

CORONARY ARTERIAL CIRCULATION IN THE BANTU¹

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ABSTRACT. Hearts from 710 adult Bantus of either sex born in Angola and aged between 25 and 68 years were studied. The authors examined the morphological pattern of the coronary arteries and compared them to hearts from Caucasians. An attempt is made to relate the anatomical structure to the reduced incidence of myocardial infarction in the Bantu population. One possible explanation is that a microcirculatory adaptation to physiological conditions could act as a defense mechanism. It is evident that the intraparietal branches of the coronary artery present a greater internal diameter than those found in Caucasian hearts.

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INTRODUCTION

Ischemic cardiopathies mainly induced by atherosclerosis are the cause of death of 25% of persons aged between 25 and 68 years in industrialized countries. Research work carried out both in the Republics of South Africa and Angola has shown that Bantus are resistant to ischemic cardiopathies in spite of their high index of atherosclerosis. We decided to study the anatomy of coronary arteries of Bantus from Angola as a possible tool for the understanding of their resistance to this cardiopathy.

METHODS AND MATERIALS

We studied hearts from 710 adult Bantus of either sex born in Angola and aged between 25 and 68 years. Dissection was performed without previous injection of the arteries in 610 hearts. In 70 hearts, the coronary arteries were injected with an acrylic substance for moulding-corrosion studies that allowed the observation of the primary and secondary division branching, and made easier the study of existing mouldable anastomoses. The coronary arteries of the other 30 hearts were injected with a 30% micropaque solution for macro and microangiographic studies, and small sections were collected for serial histological studies, fixed in Bouin solution and stained with hematein-eosin.

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RESULTS

OSTIA OF THE CORONARY ARTERIES. Of the 710 specimens used to study the number and location of the ostia of the coronary arteries, 2 ostia were observed in 618 hearts (87%). Three ostia were found in 77 hearts (10.8%), and 4 were described in 13 hearts (11 with supernumerary ostia in the right sinus and 2 in the left one—1.8%). One heart of the 710 had only one ostium (0.2%), and one heart had 5 ostia.

In 694 hearts (97.8%), the ostia were in a normal position: one in the left aortic sinus, the other in the right sinus. In one heart (0.2%), the ostia were situated in the left and in the posterior sinuses (fig. 1A). In 15 hearts (2%), the ostia were located only in one sinus: 8 in the left sinus (1.1%) and 7 (0.9%) in the right sinus (fig. 1B). In 87 hearts (12.2%), one or 2 ostia were situated in a sacciform dilatation of the aortic wall in the sinus (fig. 1C). In all cases, the ostia were under the commissural plan of the cusps.

PRIMARY DIVISION BRANCHING. This study was done with 690 hearts, since in 20 out of the 710 hearts, only one of the coronary arteries was injected with micropaque.

In 618 hearts out of 690 (89.5%), the left coronary artery was divided into 3 branches: anterior interventricular artery,

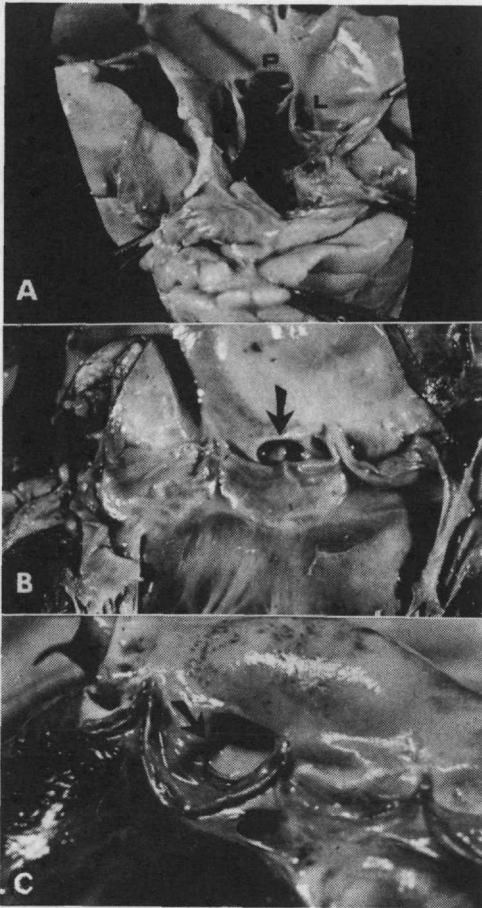


FIGURE 1. A. Horizontal section of the heart immediately above the origin of the aorta. The ostia of the coronary arteries in the left (L) and posterior (P) Valsalva sinuses can be observed. B. Heart section along the longitudinal axis of the out chamber in the left ventricle. The arrow shows a single ostium in the right Valsalva sinus for the two coronary arteries. C. Note the ostium of the right coronary artery located at the bottom of the sacciform dilatation (arrow).

