

Coronary atherosclerosis in Nigeria

A. Olufemi Williams

From Department of Pathology, University of Ibadan,
and University College Hospital, Ibadan, Nigeria

The relative rarity of ischaemic heart disease in the negro is well recognized, but there are very few morphological studies on the quantitative or qualitative aspects of the disease. Of 8,000 necropsies carried out in the University College Hospital, Ibadan, over a 10-year period, there were 10 Nigerians with proven myocardial infarcts. Of these, 4 were on the basis of coronary embolism from endomyocardial fibrosis or bacterial endocarditis. Planimetric assessment of Sudan-stained coronary arteries obtained from 279 hearts from consecutive unselected necropsies of Nigerians over the age of 10 years was carried out. Seventy-one per cent had no demonstrable atherosclerotic lesion, while in the remaining 29 per cent, the right coronary artery was slightly more affected than the left descending or circumflex arteries. The average percentage of intimal surface involvements of right and left coronary arteries was 23 and 21, respectively. Fibrous plaques or complicated lesions were infrequent. Coronary thrombi were not seen, but there was a patient who had left-sided endomyocardial fibrosis with myocardial infarction due to coronary embolism. The severity of atherosclerosis increased with age. Though fatty streaking was not uncommon, particularly in early life, the factors that appear to protect the African, including the Nigerian, from advanced stages of coronary atherosclerosis and ischaemic heart disease are poorly understood, but factors such as exercise, diet influenced by the socio-economic class, and fibrinolytic activity are probably significant.

The relative rarity of coronary artery disease in the negro including the Nigerian is well recognized and the corresponding rarity of ischaemic heart disease has been very well documented (Becker, 1946; Davies, 1948; Edington, 1954; Siew, 1958). There are very few morphological studies on the quantitative or qualitative aspects of this disease in the West African (Goodale *et al.*, 1964; Lee *et al.*, 1964), but information about atherosclerosis in the African is only forthcoming from studies on East and South African Bantus who differ from the West African in their physical and cultural characteristics, dietary habits, and genetic constitution (Walker and Grusin, 1959; Walker, 1963; Higginson and Pepler, 1954; Becker, 1946; Scott *et al.*, 1961; Florentin *et al.*, 1963; Meyer *et al.*, 1964).

The present prospective study primarily describes the extent, severity, and frequency of coronary atherosclerosis in the Nigerian, and compares the findings with other population groups and secondarily describes the frequency of ischaemic heart disease.

The coronary arteries of 279 hearts (159

male, 120 female) were studied from consecutive necropsies of patients over the age of 10 years at the University College Hospital, Ibadan, a general teaching hospital of about 500 beds. The population served by this hospital is partly urban and partly rural, a distinction that is difficult to justify in several parts of Africa. The majority of the patients were from the lower socio-economic strata of the community and belonged to the Yoruba tribe. The necropsy percentage in the hospital during the period of study was about 70.

Subjects and methods

After careful examination of the coronary ostia for occlusion or other lesions, the right and left coronary arteries were dissected off their beds and removed with their branches. For this study, the right coronary artery was from its origin (excluding the ostium) to the margin of the posterior interventricular septum excluding any branches. The left descending coronary artery included the left main coronary artery from its origin (excluding the ostium) and the anterior descending branch and any of its subepicardial branches considered to be large enough to be opened by blunt pointed iris scissors. The arteries were then opened longitudinally to expose their intimal

