

# Pathomorphological Manifestations of Antioclusive Factor in Atherosclerotic Obstruction of Coronary Arteries

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 136, No. 11, pp. 581-585, November, 2003  
Original article submitted September 2, 2003

A total of 112 hearts with limited local dilatation zones in coronary arteries (antioclusion factor) selected from 500 patients dead from chronic forms of coronary heart disease were studied by postmortem contrast polypositional coronarography and cardiometry. A relationship between antioclusion factor, on the one hand, and coronary artery stenosis and degree of vascularization of the left ventricular wall, on the other, was shown. The adaptation role of antioclusion factor in coronary blood flow disorders caused by atherosclerotic obstruction (stenosis, occlusion, thrombosis) of the major coronary arteries was demonstrated. The incidence of antioclusion factor in individual segments of coronary arteries depending on the type of atherosclerotic involvement and index of myocardial blood supply was determined.

**Key Words:** *coronary atherosclerosis; prestenotic and poststenotic vascular dilatation; coronarography; cardiometry*

Factors of natural protection of coronary blood flow from obstructive lesions of coronary arteries (CA) attract now special interest of cardiologists. It can be explained by insufficient "protective" role of collateral circulation [7] determined by its pathological changeability, physiological defects, and underdevelopment of the collaterals [1]. Insufficient compensatory effect is observed, for example, during the formation of the so-called "replacement" coronary bypass, when collateral vessels, through which the major volume of circulating blood flows, become the main vessels [6]. However, collateral blood flow evaluated as anatomically sufficient is not always functionally adequate [10,11]. Under these conditions antioclusion factor (AF, special local zones of pronounced dilatation of CA) is believed to play an important protective role in atherosclerotic obstruction of coronary blood flow.

The formation of zones of poststenotic dilatation of CA depends on the degree of their stenosis [14].

Study of AF helped us to validate its compensatory and adaptive role, consisting in the following: in pronounced focal stenosis the inner CA diameter does not lose the capacity to dynamic balance if the vessels possess the borderline dilatation zones [2,15]. Anatomically and coronarographically AF is detected in the pre- and poststenotic zones of CA as a round, club-shaped, angle-shaped, or crimped protrusion (dilatation). AF differ from CA aneurysms and megadolichoarteries by shape, length, and obligatory location near the foci of obstruction [4].

Peculiar compensatory role of AF and insufficient data on its antioclusive effect prompted us to carry out a complex study, including analysis of pathomorphology, evaluation of the incidence and diagnostic significance of AF in obstructive atherosclerotic lesions of the main CA.

## MATERIALS AND METHODS

A total of 500 hearts from patients dead from chronic coronary disease with pronounced obstructive atherosclerotic involvement of the main CA were examined. AF in the main CA was detected in 122 (21.4%) cases

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in this group (82 men and 40 women, mean age  $58.2 \pm 0.6$  years); 112 hearts from subjects of the same age and sex, dead from accidental causes, without AF, served as control.

The coronary status was studied by the method of postmortem contrast polypositional coronarography in all cases and in the control [2]. Combined coronarographic method and standard WHO anatomical method were used. Each of the studied CA branches was planimetrically divided into 4 segments equal by the area of the intima surface and compared with the respective segments on coronarograms. This methodological approach rules out the probability of "missed coronary atherosclerosis" [13] or AF missing.

The incidence of AF in isolated segments of three CA was studied in cases with the most frequent types of obstructive atherosclerosis lesions (stenosis, occlusion, and thrombosis). In order to elucidate the protective role of AF, its incidence was compared with the degree of vascularization (volume density of vessels) in the walls of the left heart ventricle with consideration for the three studied CA and the index of myocardial blood supply. This index shows how many grams of pure muscular heart weight falls (on average) per square millimeter of CA lumen in the presence of AF.

Quantitative data were statistically processed using methods of variation statistics (Student's *t* test) and alternative variations.