left atrioventricular artery (circumflex), and diagonal artery (fig. 2). The length of the diagonal artery depends on the first left ventricular branch of the interventricular artery (fig. 3A and B): the larger the former, the smaller the latter. In 3 hearts (0.4%), a large branch ran from the left atrioventricular artery, ending into the top of the left atrium. In 72 hearts

(10.5%), the left coronary artery was divided into 2 branches.

In 618 hearts (89.5%), the right coronary artery gave off 4 branches: 2 infundibular, one to the right margin and the interventricular posterior artery. In 72 hearts (10.5%), it gave off an additional 2 right ventricular branches.

In 242 out of the 690 cases (35%), the right coronary artery also gave one more branch to the posterior right ventricular wall and yet another one to the posterior left ventricular wall passing the "crux of the heart." In 687 of the hearts (99.5%), the right coronary artery gave off the sino-atrial artery that divided itself at the upper part of the right atrium.

INTERCORONARY ANASTOMOSES. Anastomoses between the coronary arteries

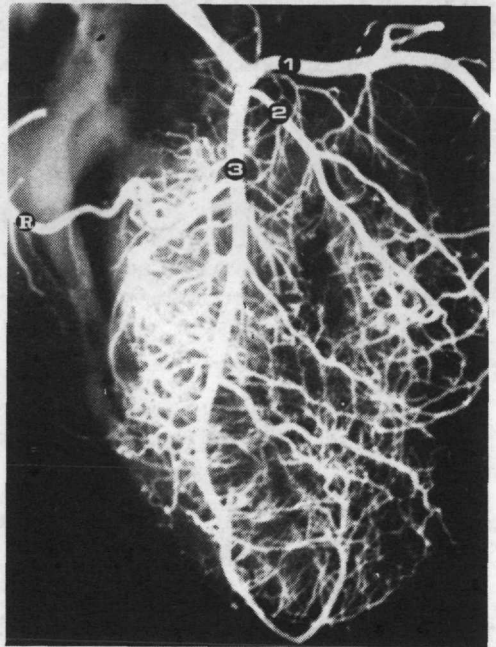


FIGURE 2. Angiography of the left coronary artery obtained by Micropaque injection into the respective ostium. Partial filling of the right coronary artery was achieved (R) suggesting the existence of the anastomoses between the two coronary arteries. 1 = circumflex artery; 2 = diagonal artery; and 3 = anterior interventricular artery.