surfaces and the presence of thrombi or emboli noted. They were rinsed in normal saline for 10 minutes and then fixed in 4 per cent formaldehyde in saline. They were stained with 5 per cent Sudan IV solution, differentiated in at least 2 changes of 80 per cent ethanol, and washed under running tap water. For tracing the outlines of the arteries and their lesions, polythene strips used for storing pathological specimens were used (Williams, 1969). The strips were laid over the arteries, pinned to cork mats, and the tracings obtained were used for planimetry. For quantitation of atherosclerotic lesions, planimetric assessment was employed (Cranston *et al.*, 1964). The outlines of different macroscopical types of atherosclerotic lesions were traced systematically, each type of lesion being represented by a particular symbol so that it could be distinguished. For this study, three types of macroscopical lesions were recognized, namely, fatty streaks, fibrous plaques, and complicated lesions. The fatty streak was a flat or slightly raised intimal lesion that stained distinctly with Sudan IV and did not show any other type of change underlying it. The fibrous plaque was a firm raised intimal lesion which in the fresh stage was pale grey, glistening, and translucent. In cases where it was partially or completely covered by sudanophilic deposits, the area was graded as a fibrous plaque rather than a fatty streak. Complicated lesions included calcification, haemorrhage, and ulceration. Histological examination was carried out on doubtful lesions, but these were infrequent. For topographic analyses, three major segments of the coronary arterial system were considered, namely the main trunk of the left coronary artery and its anterior descending branch, which is referred to as the left descending coronary artery, the circumflex branch of the left coronary artery, and the right coronary artery.

With a rolling wheel planimeter (Allbrit), the entire surface areas of the arteries were measured. The surface areas of the different macroscopical lesions were also measured systematically and recorded as percentages of total intimal surface of the respective coronary segment. To reduce error, all lesions were traversed twice with the planimeter and the readings halved to give the true surface area in cm.² The total surface areas having been obtained, the percentage surface involvement by the different atherosclerotic lesions in the segments of the coronary arteries was calculated. Several sections were taken from different areas of the heart and examined histologically, using paraffin-embedded material and staining routinely with haematoxylin and eosin. Van Gieson's stain was also used when indicated.

Results

The distribution of the 279 subjects, classified by age and sex, is shown in Table 1. Of the 279 patients, 82 (29%) had atherosclerotic lesions while the remaining 197 (71%) had no demonstrable lesion. The causes of death in the 82 patients with coronary atherosclero-

sis are summarized in Table 2. Segmental and topographic analyses in relation to age are presented in Tables 3 and 4. The average percentage of intimal surface involvement in both sexes is summarized in Table 5. The average percentage surface involvement by fatty streaks and fibrous plaques in relation to age is also presented in Table 6.

TABLE 1 Age and sex distribution of 279 Nigerians with and without atherosclerosis

Age in decades	With atherosclerosis		Without atherosclerosis		Total
	Male	Female	Male	Female	
11-20	1	4	11	10	26
21-30	10	9	21	21	61
31-40	8	9	24	33	74
41-50	13	4	23	10	50
51-60	7	4	17	8	36
61-70	8	2	7	2	19
71-80	1	0	1	0	2
81-90	1	0	0	1	2
Unknown	—	1	6	2	9
Total	49	33	110	87	279

TABLE 2 Causes of death in 82 Nigerians with coronary atherosclerosis

Cause of death	No.	Per cent
Heart disease (including hypertension)	22	26.4
Malignant diseases	13	16.1
Cirrhosis of liver	5	6.1
Infection	20	24.5
Diabetes	2	2.4
Miscellaneous	20	24.5
	82	100

TABLE 3 Involvement of coronary arteries in relation to age

Age in decades	One segment involved			Two segments involved			All three segments involved	Total
	LD	LC	R	LD and LC	LC and R	LD and R		
11-20	1	—	2	—	—	—	1	4
21-30	9	—	1	—	—	3	5	18
31-40	6	—	3	1	—	5	3	18
41-50	2	—	1	3	—	3	8	17
51-60	3	—	—	1	—	1	7	12
61-70	—	—	—	2	1	3	4	9
71-80	1	—	—	—	—	—	—	1
81-90	—	—	—	—	—	1	—	1
Total	22	—	7	7	1	16	29	82

LD, left anterior descending branch; LC, left circumflex branch; R, right coronary artery.

TABLE 4 Average extent of coronary surface involvement of atherosclerosis

Age in decades	Per cent LCA	Per cent RCA	Per cent average
11-20	17.9	29.6	23.4
21-30	13.9	14.4	14.2
31-40	10.9	13.9	15.5
41-50	27.1	24.4	25.7
51-60	27.8	39.7	33.7
61-70	25.4	37.8	31.6
71-80	50.5	0	25.3
81-90	30.3	7.3	18.8

LCA, left coronary artery (anterior descending circumflex); RCA, right coronary artery.

