

HEMORHEOLOGIC PROFILE IN PATIENTS WITH ANGINA PECTORIS

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SUMMARY

Thirteen patients (9 men and 4 women) with stable angina, whose ages ranged from 48 to 62 years (mean 57 years), were studied in order to establish the hemorheologic profile consequent to effort as well as some parameters of the oxygen transport system.

The results were compared with those obtained from a control group of 8 healthy individuals, 4 men and 4 women, whose ages ranged from 40 to 57 years (mean 48 years). The patients presented values of P50 *in vivo* during rest (R) higher than the control group ($p < 0.05$); the filtration time of blood (FT) and the flow rate of erythrocyte filtration (FR) rose significantly from the R to the precocious recovery (Rec) phase, both in the control group ($p < 0.01$) and in the patients ($p < 0.001$). There was, therefore, no remarkable difference in these parameters as well as in arterial pH, Hb and Ht at rest and after maximum effort, between the patients and the control group. The lactate presented higher values ($p < 0.05$) in the control group when only early phase of Rec was taken into account. In the patients there was a significant positive correlation during rest between 2,3-DPG and FT ($p < 0.05$) and between P50iv and FT ($p < 0.02$). This correlation was not found in the control group. It was also found a significant rise of Ht in the early phase of Rec among the patients as opposed to the control group.

The results suggest: (a) adaptation of the oxygen transport system in the patients with angina through a rise of oxyhemoglobin dissociation capacity; (b) aggravation of hemorheologic profile after effort, more conspicuous in the patients than in the control group; (c) the system of oxygen transport in the patients seems to be influenced by alterations of hemorheologic parameters.

INTRODUCTION

The importance of hemorheologic parameters for the adequate functioning of microcirculatory systems has been widely demonstrated.¹⁻⁴

Coronary artery disease is one of the chapters of vascular pathology in which the influence of these parameters has not been completely investigated, specially in what concerns the situations of stable effort angina pectoris that entail permanent vascular obstruction with attendant abnormalities of bloodflow.⁵⁻⁸ In this case hemorheologic factors may play a vital role when metabolic demands rise.

MATERIAL AND METHODS

Thirteen patients (9 men and 4 women), whose age ranged from 48 to 62 years (mean 57 years), without history of acute heart disease, hypertension, diabetes, stroke, peripheral vascular disease or hyperlipidemia, were studied. All the patients had presented typical symptoms of stable effort angina for a period of 3 months to several years and had a positive effort test. Four patients belonged to class I, 5 to class II and 4 to class III of the NYHA. In 3 out of 5 patients it was demonstrated disease of the vessels through coronariography.

TABLE 1 — Values (mean \pm SD) of hemoglobin concentration, hematocrit, arterial pH, lactate concentration, red cell filtration time and filtration rate in coronary patients and control subjects, before (rest) and after (recovery, rec) exercise test.

| Parameters | Periods | Patients (N = 13) | Controls (N = 8) |
|--|------------|----------------------|---------------------|
| Hemoglobin (g/dl) | Rest | 13.3 \pm 1.2 | 13.5 \pm 1.7 |
| | 1 min rec | 13.5 \pm 1.4 | 13.0 \pm 1.4 |
| | 10 min rec | 13.3 \pm 1.3 | 13.1 \pm 1.6 |
| Hematocrit (%) | Rest | 42.0 \pm 4.0 | 42.5 \pm 5.1 |
| | 1 min rec | 44.1 \pm 4.6 | 42.1 \pm 4.3 |
| | 10 min rec | 43.3 \pm 4.4 | 42.3 \pm 5.2 |
| Arterial Lactate (μ mol/ml) | Rest | 0.72 \pm 0.41 | 0.77 \pm 0.23 |
| | 1 min rec | 6.80 \pm 3.14 | 10.32 \pm 3.93 |
| | 10 min rec | 5.34 \pm 2.63 | 8.12 \pm 3.78 |
| Arterial pH | Rest | 7.409 \pm 0.029 | 7.403 \pm 0.020 |
| | 1 min rec | 7.348 \pm 0.043 | 7.308 \pm 0.070 |
| | 10 min rec | 7.372 \pm 0.051 | 7.338 \pm 0.058 |
| Filtration time (sec) | Rest | 25.7 \pm 5.1 | 25.5 \pm 2.2 |
| | 1 min rec | 30.5 \pm 6.0 | 30.6 \pm 3.9 |
| | 10 min rec | 25.8 \pm 4.9 | 27.7 \pm 4.1 |
| Filtration rate (μ l.sec ⁻¹) | Rest | 16.87 \pm 1.90 | 16.57 \pm 1.20 |
| | 1 min rec | 14.70 \pm 2.26 | 14.01 \pm 0.73 |
| | 10 min rec | 16.26 \pm 2.08 | 15.20 \pm 0.99 |

