). Serum total (TC) and low-density lipoprotein (LDL) cholesterol were significantly lower in African than in non-African patients [189.5 (96.67–313.2) vs 228.2 (127.6–464) mg/dL; $P=.0006$ and 100.5 (34.8–282.3) vs 146.9 (42.54–313.2) mg/dL; $P=.0001$, respectively].

Conclusion: Cholesterol levels in this group of African patients with angiographically significant CAD are within the target range recommended by the adult treatment panel III (ATP III) guidelines of the National Cholesterol Education Program (NCEP). These data have implications for risk assessment using cholesterol and the role of cholesterol lowering treatment in populations of developing countries. (*Ethn Dis*. 2004;14:515–519)

Key Words: Africans, Cholesterol, Coronary Artery Disease, Risk Factors

From the Department of Cardiology, Chris Hani Baragwanath Hospital, Soweto (MRN, MRE); School of Statistics and Actuarial Science, University of the Witwatersrand, Johannesburg (JS); and Medical Research Council, Cape Town (AD), South Africa.

Introduction

There is a marked disparity in the prevalence of coronary artery disease (CAD) among the ethnic populations of South Africa. The incidence of CAD in Caucasian and Asian (Indian) communities parallels that in Western populations and is the leading cause of morbidity and mortality in these groups.[1,2] In contrast, until the recent past, CAD in its clinical manifestations had been virtually non-existent in the Black African (henceforth referred to as African) population of South Africa.[3–7] This pattern is already changing and, within developing countries in general, a dramatic rise in the prevalence of CAD has been predicted due to rapid changes in demography and lifestyle consequent to economic development.[8,9] It is not clear whether the classic risk factors for CAD that have been identified in Western populations are equally relevant in developing countries. While there exist some data on the epidemiology of CAD in African Americans,[10–19,21] scant data is available on the profile of CAD and coronary risk factors in African populations.[20,22] However, the African-American gene pool contains a significant admixture of Caucasian genes implying that African Americans are poor samples for understanding the pathophysiology of atherosclerosis in indigenous African populations.[23] Because of its past legacy of legislated and enforced racial separation, and relatively small Caucasian (10.9%)[24] and Asian (2.6%)[24] populations that largely continue to live separately even after the demise of apartheid, South Africa provides a good environment for understanding the biology of atherosclerosis in different ethnic groups. Since 1994 ethnic-based hospital admission and referral patterns have been outlawed and patients are compelled to utilize the public healthcare facility nearest to their residence. Therefore, Caucasian patients from Kopanong Hospital (a secondary hospital south of Johannesburg previously reserved for use by Caucasian patients only) and Asian patients from Lenasia (an affluent suburb south of Johannesburg previously reserved for Asian residents only) now have to come to Chris Hani Baragwanath Hospital for tertiary care. In this study we sought to compare coronary risk factors and angiographic disease patterns between different ethnic groups with angiographically documented significant CAD, presenting to a single large urban hospital[7] that serves mainly the African community of Soweto—a community whose African population is fairly typical of urban Africa populations throughout South Africa.

Address correspondence and reprint requests to M. R. Nethononda, MD; Department of Cardiology; Chris Hani Baragwanath Hospital; P.O. Bertsham, 2013; Johannesburg, South Africa; 27-11-642-4472; 27-11-642-1588(F).

Methods

Hospital records and catheterization laboratory reports of 500 consecutive patients with no previous coronary interventions and who underwent coronary angiography at Chris Hani Baragwanath Hospital in the years 1998 and 1999 were reviewed. Out of these records, patients with significant CAD, defined as ≥50% luminal narrowing in at least one major coronary artery using quantitative coronary angiography

In contrast, until the recent past, CAD in its clinical manifestations had been virtually non-existent in the Black African (henceforth referred to as African) population of South Africa.[3–7]

