THE CORONARY ARTERIES OF THE BANTU HEART*

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Death due to coronary thrombosis among the Bantu-speaking South African negroids—apparently of Negro-Hamitic origin and commonly referred to as 'the Bantu'—is rare.[1] Angina pectoris and myocardial infarction due to coronary thrombosis are rare diseases in the Bantu.[2] Furthermore, at autopsy, the mild degree of coronary atherosclerosis is a striking feature. Since the publication of Brink's preliminary report[3] in 1949 on the coronary artery pattern in the adult Bantu, the above facts have, at times, been attributed to a racial morphological difference in the coronary artery distribution, thus implying a functional distinction. However, Elliott[2] stated, without elaborating on his contention, that the peculiarity of the arterial pattern had 'probably little if any bearing on the low incidence of coronary artery disease syndromes in the South African Bantu'.

Brink[3] listed the distinctive features of the Bantu pattern, based on the radiographic appearance of the injected coronary vessels of 17 European, 15 Bantu, and 1 Coloured hearts, as:

(1) The presence of a 'third primary division' of the left coronary artery.
(2) A high-terminating anterior-descending branch of the left coronary artery.
(3) Right coronary 'preponderance'.

As a member of a team† who surveyed coronary thrombosis and atheroma, my attention was drawn to the possibility that Brink's conclusions may constitute a racial or genetic factor influencing our data. It was therefore decided to check Brink's data and conclusions. Although the purpose of this paper is mainly to consider and discuss Brink's conclusions in the light of new data, other observations which have been encountered will also be presented.

MATERIAL

All available hearts of cadavers from the dissecting-room of the University of Cape Town were collected, and autopsy specimens have been obtained from the Pathology Department of the University of Cape Town and the South African

* A preliminary report was read at the South African Medical Congress in Pretoria in 1955. A modified form of this paper was read before the Anatomical Society of Great Britain and Ireland in London in September 1957, and abstracted in the *Journal of Anatomy* (London) (**92** (part 4), 634) of October 1958.

† Organized by Prof. J. F. Brock and Dr. B. Bronte-Stewart, of the Department of Medicine, University of Cape Town, and the Council for Scientific and Industrial Research—University of Cape Town Clinical Nutrition Research Unit.

Police Morgue, Cape Town. Ten hearts were also received from the Police Morgue, Nairobi. A total of 278 hearts from 86 European South Africans, 109 Cape Coloured‡ and 83 Bantu subjects were carefully dissected. In the present paper the left coronary artery (A. coronaria sinistra) and its branches will be chiefly considered.

OBSERVATIONS

The observations are mainly concerned with Brink's 'third primary division of the left coronary artery'. This terminology was originated by Brink,[3] who otherwise followed Spalteholz's classification,[4] which is neither satisfactory nor in current usage. The terminology used below is in accordance with the *Nomina Anatomica* accepted by the Sixth International Congress of Anatomists, 1955.

Variations in the coronary arteries and their branches have been recorded previously by Campbell,[5] but while most investigators have studied the anastomoses and the variations of the origins of the right and left coronary arteries from the aorta, little attention has been paid to the incidence of the variations of the branches of the major divisions of the coronary arteries. Gross[6] briefly comments on such variations, and his description is generally in accordance with my observations (*vide infra*). Schlesinger[7] stated that all investigators of the coronary artery tree find that its pattern is distinctly inconsistent.