Discussion

The method of planimetric assessment of atherosclerosis was preferred because it had been found that reproducibility of results was much better than visual estimates (Strong and Eggen, 1965; Williams, 1969). Another advantage of planimetry was that it provided relatively accurate qualitative and quantitative records of disease severity, and furthermore the tracings were permanent and could be used for comparative studies.

In a preliminary study of coronary arteries in early life in Nigerians, no lesion was observed in patients under the age of 10 years. This group of patients was therefore excluded from the present study. The relative paucity of subjects in the fifth decade upwards was not as a result of selection but a reflection of the African population structure or hospital admissions (Table 1). It is noteworthy that about one-third and one-half of all the patients in the fifth and sixth decades, respectively, had detectable coronary artery disease (Tables 1 and 2). This is in keeping with the observation that atherosclerosis increases with age. The ratio of affected to healthy arteries (1:2.5) is of interest, as it indicates, though crudely, the relative ratio frequency of coronary atherosclerosis in this series. This paper considers two major classes of mural atherosclerosis: fatty streaks and raised lesions. The

TABLE 6 Average per cent of intimal surface involved with fatty streaks and raised lesions in coronary arteries of 82 Nigerians at necropsy

Age in decades	Fatty streaks (%)	Raised lesions (%)
11-20	22.9	0
21-30	15.1	0
31-40	15.3	4.6
41-50	17.3	3.5
51-60	37.7	0.9
61-70	27.9	4.6
71-80	25.2	0
81-90	18.8	0

latter includes fibrous plaques, calcified lesions, and lesions complicated by haemorrhage, ulceration, or thrombosis. Raised lesions evidently indicate a relatively advanced stage of atherosclerosis. The present study reveals that there is a steep rise in the amount of fatty streaking during the 11-20 year age-group. This is followed by a fall in the second, third, and fourth decades, and a rise in the fifth and sixth decades. There is considerable disparity between the amount of

FIG. 1 Average percentage of intimal surface involvement of coronary arteries by fatty streaks and raised lesions. Note the disparity in the extent of fatty streaks and fibrous plaques.

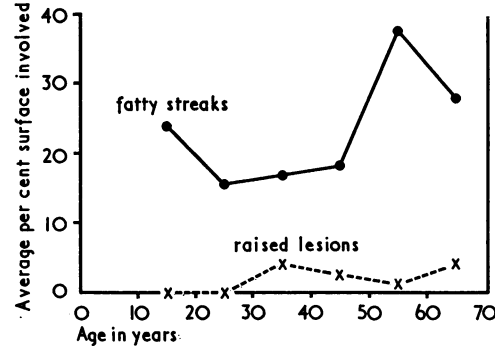


TABLE 5 Average per cent intimal surface involvement in 82 Nigerians with atherosclerosis of coronary arteries

Left descending (%)			Left circumflex (%)			Right (%)			Total area involved (%)	
Fatty streaks	Fibrous plaques	Complicated lesions	Fatty streaks	Fibrous plaques	Complicated lesions	Fatty streaks	Fibrous plaques	Complicated lesions	Left ant. desc. and circumfl. artery	Right coron. artery
19.1	1.03	1.1	16.1	0.2	0.6	21.7	1.4	0.3	20.6	23.2

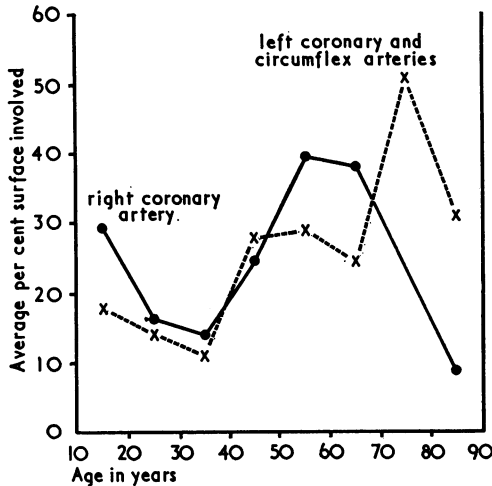
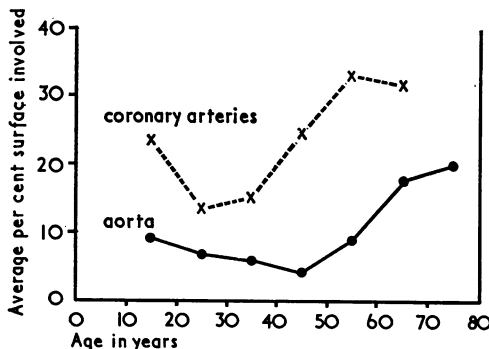