(QCA), formed the study cohort. Data analyzed included demographics (age, gender and ethnicity); mode of presentation (acute myocardial infarction [AMI], unstable angina [UA] and stable angina [SA]); presence of coronary risk factors (smoking, hypertension, diabetes, hyperlipidemia, and obesity); the number of coronary arteries affected and extent of CAD (focal or diffuse); echocardiographically determined left ventricular ejection fraction (LVEF); and treatment modality (medical, percutaneous coronary intervention [PCI], and coronary artery bypass graft [CABG] surgery). Patients were classified as either of African or non-African (Caucasian and Indian) descent. Patients of mixed ethnicity based on the opinion of the attending physician or presenting himself or herself as such were not included in the study. Acute myocardial infarction (AMI), UA, and SA were defined using the criteria of the American Heart Association. A patient was considered to have diabetes based on history of diabetes, persistent blood glucose elevation above 198.2 mg/dL or use of oral hypoglycemic agents or insulin. Obesity was present or absent based on the opinion of the attending physician at the time of the incident hospital admission. Hypertension was diagnosed if a patient had persistent blood pressure elevation greater than 140/90 or was on blood pressure lowering medications. Fasting serum lipid levels were measured in the fasting state within the first 24 hours of the incident hospital admission. Coronary angiography was performed according to standard Judkins techniques. Coronary angiographic findings included assessment of anatomical location of CAD and extent of atherosclerosis within coronary arteries (focal or diffuse). Anatomical location refers to involvement of each of the 3 major coronary arteries (left main [LM], left anterior descending [LAD], left circumflex [CX], and right coronary artery [RCA]). Coronary atherosclerosis was defined as focal if it was discrete and involved a short segment of one or more coronary arteries. Conversely, the disease was defined as diffuse if any of the following features were observed in one or more coronary arteries: multiple irregularities, stenoses, or ectasia. Coronary angiograms were evaluated visually and independently by 2 experienced cardiologists blinded to ethnicity of study patients. In the case of any disagreement a third observer was consulted to reach a consensus of opinion.

Table 1. Baseline characteristics and serum cholesterol concentrations

	African *N*=85	Non-African *N*=121	*P* Value
Male sex (%)	69	88	.0023
Age (Y) (median)	59	56	.1333
Myocardial infarction (%)	51	45	.4786
Unstable angina (%)	24	34	.1620
Stable angina (%)	27	22	.5096
Type 1 diabetes (%)	7	5	.5608
Type 2 diabetes (%)	21	16	.3616
Hypertension (%)	78	55	.0006
Current smoking (%)	67	78	.1463
Total cholesterol (median) mg/dL	189.5	228.2	.0006
LDL-C (median) mg/dL	100.5	146.9	.0001
HDL-C* (median) mg/dL	38.7	38.7	.6785
Triglycerides (median) mg/dL	123.9	177.0	.0090
No. of risk factors (median)	3	3	.4076

Y=years; LDL-C=low-density lipoprotein cholesterol; HDL-C=high-density lipoprotein cholesterol.
* Ranges 27.09–65.79 for Africans and 7.74–61.92 for non-Africans.

Statistical Analysis

Categorical variables were compared with the use of both the 2-tailed Fisher exact and the chi-squared tests. Continuous variables were compared using the Mann-Whitney *U* test. A *P* value of $<.05$ was considered to be significant.

RESULTS

Out of a total of 500 consecutive patients with no previous coronary interventions who underwent diagnostic coronary angiography at Chris Hani Baragwanath Hospital from January 1998 to December 1999, 206 had significant CAD. Eighty-five out of 206 patients (41%) were Africans and the remaining patients were non-Africans (Caucasian and Indian). The latter 2 ethnic groups were grouped together because in South Africa they have similar lifestyles and patterns of CAD. Fifteen patients (7%) were on anti-hypertensive therapy with no significant differences in the use of thiazide diuretics and beta-blockers between Africans and non-Africans. None of the patients were on aspirin or lipid lowering therapy prior to the incident hospital admission. Baseline clinical features and serum lipid levels are summarized in Table 1, and angiographic data, echocardiographic characteristics and treatment strategies are summarized in Table 2. There were significantly more females in the African