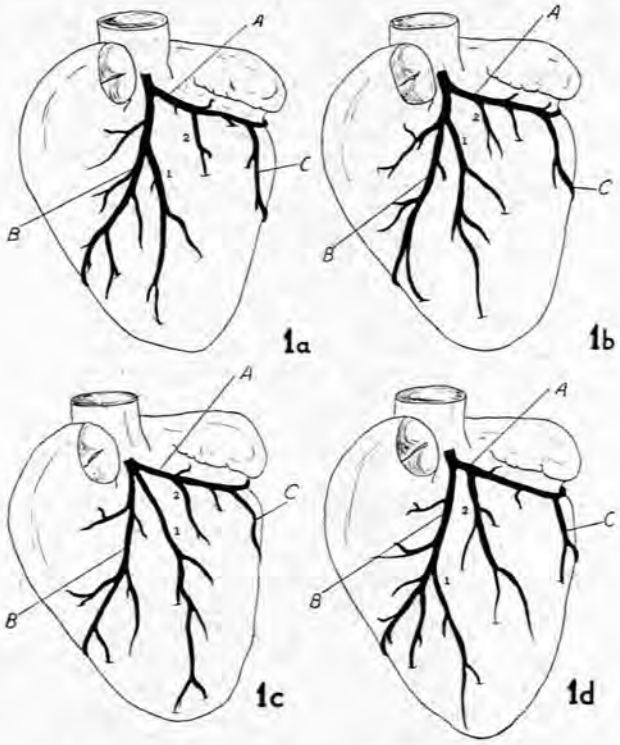

Fig. 1. Schematic representation of the variations of the major left ventricular artery. *Figs.* 1*a*, *b* indicate the commonest sites of origin. In *Fig.* 1*c* the major LVA arises at the bifurcation, while in *Fig.* 1d it arises low down and the minor LVA takes over the distribution of most of the anterior wall of the left ventricle.
A—ramus circumflexus; B—ramus interventricularis anterior; C—left marginal artery; 1—major LVA; 2—minor LVA.

‡ The Cape Coloured people are a local 'hybrid' population whose basic ancestry is composed of White Caucasoids, Hottentots and Malays, while a minimal Bantu element may also be considered to have contributed to their genotypes. It has only taken about 250 years for this group to 'evolve'.

About 1-2 cm. beyond its origin from the aorta, the A. coronaria sinistra usually divides into its 2 primary trunks—the ramus circumflexus and the ramus interventricularis anterior (following the nomenclature of the *Nomina Anatomica*, p. 32). The ramus circumflexus (usually referred to as 'the parent trunk of the left coronary artery', *vide infra*) turns to the left in the atrioventricular groove, wherein it passes backwards round the left margin of the heart in company with the coronary sinus as far as the posterior interventricular sulcus, where it finally reaches, or partially anastomoses, with the right coronary artery. The ramus interventricularis anterior descends in the anterior interventricular sulcus to the incisura cordis. This is the 'anterior descending' branch of Spalteholz referred to by Brink. This ramus in turn gives off a number of branches to the ventricular walls on each side of the anterior interventricular sulcus: these have occasionally been called 'marginal branches'. Commonly, a large unnamed 'marginal' branch is given off by the ramus interventricularis anterior a short distance below its origin. This vessel, which courses towards the apex of the heart, has a number of small branches; I shall designate it the *major left ventricular artery* (abbreviated—major LVA). Spalteholz[4] called it the 'primary anterior descending', while the continuation of the ramus interventricularis anterior below the origin of the major LVA he named the 'secondary anterior descending'. The 'primary anterior descending' branch plus the short trunk above it were included in the term 'anterior descending branch'. This terminology, however, is very confusing.

The major LVA is extremely variable in its origin (*Fig.* 1a-c) and it commonly (Table I) arises at the site of bifurcation of the 2 primary trunks (*Figs.* 3A, 3B; *Fig.* 1c); when it arises here it has been called the 'third primary division' by Brink. The area supplied by the major LVA may also often receive another vessel, which arises from the ramus circumflexus at a varying distance from its origin at the bifurcation of the left coronary artery. This branch of the ramus circumflexus, which I designate the *minor left ventricular artery* (minor LVA), is a rather constant branch arising proximal to another large branch, which has been called the 'left marginal artery' by Wood Jones[8] and others. I have not been able to trace who first used this term. In this series it is observed that the minor LVA may supplement the major left ventricular artery or may replace it in supplying the anterior surface of the left ventricle. The origin of the minor LVA also varies considerably (Table III) and, commonly, it too may arise from the left coronary where it bifurcates into its two primary divisions (*Fig.* 3B). This explains some of Brink's cases of 'third primary division'. These variations are not surprising because these arteries are merely enlarged vasa vasorum developed to fulfil the needs of the heart musculature.