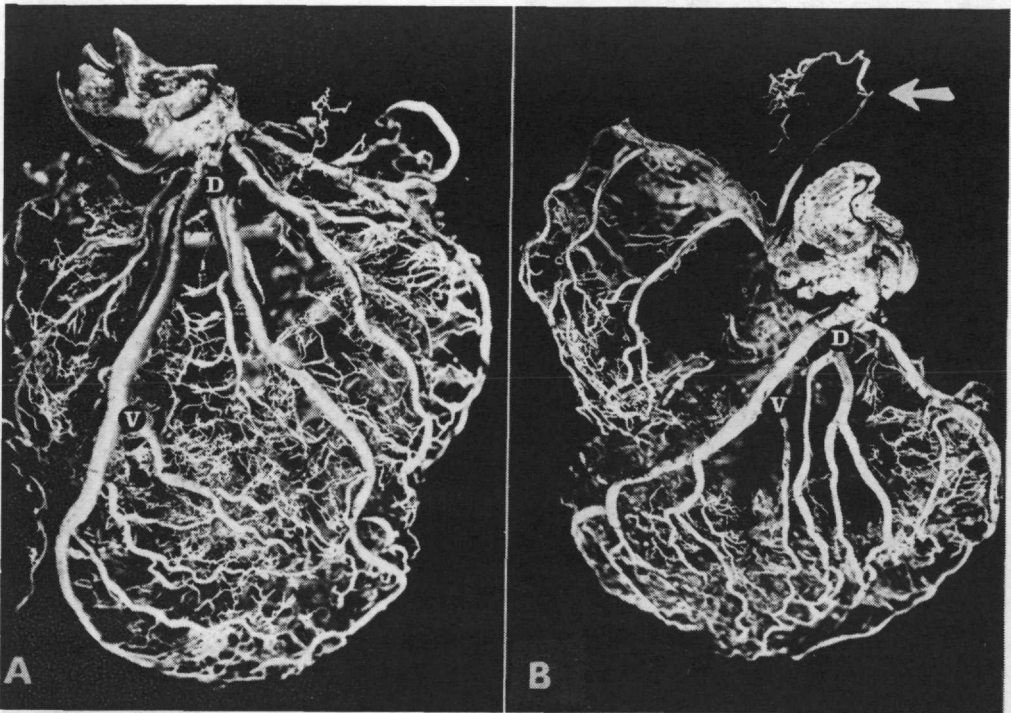


FIGURE 3. Casts of the coronary arteries obtained by moulding-corrosion after injection with Rhodopax AX 85/15. A. A large diagonal artery (D) and a small first left ventricular artery (V) are shown. B. The diagonal artery (D) is small and the first left ventricular artery (V) is large. It is possible to observe the existence of a developed sinoatrial node artery (arrow).

were clearly visible only in 2 hearts, representing 0.2% of those examined. In one, the casting of the anastomoses was possible because of their dimensions. In the other, although the injection of the left coronary artery with a solution of micropaque at 30% did not fill the capillaries, it exhibited the right coronary artery. This result was possible only by the existence of anastomoses between the 2 systems (figs. 2 and 4).

PREPONDERANT CIRCULATION. We applied Schlesinger's (1948) concept of coronary preponderance. In 242 hearts (34%), the circulation was preponderantly right; in 239 (33.6%), it was left; the remaining 229 hearts, (32.2%) had a balanced circulation.

MICROCIRCULATION. The microangiographic profile of the coronary arteries studied by injection of micropaque showed intraparietal branches having a large inner

diameter. This type of division is different from the Caucasian type. Bantu hearts presented the intraparietal branches with early and dense ramification. These aspects were confirmed by histological studies in serial sections (fig. 5A, B and C).

DISCUSSION

Since the gross anatomy of the coronary circulation of the Bantu hearts is similar to that of the Caucasian, the number and location of the ostia are the same as those described in Schlesinger (1948), James (1961), Champrasseur et al. (1971), and Leguerrier et al. (1976).

The percentage of variation we found was similar to that of previous studies. White and Edwards (1948) found one ostium in the posterior sinus, but this variation was considered exceptional

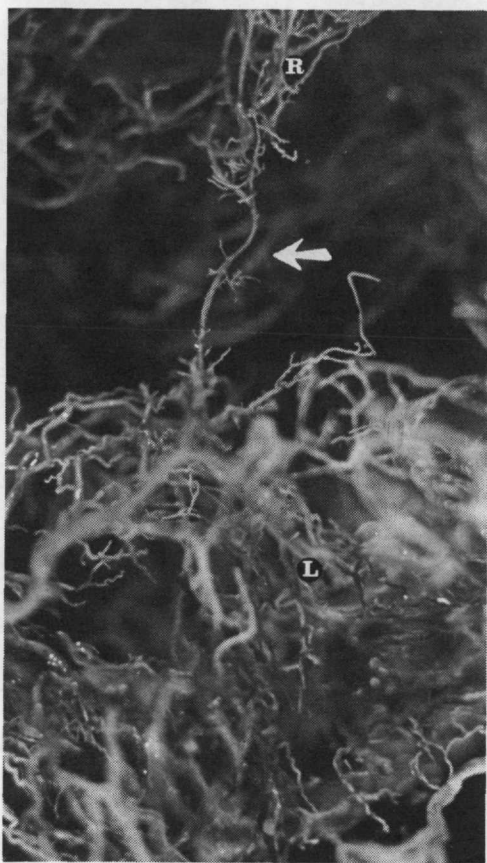


FIGURE 4. Rhodopax AX 85/15 casting of the coronary arteries. The arrow shows anastomosis between branches of the left (L) and right (R) coronary arteries.

(Leguerrier et al. 1976), and we confirm such rarity.

One supernumerary ostium is a frequent variation in studies by Schlesinger (1948), Gensini et al. (1967), and Penther et al. (1976). In our study, we found it in 10.8% of the cases, that is, a percentage less than those referred to by the aforementioned authors. As described in those publications, the more frequent situation of the supernumerary orifice is the right sinus (94.8%), i.e. 73 cases in 77 hearts.