Table 2. Angiographic and echocardiographic data, and treatment strategies

	African N=85	Non-African N=121	P Value
Left main stem (%)	8	5	.5777
Left anterior descending (%)	71	64	.3639
Circumflex (%)	49	44	.4759
Right coronary (%)	62	63	.8838
No. of affected vessels (median)	2	2	.2664
Diffuse disease (%)	46	54	.7748
Median LVEF (%)	52	55	.0756
Medical treatment (%)	39	45	.3927
PCI (%)	29	33	.6468
CABG (%)	32	22	.2604

LVEF=left ventricular ejection fraction; PCI=percutaneous coronary intervention; CABG=coronary artery bypass grafting.

group (31% vs 12%, *P*=.0023). Age and mode of presentation were not significantly different between the 2 groups. Traditional risk factors for CAD, such as smoking and diabetes, were not significantly different between the 2 groups. However, there were significantly more patients with hypertension in the African group (78% vs 55%, *P*=.0006). In addition, median serum total cholesterol, LDL cholesterol, and triglyceride levels were significantly higher in the non-African group (228.2 mg/dL vs 189 mg/dL, *P*=.0006; 146 mg/dL vs 100.5 mg/dL, *P*=.0001; and 177 mg/dL vs 123.9 mg/dL, *P*=.009). The median number of risk factors, serum HDL cholesterol levels, and the number of vessels affected, anatomical location and extent (focal or diffuse) of CAD displayed no differences between the 2 groups. In addition there was no significant difference in the LVEF between the 2 groups. Similarly, the main CAD treatment strategy was not significantly different between the 2 groups.

DISCUSSION

Despite the high prevalence of certain traditional risk factors for CAD such as hypertension, smoking, and obesity in Africans, earlier observational and postmortem studies from South Africa have indicated that CAD was rare among Africans.[3–7] Several reasons have been postulated for this observation such as low saturated fat consumption, more physically active lifestyle and the youthful nature of urban African populations. Other factors postulated include: inherent ethnic immunity to development of CAD; higher HDL cholesterol levels among Africans; and possible less atherogenicity of certain risk factors common to Africans such as hypertension and obesity.[4,5,21]

Differences in biological characteristics, clinical features, lesion morphologies, treatment strategies and outcomes between African Americans and Caucasians with CAD have been documented in the United States. Not only do African Americans have a higher prevalence of baseline coronary risk factors but they also tend to have anatomical and biological characteristics that have the potential to influence pathophysiology and clinical manifestations of atherosclerosis in a different manner than their Caucasian counterparts. These include heightened endogenous fibrinolysis, higher prevalence of left ventricular hypertrophy, increased occurrence of single vessel disease with discrete uncomplicated lesion morphology, and a high likelihood of sudden cardiac death.[14,23] In addition, African Americans are less likely to receive thrombolytic therapy or to undergo PCI or CABG surgery.[10,11,14] These differences perhaps account for similar short-term and higher long-term mortality in African Americans compared to their Caucasian compatriots.[10,14,23]

Unlike the American experience, our study demonstrates no significant differences between African and non-African South African patients with regard to certain presenting clinical characteristics and some baseline coronary risk factors. In addition, the overall burden of coronary risk factors, anatomical location, and extent of atherosclerosis were not significantly different between our study groups. The latter finding is in contrast to a recent American observation that demonstrated a higher atherosclerotic burden in Caucasians compared to African Americans and Hispanics.[22] The higher proportion of females and more prevalence of hypertension in Africans with significant CAD observed in this study are in accordance with observations made in African Americans.[10,14] Previous studies have shown that obesity is common in African females both in South Africa and in the United States.[5,21] It has been postulated that this preponderance of females among African patients with CAD could be due to obesity-induced loss of protection normally afforded by higher serum HDL cholesterol usually found in African patients.[12,21,23] However, in this study both serum HDL cholesterol levels and the presence or absence of obesity were not significantly different between African and non-African patients.