Of the 278 specimens examined, only 91 exhibited the 'third primary division' (3 PD). The 'race' and sex distribution are summarized in Table I. It is clearly indicated in

TABLE I. DIFFERENCES BETWEEN THE 3 RACIAL GROUPS

		Third Primary Division				% Present in total (Male and Female)	Female/Male Ratio	
		Absent	%	Present	%		Present	Absent
White (South Africans) (86)	Female	20	61	13	39			
	Male	36	68	17	32	35	·7	·6
Cape Coloured (109)	Female	25	69	11	31			
	Male	51	70	22	30	30	·5	·5
Bantu (Africans) (83)	Female	10	56	8	44			
	Male	45	69	20	31	34	·4	·2

Table I that there is no significant difference between the 3 racial groups as far as the presence of the 'third primary division' of the left coronary artery is concerned. Moreover, there is also no significant sex variation. The Bantu female series is really too small to be expressed as a percentage, but even here the 3 PD is usually absent. The sex ratio in the Bantu is not representative because of the small number of females compared with the large number of males in the series. Consequently Brink's conclusions, based upon a very small series, may no longer be considered valid.

The proof of the view that the 3 PD is merely a variation of the major or minor left ventricular artery is furnished by the following data: When the 3 PD was present it 'replaced' either the major or minor LVA as shown in Table II. In only one case were both (represented as small branches) present in addition to the 3 PD.

Since there is no necessity to break the data down to sex and race distribution, it can be observed that in 44 cases (out of 82) the minor LVA arose at the bifurcation of the left coronary artery and in 35 cases the major LVA arose at the bifurcation. In 2 cases a large vessel arising at the bifurcation supplied the area of the left ventricular wall usually subserved by both the major and minor left ventricular arteries.

TABLE II. REPLACEMENTS OF THE 'THIRD PRIMARY DIVISION'

		Replaces major LVA	Replaces minor LVA	Replaces both	Both present
White (South Africans) (30)	Female	7	6	1	
	Male	8	8		
Cape Coloured (28)	Female	4	6		
	Male	8	10		
Bantu (Africans) (24)	Female	5	2		
	Male	3	12	1	1
Total 82		35	44	2	1

In order to verify the different origins of the major and minor left ventricular arteries, an analysis was made later of those hearts in which the observations could still be determined. It was noted whether each artery arose: (*a*) within 1 cm. of the bifurcation of the left coronary artery, (*b*) 1-2 cm. from the bifurcation, and (*c*) beyond 2 cm. from the bifurcation. The results are indicated in Table III. Thus, of 173 instances of the minor left ventricular artery, 151 arose within 1 cm. of the bifurcation of the left coronary artery, while 20 arose between 1 and 2 cm. away and 2 cases were beyond 2 cm. from the bifurcation. In 167 cases with a major LVA, 82 arose within 1 cm. of the bifurcation, 55 were 1-2 cm. away and 30 were beyond 2 cm. Because of occasional tortuosity of the formalinized vessels and because measurements could not be exact, (*a*) and (*b*) should be considered together.

TABLE III. THE VARYING ORIGIN OF THE MAJOR AND MINOR LEFT VENTRICULAR ARTERIES

	White	Coloured	Bantu
Minor left ventricular artery			
a (<1 cm.)	48	55	48
b (1-2 cm.)	8	8	4
c (>2 cm.)	1	1	0
Major left ventricular artery			
a (<1 cm.)	31	25	26
b (1-2 cm.)	16	25	14
c (>2 cm.)	11	17	2

It was also possible to analyse 117 specimens for the combinations of the positions of origin of the major and the minor LV arteries. For simplicity, the major LVA is designated as 1 and the minor artery as 2:

1 (*a*)+2 (*a*), 48 cases
1 (*a*)+2 (*b*), 36 cases
1 (*a*)+2 (*c*), 20 cases
1 (*b*)+2 (*a*), 4 cases
1 (*b*)+2 (*b*), 4 cases
1 (*b*)+2 (*c*), 3 cases
1 (*c*)+2 (*a*), 1 case
1 (*c*)+2 (*b*), 1 case

When both vessels occurred in the same specimen, they both arose near the bifurcation of the left coronary artery. It was noted that occasionally 2 vessels arose at the same site in the case of the minor LVA. When the major and minor branches were small and supplied less than half of the anterior surface of the left ventricular surface, then the anterior interventricular artery gave off a number of branches which coursed in the direction of the apex to supply the rest of the anterior surface.

DISCUSSION

Each of Brink's criteria will be considered and in turn elaborated.

1. *The Third Primary Division of the Left Coronary Artery*

The new data clearly indicate that the variation in the supply of the left ventricular wall described by Brink is an individual one and not a racial one, appearing as frequently

in Europeans and Coloured people as in the Bantu, irrespective of sex. The 'third primary division' is merely a variation of the major or minor left ventricular artery.

2. *High Terminating Anterior Descending Branch of the Left Coronary Artery*

In this regard Brink does not define metrically what is meant by 'normal', 'high' or 'low' termination. However, this 'high terminating anterior descending branch' is only an occasional reflection of the presence of his so-called 'third primary division'. In many of those cases (in each racial group) where the anterior surface of the heart is supplied by a large minor LVA, arising either at the bifurcation of the left coronary or from the ramus circumflexus, the major LVA is small or short. This constitutes the majority of Brink's cases of 'high terminating anterior descending branch'. This, again, is purely an individual variation. There is no constant correlation between the origin of a major or minor LVA at the bifurcation and the distance travelled by the anterior interventricular artery.

3. *Right Coronary Preponderance*

Schlesinger[7] discussed the application of right coronary preponderance to the incidence of coronary artery thrombosis. Brink stated that 'the *great majority* (my italics) of Bantu hearts so far studied have been shown to belong to the right coronary pattern'. As he only studied 15 specimens this is an invalid generalization. Schlesinger meant that the right coronary artery also supplies part of the left ventricular wall posteriorly in the region of the interventricular septum. However, Adachi[9] found no racial variation in the ratio of right and left coronary arterial distribution in this area in large samples from 4 races, though 3 types of individual variation were noted. In all 4 races right ventricular preponderance occurred in 68% (mean) of cases. Campbell[5] analysed the distribution of the coronary arteries in this region in 50 White hearts. He described 5 main types of distribution, wherein the right coronary artery 'preponderates' in 74% of cases. In his series of 15 Bantu hearts, Brink found 11 (i.e. 73%) exhibiting this feature. Thus there is no cause for his claim that right artery preponderance is a particular feature of the South African Bantu negroids.

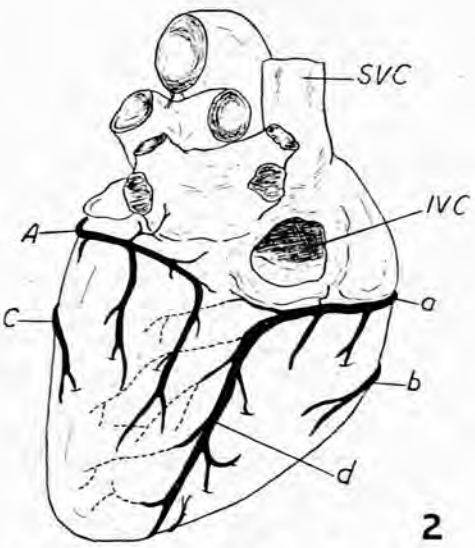

Fig. 2. Diagram illustrating arteries of heart, viewed from below. In cases of 'right coronary preponderance', the ramus interventricularis posterior of the right coronary artery sends large ramifying branches (indicated by stippled lines) across the interventricular sulcus to supply the wall of the left ventricle, replacing the terminal branches of the ramus circumflexus of the left coronary artery.
A—ramus circumflexus; C—a branch of the left marginal artery; a—right coronary artery; b—a branch of the right marginal artery; d—ramus interventricularis posterior of the right coronary artery.

