

ARCUS SENILIS CORNEAE—ITS RELATIONSHIP TO SERUM LIPIDS IN THE SOUTH AFRICAN BANTU*

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Arcus senilis is the name given to the corneal fatty ring, which, when fully developed, forms a complete white circle around the cornea, separated from the limbus by a clear zone. It is believed to be benign, and is not usually noticed by the patient. The adjective, senilis, denotes that it is largely a sign of old age.

In 1901, Takayasu¹ showed that the arcus was an accumulation of fat in the corneal tissue, and in 1911 it was shown that elderly patients with arcus senilis had a high blood cholesterol content.² Typical arcus can be produced in rabbits fed with oil and cholesterol—the lesion recedes when the fatty diet is abandoned.³ The pathological changes in the arcus in humans and those induced in rabbits are similar. In both, fatty infiltration of the corneal parenchyma occurs, consisting mostly of neutral fat, cholesterol, phospholipids and doubly refracting crystals. Two recent reports emphasize the lipid nature of the corneal deposits, identifying the components of the arcus as probably a cholesterol derivative with some associated phospholipid and glyceride, and that it is not dependent on degenerative changes in the cornea.^{4,5}

Disturbed fat metabolism has been commented on in young persons with arcus, and, conversely, in young persons with disturbed fat metabolism a greater incidence of arcus has been noted. Forsius summarizes his investigation as follows: 'arcus in young persons is associated with extensive lipidochemical alterations in the serum; while arcus in elderly persons is not dependent upon disturbed fat metabolism as a rule—local senile changes predominating here'.⁶ Similar findings were reported by Boas *et al.*⁷ and Finley *et al.*⁸ The arcus, or fatty ring, may thus represent fatty infiltration or deposition from the serum, similar to that which may occur in coronary artery disease, since arcus cornea has been found to be associated with a raised incidence of atherosclerosis,⁹ and to have a significantly increased incidence in younger men with myocardial infarction,¹⁰ although this latter observation has not been confirmed by others.¹¹

Arcus corneae is a phenomenon frequently observed in the White (Caucasian) population, particularly in the older age-groups.¹² The arcus phenomenon in relatively

young people is a frequent accompaniment of hypercholesterolaemia but may develop in people, e.g. the Eskimos, in whom no chemical defect in the plasma can be demonstrated.¹³ In North America, the incidence among Negroes is higher than among the White population.¹⁴ Arcus appears to be a great deal commoner among the Bantu in South Africa than among the Whites, and is particularly frequent among the younger age-groups.† We did not undertake a survey of the prevalence of arcus for purposes of this paper.

In the South African Bantu coronary artery disease is extremely rare,^{15,16} yet, as mentioned above, arcus senilis appears to be a great deal commoner than among the White population groups. Davidson and Kolbe found no association between arcus senilis and serum cholesterol levels in Africans in Zambia.¹⁷ In view of the conflicting opinions regarding the relationship of arcus senilis with lipid disturbances and/or coronary artery disease, we decided to study the lipid pattern in the serum of South African Bantu subjects with arcus senilis, and to compare the lipid levels with those found in the urbanized Bantu in an unselected population group.^{18,19} It must be pointed out, however, that in these latter studies some of the subjects may have had arcus senilis, as it was not specifically looked for or excluded.

MATERIAL AND METHODS

One hundred and twenty-nine Bantu subjects, both inpatients and outpatients at Edenvale Hospital, were investigated. These subjects were attending for various clinical conditions, not obviously associated with arcus senilis or with disorders of lipid metabolism. They were grouped according to age as shown in Table I.

TABLE I. OUTPATIENTS GROUP

Age (years)	Males	Females
21 - 30	9	5
31 - 40	7	13
41 - 50	16	28
51 - 60	13	15
Over 60	12	11
Total	57	72

*Date received: 19 December 1968.

†Personal observations (D.B.).

All, except one patient aged 56 years, were normotensive. One patient, aged 50 years, had bilateral cataracts extracted in 1958, and one aged 25 years had a left corneal opacity with bilateral arcus.

We originally classified arcus as follows:

Mild to moderate arcus: A faint to moderate translucent circular zone in the periphery of the cornea, not necessarily involving the entire circle of the cornea, and with a ring of clear cornea between arcus and limbus.

Marked arcus: A dense, white ring, almost complete, with no clear cornea between ring and limbus, and in which the entire circle of cornea was usually involved.