Serum total cholesterol, LDL cholesterol, and triglyceride levels were significantly lower in African compared to non-African patients. More importantly, the median serum LDL cholesterol level in the African patients was 100.5 mg/dL prior to initiation of a cholesterol-lowering diet or drug therapy. Numerous studies have shown that serum cholesterol levels of Africans are appreciably lower than those for Whites. For example, Pavan et al[20] found significantly lower serum cholesterol levels among Africans from Tanzania compared to

Unlike the American experience, our study demonstrates no significant differences between African and non-African South African patients with regard to certain presenting clinical characteristics and some baseline coronary risk factors.

Brazilian and Italian Caucasians. Laksman et al[12] found significantly higher serum triglyceride levels in 622 Caucasian (152.8 ± 102.9 mg/dL) compared to levels in 594 African (115.8 ± 99.0 mg/dL) hypertensive male US citizens. In addition, Africans had significantly higher serum HDL cholesterol levels, 52 ± 14.0 mg/dL vs 45 ± 11.0 mg/dL. However, serum total cholesterol and LDL cholesterol levels were not significantly different between the 2 ethnic groups. In South Africa, 3 community surveys conducted by Seedat et al[1,2,5] (from 1984 to 1987) among 778 Indian, 458 African, and 396 English-speaking Caucasian adults from Durban found that 17% of the Indian and 27.8% of the Caucasian adults had serum total cholesterol levels=251.4 mg/dL. However, none of the Africans had serum total cholesterol levels above 189 mg/dL.

Our findings have a number of important implications. First, the finding of relatively low serum cholesterol levels among African patients with established CAD from developing countries raises the issue of whether it is appropriate to use the same serum cholesterol thresholds recommended for cardiovascular risk prevention in Western nations or whether a different set of recommendations should be developed for indigent African patients in developing countries. Available data on the value of cholesterol-lowering drug therapy in both primary and secondary prevention are derived almost exclusively from cohorts of patients who are Caucasians from Western populations. Second, the relatively low total and LDL cholesterol levels found in these populations could account for the relative rarity of CAD among Africans from developing countries. There is also a remote possibility that the few Africans who develop CAD have some, as yet undetermined, genetic susceptibility, which operates even when the serum LDL cholesterol level is low. Last, it appears that indigenous Africans with CAD, while sharing a few characteristics such as higher proportion of females affected and prevalence of hypertension, do not have the same high coronary risk factors burden as their American counterparts, perhaps accounting for the disparity in the prevalence of CAD in these African groups from the 2 continents. These hypotheses need to be investigated further by appropriately designed prospective studies.

Study Limitations

The present study is limited by a number of factors. First, retrospective analyses can be inherently biased. Second, our sample size is small necessitating caution in the interpretation of our findings. Third, the definition of race can be subjective and often self-described, ie, based on the opinion of the patient, registering clerk, or admitting physician. Fourth, as an acute phase response serum cholesterol levels sampled during the peri-infarction period are an underestimate of the true serum cholesterol level. Furthermore, different laboratories can use different methods to measure serum lipids making comparison of levels measured across countries difficult. Fifth, the definition of obesity was based on the subjective assessment of the admitting physician and not on calculation of the body mass index. Sixth, angiographic evaluation of coronary artery disease can underestimate the extent of coronary artery disease as intravascular ultrasound has taught us that angiographic disease is just the tip of an iceberg. Last, even within the same institution, physicians vary in their clinical judgments, practice, and level of technical expertise, which makes comparison of the various outcome measurements difficult.

ACKNOWLEDGMENTS

The authors thank Prof Y. Variava for his critical review of the manuscript, and Drs. F. Zhange and A. R. Essop for reviewing coronary angiograms.