FURTHER NOTES ON TERMINOLOGY

The anatomical information on coronary arteries in the literature is sparse and the terminology is most variable. It has been indicated that Spalteholz's classification[4] is confusing. The majority of modern text-books (Aitken *et al.*,[10] Last,[11] Yoffey,[12] Wood Jones,[8] Grant and Brash,[16] and Johnston and Whillis[14]) describe the left coronary artery as arising from the left posterior aortic sinus, passing to the left and then forwards between the root of the pulmonary trunk and the auricle of the left atrium to the upper end of the anterior interventricular groove. Here it gives off an interventricular branch (called 'the anterior interventricular artery' by Wood Jones[8]), and the left coronary artery then passes round the left surface of the heart, in the left part of the atrioventricular groove, where it comes into relation with the coronary sinus and ends by anastomosing with the right coronary artery. In *An Atlas of Anatomy* by Grant,[13] Fig. 409 illustrates the left coronary artery dividing at the top of the interventricular groove into a circumflex branch and an 'interventricular (anterior descending) branch'. This division is also shown by Woerdeman[15] in Fig. 289. Of all the above text-books, only Wood Jones[8] and Aitken *et al.*[10] mention a 'left marginal branch', while in Gray's *Anatomy* (30th edition, p. 713) in Fig. 692 a large unnamed branch, larger than the parent trunk of the left coronary artery from which it arises, is figured in the position of this 'left marginal artery'. Grant and Brash[16] also indicate the left marginal artery in Figs. 1,057 and 1,058, as does Woerdeman[15] in Fig. 289. This 'left marginal artery' cannot be the same as the minor LVA because when the minor LVA is present a large branch is usually seen to run along the left margin of the heart (as seen from the front) towards the apex (Figs. 3 and 4). Usually, when this branch is very large, the ramus circumflexus is seen to continue as a small or minute vessel in the atrioventricular groove.

Last[11] states that the parent trunk of the left coronary is generally called the 'circumflex branch of the left coronary artery' by clinicians. Although many of the modern text-books have adopted this description, it is strange that the *Nomina Anatomica* has followed the older text-books (e.g. Piersol,[17] Spalteholz[4]), where the left coronary artery is described as dividing into 2 major branches at the upper end of the anterior interventricular groove. Piersol,[17] however, refers to the interventricular artery as the ramus descendens anterior. The observations made in the present series can be summarized as follows:

(1) The left coronary artery commonly gives off a branch at the upper end of the anterior interventricular groove (the minor or major LVA), which may occasionally be even larger than the 'parent trunk'.