In the early part of the study we differentiated mild from marked arcus, but we subsequently found no significant differences in the results and so all the results were grouped together.

Investigations

Venous blood was drawn from each subject after an overnight, 12-hour fast. The naked-eye appearance of the serum was clear in all subjects. In the case of the unselected control group, the majority of subjects were blood donors or members of the institute staff and known to be in good health. The triglyceride levels in the control group were determined only on male mineworkers who underwent a careful physical examination and were clinically normal. It was not possible to obtain blood specimens from these volunteers before breakfast and after an overnight, 12-hour fast. The Bantu mineworkers had a light breakfast before starting an 8-hour shift underground without any food intake during the shift, except in some cases, where a midday drink of Bantu

beer was taken. All specimens of blood were drawn immediately after the day's shift had been completed and before the subjects had consumed any food. The naked-eye appearance of the serum in all subjects in the control group was clear.

The following biochemical tests were carried out: cholesterol, phospholipids, triglycerides, beta-lipoprotein cholesterol and, in the arcus group, the beta-lipoprotein precipitin test.

The following techniques were used:

Cholesterol was estimated by the method of Sperry and Webb,²⁰ and phospholipids according to the method of Fiske and Subbarow.²¹

Triglycerides were estimated by a modification of the method of Van Handel and Zilversmit, using activated silicic acid and isopropyl ether.²²

The beta-cholesterol was precipitated with calcium chloride in the presence of heparin by the method of Burstein and Samaille,²³ and the cholesterol in the precipitate was estimated by the technique of Pearson *et al.*²⁴

The beta-lipoprotein precipitin test was estimated using the Hyland Beta-L test kit.

Total lipid levels were calculated as follows: Total lipids = phospholipid + total cholesterol + fatty acids of cholesterol esters + triglycerides.

RESULTS

Tables II and III depict lipid levels in a group of 129 South African Bantu male and female subjects with arcus senilis corneae, and in an unselected group of 159 urbanized South African Bantu male and female subjects living on the Witwatersrand, respectively.

The incidence of raised lipid levels in the arcus senilis group is shown in Table IV.

TABLE II. LIPID LEVELS IN SOUTH AFRICAN BANTU SUBJECTS WITH ARCUS SENILIS CORNEAE

Investigations	20-30 yrs	31-40 yrs	41-50 yrs	51-60 yrs	61-70+ yrs
Total lipids (mg./100 ml.)	528±114	568±133	573±152	528±169	524±140
Phospholipids (mg./100 ml.)	215±42	223±44	212±44	205±57	201±46
Cholesterol (mg./100 ml.)	166±43	179±47	164±42	156±52	152±41
C/P ratio	0.77±0.11	0.80±0.09	0.76±0.08	0.74±0.12	0.76±0.10
Triglycerides (mg./100 ml.)	75±53	90±41	120±82	101±64	95±60
Beta-cholesterol %	65±9	68±10	65±7	66±7	63±7
Beta-cholesterol (mg./100 ml.)	109±38	125±44	106±39	102±48	97±34
Beta-precipitin (mm.)	2.6±0.5	2.7±0.7	2.6±0.6	2.5±0.6	2.5±0.6
No. of subjects: Males	9	7	16	13	12
Females	5	13	28	15	11
Total	14	20	44	28	23

Total subjects studied: 129 (57 males:72 females).

TABLE III. LIPID LEVELS IN NORMAL SOUTH AFRICAN BANTU SUBJECTS

Investigations	20-30 yrs	31-40 yrs	41-50 yrs	51-60 yrs	61-70 yrs
Total lipids (mg./100 ml.)	509±131	567±106	599±117	592±123	547±154
Phospholipids (mg./100 ml.)	190±45	234±39	235±78	243±43	240±49
Cholesterol (mg./100 ml.)	153±23	152±29	163±34	172±35	158±18
C/P ratio	0.72±0.04	0.66±0.04	0.71±0.04	0.72±0.09	0.66±0.10
Triglycerides (mg./100 ml.)	80±19	73±17	66±17	68±11	—
Beta-cholesterol %	65±13	68±12	69±11	69±10	68±6
Beta-cholesterol (mg./100 ml.)	89±26	105±14	114±28	120±22	101±41
No. of subjects: Males	15	17	20	15	14
Females	22	13	17	20	6
Total	37	30	37	35	20

Total subjects studied: 159 (81 males:78 females).