After a week, during which all therapy was withdrawn and only nitroglycerin S.O.S. was allowed, a maximum exercise test (Bruce's protocol) was performed, only limited by symptoms. Arterial blood samples (from radial or brachial arteries) were collected at rest and during the recovery phase (1st and 10th minutes), to assay plasma lactate⁹ and blood pH (Radiometer system). Venous blood was also collected (from antecubital veins) at the same time to assay hemato-

crit, hemoglobin concentration (by routine hematologic techniques), erythrocyte concentration of 2,3-diphosphoglycerate,¹⁰ filtration time of total blood and rate of erythrocyte filtration.¹¹ P50 *in vivo* (P50 iv) was evaluated¹² only at rest. The results were compared with those obtained, under similar circumstances, in a control group composed of 4 healthy men and 4 healthy women, whose ages ranged from 40 to 57 years (mean 48 years).

TABLE 2 — Values (mean \pm SD) of red cell 2,3-diphosphoglycerate (2,3-DPG) concentration and hemoglobin-oxygen affinity (calculated as the P50 *in vivo*) in coronary patients and controls before exercise test.

| Groups | 2,3-DPG (μ mol/gHb) | P50 <i>in vivo</i> (mmHg) |
|----------------------|-----------------------------|------------------------------|
| Patients (N = 13) | 17.54 \pm 3.06 | 32.1 \pm 2.9 |
| Controls (N = 8) | 18.00 \pm 3.71 | 29.4 \pm 1.9 |

RESULTS

The results obtained are summarized on Table 1 and Table 2. The resting value of P50iv was higher in the patients ($p < 0.05$). The hematocrit rose from the resting phase to the early recovering phase (1st minute), but this rise was only statistically significant among the patients ($p < 0.05$). The filtration time of total blood and the rate of erythrocyte filtration rose significantly from the resting phase to the early recovering phase, both in the control group ($p < 0.01$) and in the patients ($p < 0.001$). There was no remarkable

difference between the two groups of individuals concerning the comparison of the following parameters: hemoglobin concentration, hematocrit, 2,3-diphosphoglycerate, arterial pH, filtration time of total blood and rate of erythrocyte filtration. The lactate presented higher values among the control group when the early recovering phase was considered ($p < 0.05$), what can be related with the greater effort made by the controls when compared with the patients ($p < 0.05$). It was possible, only among the patients, to establish a positive correlation ($r = 0.60$, $p < 0.05$) between the concentration of 2,3-diphosphoglycerate and the filtration time and ($r = 0.62$, $p < 0.02$) between P50iv and the filtration time of total blood (both correlations concerning the resting phase).

DISCUSSION

The importance of blood hyperviscosity as a risk factor and physiopathologic determinant of coronary disease has been frequently described and the hematocrit is the parameter most often implicated.^{6,13-15}

The behaviour of our group of patients, concerning the influence of exertion on this parameter, seems to confirm its importance in this sort of pathology.

The slight aggravation of evaluated hemorheologic parameters after exercise was more conspicuous among the patients than in the control group. Although the difference is not statistically significant, we think it should be valued considering the shorter time of exercise duration among the patients.

The hemorheologic alterations described in our group of patients probably contribute to provoke an adaptation of tissue perfusion and oxygen transport system, as seems to be evident from the rise of P50iv and from the positive correlations, concerning the group of patients, between the filtration time of total blood and P50iv of erythrocyte concentration of 2,3-diphosphoglycerate, respectively.

Our results connote that the phenomena of adaptation are twice effective since, besides the influence on the oxyhemoglobin dissociation capacity, they still interfere with erythrocyte flexibility that would be even less marked were it not for the control action of 2, 3-diphosphoglycerate at that level.

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