## RESULTS

The incidence of AF in separate segments of three main CA pathognomonically depended on the type of atherosclerotic involvement (Table 1). The highest incidence of AF was detected in the anterior interventricular branch of the left CA (28.5%) in all types of involvement. AF was the most incident (19.6%) in stenosis and much more rare in occlusions and thromboses of the same CA (7.1 and 1.8% cases, respectively). The right CA ranked second by the incidence of AF: 12.5% cases in all types of lesions in segment 1. AF was more often detected in stenosis (10.7% cases) and rarely in occlusions (5.9 times more rarely). Thrombotic lesions in this segment of the right CA were not paralleled by antioclusion changes. AF was rarely seen in the circumflex branch of the left CA (8.9% cases); in all cases these were stenoses of segment 1.

AF was most often detected in segments 2 and 3 (17.9 and 14.3% cases, respectively) of the anterior interventricular branch of the left CA, being more often associated with stenoses (14.3 and 7.1%). In occlusions and thromboses of the same CA, AF was 2-fold more incident in segment 3 (3.6 and 3.6%) in comparison with segment 2 (1.8 and 1.8%). AF was rarely detected in segments 2 and 3 of the right CA and circumflex branch of the left CA and only in stenosis. In segments 4, AF was detected only in the

**TABLE 1.** Percentage of AF in CA Segments in Different Types of Atherosclerotic Involvement

Type of involvement		Segment			
		1	2	3	4
Right CA	stenosis	10.7	1.8	1.8	—
	occlusion	1.8	—	—	—
	thrombosis	—	—	—	—
	all lesions	12.5	1.8	1.8	—
Anterior interventricular branch of left CA	stenosis	19.6	14.3	7.1	1.8
	occlusion	7.1	1.8	3.6	3.6
	thrombosis	1.8	1.8	3.6	3.6
	all lesions	28.5	17.9	14.3	9.0
Circumflex branch of left CA	stenosis	8.9	3.6	1.8	—
	occlusion	—	—	—	—
	thrombosis	—	—	—	—
	all lesions	8.9	3.6	1.8	—
Mean values for three CA	stenosis	13.1	6.5	3.6	0.6
	occlusion	2.9	0.6	1.2	1.2
	thrombosis	0.6	0.6	1.2	1.2
	all lesions	16.7	7.8	5.9	2.9

**TABLE 2.** Incidence of AF in CA, Degree of Vascularization (Volume Density of Vessels) of the Left Ventricle, and Index of Myocardial Blood Supply ( $M \pm m$ )

Coronary artery	Incidence of the factor, %	Volume density of vessels in left ventricle, %				Index of myocardial blood supply g/mm <sup>2</sup>	
		anterior wall	posterior wall	lateral wall	apex and septum	study group	control group
Right CA	16.1	44.4±1.2	38.8±1.6	36.4±1.2	36.2±1.4	19.4	22.8
Anterior interventricular branch of left CA	69.6	68.8±1.6	56.4±0.8	52.8±1.4	50.6±0.8	18.6	24.6
Circumflex branch of left CA	14.3	38.2±1.4	36.4±1.2	34.4±1.6	32.2±1.2	19.8	26.2
Total	100	151.4±1.4	131.6±1.2	123.6±1.4	119.0±1.2	19.3	24.5

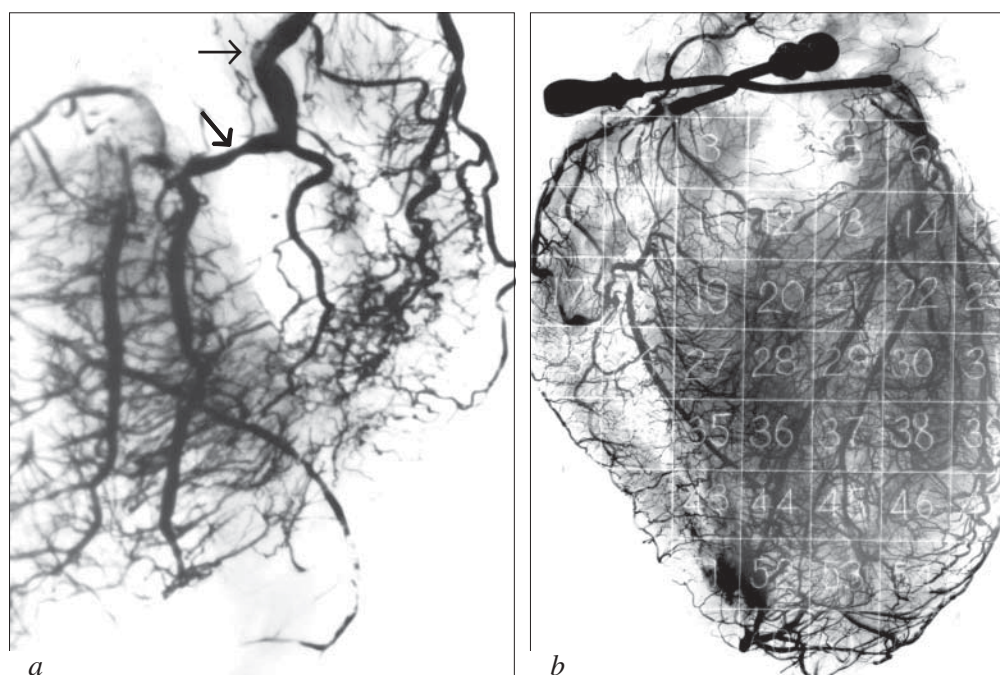
anterior interventricular branch of the left CA, most often in occlusive (3.6%) and thrombotic (3.6%) lesions.