FIG. 2 *Average percentage of surface involvement of right and left coronary arteries by atherosclerosis in Nigerians. Note the slight increase of involvement of the right coronary in the fifth and sixth decades.*

fatty streaking and raised lesions (Fig. 1). Fibrous plaques are not observed in the first two decades of life, and the severity is insignificant in later life as the average surface area involved is less than 5 per cent of the total coronary artery surface (Fig. 1). This raises the question of the interrelation of fatty streaks and fibrous plaques. When fatty streaks and raised lesions are considered together, the total areas involved in the left coronary artery with its circumflex branch

FIG. 3 *Average percentage of intimal surface involvement of aorta and coronary arteries by fatty streaks and raised lesions in both sexes. Note the initial rise of atherosclerosis, mainly fatty streaks, in early life (525 aortas, 279 coronary arteries).*



and the right coronary artery are 20.6 per cent and 23.2 per cent respectively (Table 5). The right coronary artery does not appear to be more involved with atherosclerosis than the left except in the fifth and sixth decades (Fig. 2), but this is not statistically significant. The relative paucity of fibrous plaques and complicated lesions in all the arteries is highly significant as it explains the relatively low incidence of the complications of coronary atherosclerosis in the Nigerian (Fig. 1).

The steep rise of fatty streaks observed in early life in the coronary arteries has also been observed in the aortas of Nigerians (Fig. 3) (Williams, 1969), New Orleans Negroes and South African Bantus (McGill, 1968). There is, however, some correlation between the rate of fatty deposition in the coronary arteries and aorta of Nigerians (Fig. 3).

The most common single coronary segment to be involved is the left anterior descending coronary artery. It is about three times as frequently affected as the right coronary artery. Except in one patient where the left circumflex artery is involved in conjunction with the right coronary artery (Table 3), it is invariably involved with the left descending coronary artery. In fact, there is not a single instance in which the circumflex artery alone is involved. It is, however, not uncommon for all three segments to be involved as seen in about one-third of all our patients (Table 3).

The causes of death in the 82 patients with atherosclerotic lesions revealed that about one-quarter of all the patients had cardiac diseases including hypertension. Apart from hypertensive cardiomegaly, other cardiac conditions observed were rheumatism, bacterial endocarditis, and endomyocardial fibrosis. There was only one case of acute myocardial infarction in the whole series. This was due to coronary embolism from mural thrombosis in a heart with left ventricular endomyocardial fibrosis (Fig. 4). Of 8,000 necropsies carried out in the University College Hospital over a 10-year period, there were 10 Nigerians with proven myocardial infarcts. Some of these were on the bases of endomyocardial fibrosis or infective endocarditis. The present study confirms previous observations that coronary atherosclerosis and coronary heart disease are relatively rare in the negro or in peoples inhabiting developing countries (Richir and Quenum, 1961; Murthy, Dutta, and Ramalingaswami, 1963; Lee *et al.*, 1962; Thomas *et al.*, 1960).