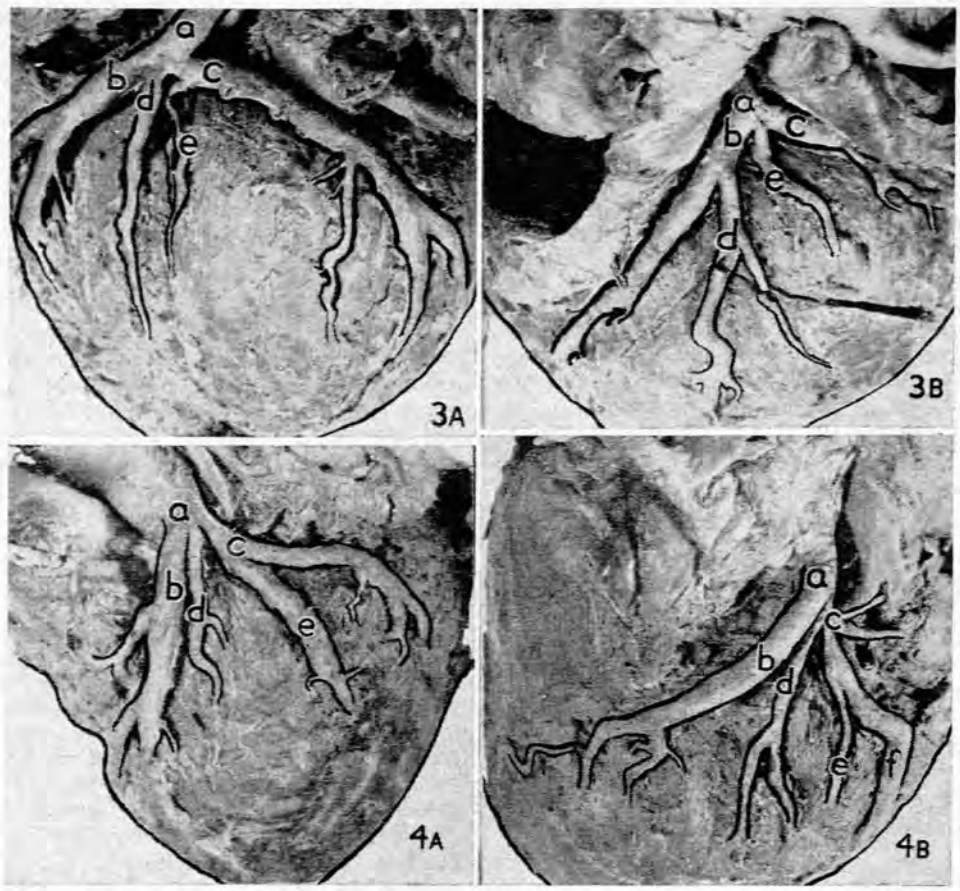

Fig. 3. Hearts of European individuals. In 3A the 'third primary division' is formed by the major LVA, the minor LVA arising just to the left of the bifurcation. In 3B, the '3PD' is formed by the minor LVA.*

Fig. 4. Hearts of Bantu individuals. In both, the major LVA arises at the bifurcation of the left coronary artery. In 4A the major LVA is small and the anterior interventricular artery gives off large branches to supply the region of the apex. In 4B the major LVA supplies a much larger part of the ventricular surface, as far as the apex.*
a—left coronary artery; b—ramus anterior interventricularis; c—ramus circumflexus; d—major left ventricular artery; e—minor left ventricular artery; f—left marginal artery.

(2) The left coronary artery usually has its axis directed in the line of the anterior interventricular artery, the so-called 'parent trunk' then 'continuing' at almost a right angle to the original direction of the flow.

(3) In addition, this 'parent trunk' is usually narrower in calibre than the anterior interventricular branch and may even end before it reaches the posterior portion of the atrioventricular groove; often most of its blood is directed along the left marginal branch towards the apex:

In the light of these observations it appears more logical to consider the 'parent trunk' of the left coronary artery beyond the upper end of the anterior interventricular groove as a branch of the left coronary artery. Thus the terminology of the *Nomina Anatomica* (1955) would be acceptable and text-books should revert to the old description wherein the left coronary artery divides into 2 branches at the upper end of the anterior interventricular groove, namely, the ramus interventricularis anterior and the ramus circumflexus.

CONCLUSIONS

From a series of 83 Bantu, 86 European and 109 Coloured hearts there is sufficient evidence to indicate that the anatomical distribution of the coronary arteries in Bantu hearts is not significantly different from that of the other racial groups studied. Where 'racial variants' have been claimed previously, careful observations and interpretations indicate that such differences may be ascribed to individual variations.

Just as the lung is divided into bronchopulmonary segments, so it will become necessary to describe the common variations of the branches of both coronary arteries to determine the myocardial areas supplied by each branch. Because of the rapid advances in cardiac surgery this study will be invaluable. I am at present carrying out a preliminary study in this respect.

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