Hence, AF was maximally incident in the anterior interventricular branch of the left CA; the incidence of AF was lower in the distal segments of 3 studied arteries (16.7, 7.8, 5.9, and 2.9 in segments 1, 2, 3, and 4, respectively, Table 1). The association of AF with stenotic involvement of the first segments of the studied CA was pathognomonic. AF was often detected in segments 3 and 4 in occlusive and thrombotic lesions of the anterior interventricular branch of the left CA.

This incidence of AF in the main CA and the type of involvement of their segments persuasively prove

that AF form when it is necessary for the correction of developing deficiency of coronary blood supply in ischemic zone of the myocardium [8]. The presence of these limited zones of pre- and poststenotic dilatation is explained also by their protective role for ischemic myocardium because of inadequate functioning of the collateral coronary blood flow [15].

Analysis of vascularization degree in functionally overexercised left ventricle showed that the volume density of vessels in all compartments of the heart was maximum if AF were located in the anterior interventricular branch of the left CA (Table 2). AF were detected in this CA in the maximum number of cases (69.9%). If AF were present in the right CA (in 16.1%



**Fig. 1.** Prestenotic dilatation of coronary arteries in atherosclerotic obstructions. *a*) Limited angle-shaped prestenotic dilatation of the anterior interventricular branch of left coronary artery (arrow). Fragment of coronarogram of patient S., 68 years; *b*) limited sharply expressed club-shaped prestenotic dilatation of right coronary artery (arrow). Coronarogram of patient G., 64 years, superposed on the marker network for estimating the volume of vascularization.



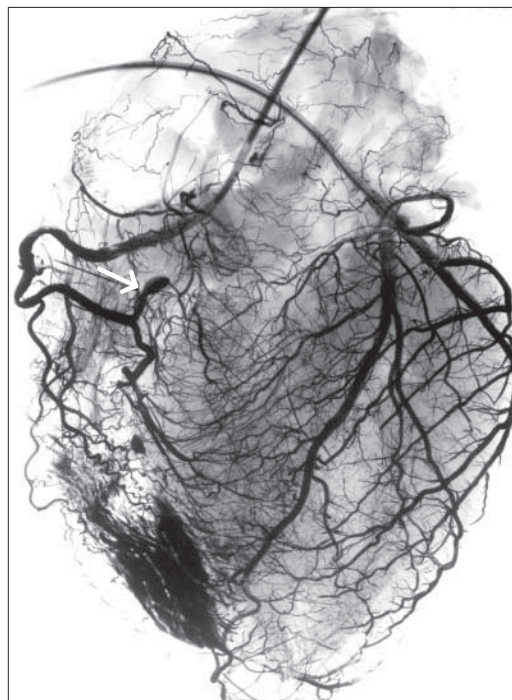
cases), vascularization of the left-ventricular walls ranked 2nd by its intensity. The minimum vascularization of left-ventricular walls corresponded to the minimum incidence of AF in the circumflex branch of the left CA (14.3% cases). It is noteworthy that the degree of left-ventricular wall vascularization decreased from the anterior wall towards the apex and septum (for the posterior and lateral walls; Table 2).