Four specimens with one supernumerary ostium in the left sinus correspond to a smaller percentage (0.5%) than the 1.5% found by Mouchet (1933) or by Hal-

bertsma (as referred by Leguerrier et al. 1976) who indicated a percentage of 2%. However, it is similar to the one stated by James (1961) and by Neimann et al. (1975) of 0.9% and 0.75%, respectively.

Eleven cases of 2 supernumerary ostia in the right sinus represent 1.6% of all hearts studied. Thus, it represents a larger frequency when compared with the 2 cases in the left sinus (0.4%). This type of variation is not referred by Leguerrier et al. (1976) and is considered rare by the other

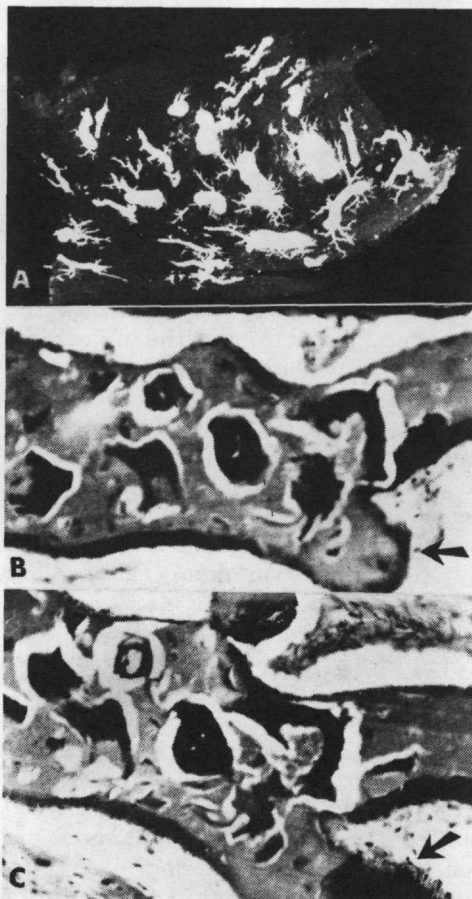


FIGURE 5. A. Microangiography of a section of the left ventricle wall after Micropaque injection of the coronary arteries. Intraparietal branches with large diameter and dense ramification. B and C. Two serial sections of the ventricular wall (thickness 10 μ , H. E., $\times 200$). The large caliber of the collateral branches is clearly visible (arrows).

authors (Schlesinger 1948, James 1961, and Champrasseur et al. 1971).

The number of branches of the coronary arteries is variable according to several studies (James 1961, Hood 1973, DiDio and Wakefield 1975, Neimann et al. 1975, and Secerov and Ovicina 1978). Brink (1949), however, explained the resistance of Bantu hearts to infarction, from the radiographic pattern of injected coronary vessels of 15 Bantu, 1 colored and 17 white, according to the following:

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

Singer (1959), after 278 observations by dissection of the coronary arteries of 86 white South African, 109 Cape colored, and 83 Bantu hearts, concluded that "the anatomical distribution of the coronary arteries in Bantu hearts is not significantly different from that of the other racial groups studied." In our study, the diagonal artery is more frequent than in Singer's observations, although not constant. We believe that the differences probably depend more on an anatomical and individual variation rather than on a racial one. The termination of the anterior interventricular artery is variable as it is in the hearts of the white; finally, there is no significant preponderance of the right coronary artery.

The existence of intercoronary anastomoses is not a frequent feature in the Bantu heart, and, therefore, not a protective factor. In Caucasian hearts, Hood (1973) used arteriographic pictures and concluded that the anterior interventricular artery establishes the collateral pathway more frequently than the other coronary branch. This artery, however, is the most frequent and dangerous site of infarction. In a dynamic study, Carrol et al. (1974) observed that "the collateral vessels do not restore normal regional segment

ventricular motion" after myocardial infarction. Thus, we have reasons to suppose that it is neither the absence of arterial anastomoses that causes predisposition of Caucasians to heart infarction nor their presence that causes the resistance of the Bantu hearts.

It is the microcirculation of the Bantu heart, we believe, that protects the myocardial wall against infarction causes. It is clear that the intraparietal branches of the coronary artery present a greater inner diameter than those of Caucasian hearts. These branches divide themselves more precociously, giving off a larger peripheral vascular area. So, the peripheral vascular resistance is smaller than that of Caucasians' hearts, and consequently, the blood flow is also easier. We suggest, therefore, that this biophysical characteristic is perhaps the protection factor of Bantu hearts.

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