In a previous study cerebral atherosclerosis was found to be less severe in the Nigerian when compared with other population groups (Williams, Resch, and Loewenson, 1969), and

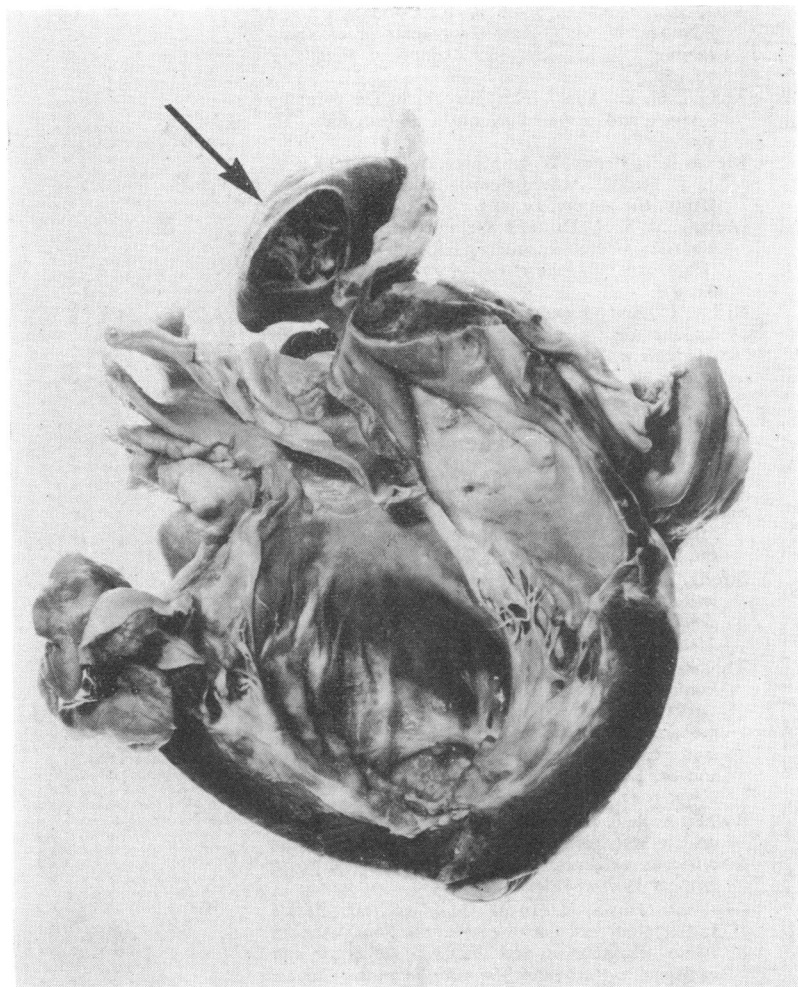


FIG. 4 Heart with left ventricular endomyocardial fibrosis. Note the thickened fibrous tissue occupying the apex and outflow tract of the left ventricle. The interventricular septum, which is dark, is the seat of recent infarction. This is due to a coronary embolus. The left atrial appendage is filled with an antemortem thrombus (arrow). There is also a small aneurysm at the apex of the left ventricle.

raised lesions in the aorta were also relatively low in the Nigerian (Williams, 1969). It can therefore be concluded that atherosclerosis of the aorta, coronary, and cerebral arteries is less severe in the Nigerian than in certain Caucasian groups living in highly developed and industrialized countries. The relatively extensive coronary and aortic fatty streaking in the Nigerian duplicates what has been observed in other Negro groups from New Orleans, Jamaica, Puerto Rico, Sao Paulo, and Durban (McGill, 1968). Furthermore, the tendency to develop a minimal degree of raised lesions is noteworthy, particularly when it is compared with non-negro populations. It appears that the negro, including the Nigerian,

is more susceptible to deposition of lipid in the arterial intima in early life, but the lipid does not predispose to the advanced lesions of atherosclerosis. The negro populations with extensive coronary lipid deposition are worthy of further studies, as they offer a unique opportunity to relate environment, lipid metabolism, diet, fibrinolytic activity, and other characteristics to the formation of fatty streaks. Failure to convert fatty streaks to fibrous plaques, or the relative paucity of fibrous plaques and complicated lesions in the Nigerian explains the relative rarity of coronary heart disease. This finding also offers an opportunity to elucidate the problem of coronary atherosclerosis and ischaemic heart

disease in general before the community becomes industrialized and subsequently affluent. If this study is carried out again several years after industrialization and the standard of living has improved, it is likely that the severity and extent of the disease will not be as low as it is now.

The author wishes to thank Messrs. Owolabi and Osotimehin for their technical assistance.

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