When analyzing the correlation between the degree of left-ventricular vascularization and the incidence of AF in the main CA, it is most important to evaluate the changes in the index of myocardial blood supply (Table 2). AF in the anterior interventricular branch of the left CA and pronounced vascularization of left-ventricular walls corresponded to normal or slightly shifted index of myocardial blood supply (18.6 g/mm<sup>2</sup>). AF in the right CA and circumflex branch of the left CA were associated with myocardial blood supply indexes close to normal (19.4 and 19.8 g/mm<sup>2</sup>, respectively). On the other hand, the index of myocardial blood supply in the control varied and was 22.8, 24.6, and 26.2 g/mm<sup>2</sup>.

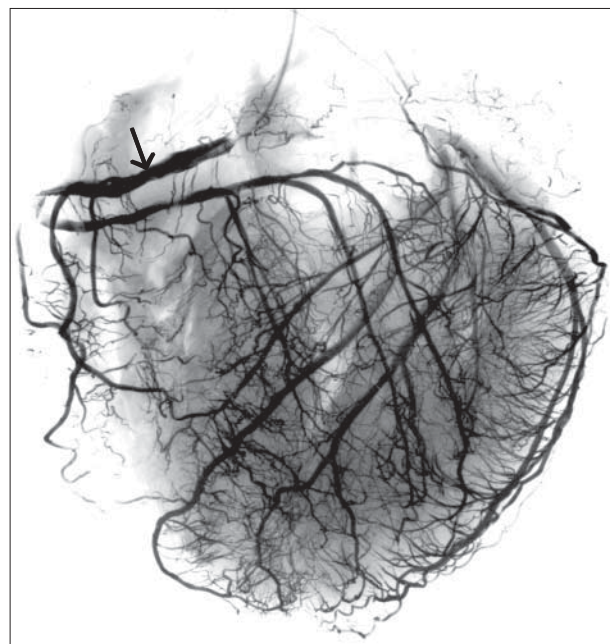
The detected close correlation between the incidence of AF in the main CA and degree of cardiac left-ventricular wall vascularization under conditions of increasing blood flow rate and pressure gradient was paralleled by the Venturi effect [11], promoting activation of the coronary blood flow. On the other hand, the index of myocardial blood supply, as an integral indicator of the coronary vessels correspondence to myocardial requirements, confirm the fact of peculiar protection of coronary blood flow by AF in obstructive involvement of the main CA.

Serial analysis of polypositional coronarograms showed AF in the majority (42.9%) of cases as deep angle-shaped prestenotic dilatations of CA, combined with pronounced dilatation of the main vascular formations of the left and right coronary basins (Fig. 1). Sharply pronounced club-shaped prestenotic and poststenotic dilatations of CA (Fig. 2) observed in the presence of diffuse dilatation changes in left coronary vessels and numerous collateral anastomosis capillaries ranked second by the incidence of coronarographic manifestations (35.7% cases). Muff-shaped annular poststenotic and comparatively long AF were seen in the minimum (21.4%) number of cases (Fig. 3). These zones of local dilatation were also seen in the presence of dilatation of the main and ramifying branches of the left coronary vessels.

Hence, higher incidence of AF in the anterior interventricular branch of left CA in stenotic involvement of its segments and close correlation between AF and degree of cardiac left-ventricular vascularization indicate pronounced defense of impaired coronary blood flow. The specific features of blood flow in CA



**Fig. 2.** Limited sharply pronounced club-shaped poststenotic dilatation of right coronary artery in obstructive atherosclerotic involvement (arrow). Coronarogram of patient V., 66 years.



**Fig. 3.** Muff-shaped annular poststenotic dilatation of right coronary artery (arrow). Coronarogram of patient K., 68 years.

involved in obstructive atherosclerosis and the acting pressure gradient underlie the development of AF in the pre- and poststenotic zones of CA [12].

It is noteworthy that the protective role of AF is illustrated by a well-known concept of donor arteries and recipient arteries [3,5]. The detected special zones of local dilatation of CA, irrespective of the type of

their formation, are not maximum, and are liable to change under the effect of drugs [9]. That is why the compensatory processes developing during the formation of AF in impaired system of coronary circulation have a positive impact on changes in cardiac angio-architectonics and coronary hemodynamics, thus indicating the significance of the studied phenomenon.

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