TABLE IV. INCIDENCE OF RAISED LIPID LEVELS IN THE ARCUS SENILIS CORNEAE GROUP

Investigations	Total No. of subjects	Males	Females	Percentage showing raised lipid levels
Total lipids (mg./100 ml.)	48 M 70 F	4	4	7
Phospholipids (mg./100 ml.)	56 M 70 F	0	0	0
Cholesterol (mg./100 ml.)	57 M 71 F	4	10	11
C/P ratio	56 M 70 F	1	1	2
Triglycerides (mg./100 ml.)	56 M 72 F	15	24	30
Beta-cholesterol %	55 M 72 F	7	4	9
Beta-cholesterol (mg./100 ml.)	55 M 72 F	3	11	11

TABLE V. SERUM TRIGLYCERIDE LEVELS IN THE ARCUS SENILIS CORNEAE GROUP

Age (years)	Total No. of subjects	Subjects with raised levels	Subjects with normal levels	Mean levels in group with raised levels (mg./100 ml.)	Mean levels in group with normal levels (mg./100 ml.)
21-30	14	2 M 0 F	7 M 5 F	179 ± 23	58 ± 32
31-40	19	2 M 5 F	4 M 8 F	136 ± 18	62 ± 26
41-50	44	7 M 10 F	9 M 18 F	198 ± 73	69 ± 30
51-60	28	3 M 4 F	10 M 11 F	181 ± 77	74 ± 23
61-70+	23	1 M 5 F	11 M 6 F	179 ± 45	65 ± 28
Total	128	15 M 24 F	41 M 48 F	181 ± 64	67 ± 28

Table V is an analysis of the triglyceride levels in the arcus senilis group and shows that 89 subjects (70%) had normal levels (mean 67 ± 28 mg./100 ml.), while 39 subjects (30%) had elevated levels (mean 181 ± 64 mg./100 ml.).

COMMENTS AND DISCUSSION

Analysis of the lipid levels (except triglyceride levels) in the arcus senilis corneae group when compared with the values previously obtained by us in a group of normal Bantu subjects (male and female) showed no marked statistical differences. The levels obtained in the arcus group show no significant age or sex trends and confirm our previous observations that in the Bantu, unlike the Whites, no significant increase in lipid levels occurs after the age of 10 years, and that the Bantu could be considered to be a homogenous group.¹⁰ When we compare the triglyceride levels in the arcus group with those in the control group, the striking feature is the marked differences in the standard deviations in the two groups, despite the fact that the mean levels are not significantly different. This suggests that the arcus group is not homogenous and consists of two population samples, one sample representing true normals and showing a mean level not significantly different from the normal Bantu population, and a second sample representing subjects with a higher mean level. This is borne out by our study. Whereas 70% of the arcus group showed normal triglyceride levels, 30% had raised values (27% in the male

group and 33% in the female group). The elevated triglyceride levels were unrelated to the age or sex of the subjects.

In the case of the other lipid parameters studied, the percentages of increased lipid levels in the arcus group, when compared with the normal group, were as follows: Total lipids 7%, total cholesterol 11%, beta-cholesterol percentage and absolute beta-cholesterol levels 9% and 10% respectively, cholesterol phospholipid ratio 2%; and all the phospholipid levels were within the range of normality.

Contrary to previous studies predominantly in White population groups, no significant differences were observed in the serum lipid levels in the majority of South African Bantu subjects with arcus senilis corneae, except that a higher percentage showed increased triglyceride levels.

In view of the low prevalence of ischaemic heart disease and the frequency with which arcus senilis is found in the South African Bantu, it seems apparent that there is no relationship between atherosclerosis, ischaemic heart disease and arcus senilis in the South African Bantu.

The fact that this condition is frequently found in young Bantu subjects suggests that it is unrelated to the ageing process and that the term arcus senilis is an unsatisfactory one.

SUMMARY

Lipid levels in 129 South African Bantu subjects with arcus senilis corneae were compared with a group of 159 South African Bantu subjects living on the Witwatersrand. No significant differences were observed in the two groups for total lipids, cholesterol, phospholipid, cholesterol phospholipid ratio and beta-cholesterol.

Although the mean triglyceride levels were comparable in the two groups, the standard deviation in the arcus group was considerably higher. This suggested that the arcus group was not a homogenous one.

There does not appear to be a relationship between atherosclerosis, coronary artery disease and arcus senilis corneae in the South African Bantu.

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