REFERENCES

1. Seedat YK, Mayet FGH, Khan S, Somers SR, Joubert G. Risk factors for coronary heart disease in the Indians of Durban. *S Afr Med J.* 1990;78(8):447–454.
2. Seedat YK, Mayet FGH, Gouws E. Risk factors for coronary heart disease in the White community of Durban. *S Afr Med J.* 1994; 84(5):257–262.
3. Di Bisceglie AM, Miller MT, Blumsohn D. Myocardial infarction in an intensive care unit for Blacks. A review over 6 years. *S Afr Med J.* 1982;61(24):902–904.
4. Seftel H. The rarity of coronary heart disease in South African Blacks. *S Afr Med J.* 1978; 54:99–105.
5. Seedat YK, Mayet FGH, Latif GH, Joubert G. Risk factors for coronary heart disease in Durban Blacks—the missing link. *S Afr Med J.* 1992;82(4):251–256.
6. Isaacson C. The changing pattern of heart disease in South African Blacks. *S Afr Med J.* 1977;52(20):793–798.
7. Walker ARP, Sareli P. South Africa: paradox of coronary heart disease. *Lancet.* 1997; 349(suppl 3):14.
8. Watkins LO. Coronary heart disease and coronary disease risk factors in Black populations in underdeveloped countries: the case for primordial prevention. *Am Heart J.* 1984;108(3, pt 2):850–862.
9. Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. *Circulation.* 1997;97:596–601.
10. Taylor HA, Canto JG, Sanderson B, et al. Management and outcomes for Black patients with acute myocardial infarction in the reperfusion era. National Registry of Myocardial Infarction 2 Investigators. *Am J Cardiol.* 1998;82(9):1019–1023.
11. Chen J, Rathore SS, Radford MJ, Wang Y, Krumholz H. Racial differences in the use of cardiac catheterization after acute myocardial infarction. *N Engl J Med.* 2001;344:1443–1449.

12. Laksman MR, Reda D, Materson BJ, et al. Comparison of plasma lipids and lipoprotein profiles in hypertensive Black versus White men. *Am J Cardiol.* 1996;78:1236–1241.
13. Liao Y, Cooper RS, Ghali JK, et al. Survival rates with coronary artery disease for Black women compared with Black men. *JAMA.* 1992;268:1867–1871.
14. Marks DS, Mensah GA, Kennard ED, Detre K, Holmes DR. Race, baseline characteristics, and clinical outcomes after coronary intervention: the new approaches in coronary intervention (NACI) registry. *Am Heart J.* 2000; 140(1):162–169.
15. Gillum RF, Liu KC. Coronary heart disease mortality in United States Blacks, 1940–1978: trend and unanswered questions. *Am Heart J.* 1984;108(3, pt 2):728–732.
16. Dwyer EM, Asif M, Ippolito T, et al. Role of hypertension, diabetes, obesity, and race in development of symptomatic myocardial dysfunction in predominantly minority population with normal coronary arteries. *Am Heart J.* 2000;139(2):297–304.
17. Diez-Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. *N Engl J Med.* 2001; 345:99–106.
18. Strong JP, Oalmann MC, Newman WP, et al. Coronary heart disease in young Black and White males in New Orleans: community pathology study. *Am Heart J.* 1984;108(3, pt 2): 747–759.
19. Keil JE, Loadholt B, Wenrich MC, Sandifer SH, Boyle E. Incidence of coronary heart disease in Blacks in Charleston, South Carolina. *Am Heart J.* 1984;108(3, pt 2):779–786.
20. Pavan L, Casiglia E, Pauletto P, et al. Blood pressure, serum cholesterol, and nutritional state in Tanzania and in the Amazon: comparison with an Italian population. *J Hypertens.* 1997;15:1083–1090.
21. Glueck CJ, Gartside P, Laskarzewski PM, Khourys P, Tyroler HA. High-density lipoprotein cholesterol in Blacks and Whites: potential ramifications for coronary heart disease. *Am Heart J.* 1984;108(3, pt 2):815–826.
22. Budoff MJ, Yang TP, Shavelle MR, Lamont DH, Brundage BH. Ethnic differences in coronary atherosclerosis. *J Am Coll Cardiol.* 2002;39:408–412.
23. Asher RC, Topol EJ, Moliterno DJ. Insight into the pathophysiology of atherosclerosis and prognosis in Black Americans with acute coronary syndromes. *Am Heart J.* 1999;138: 1073–1081.
24. *South African Yearbook 2001/02.* Pretoria: Government Printer; 2002.