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ARTERIAL-VEINUS DIFFERENCES IN METABOLIC AND RHEOLOGICAL PARAMETERS IN
PERIPHERAL OBLITERATIVE ARTERIAL DISEASE PATIENTS

°Materazzi M., °Ralli L., *Bianciardi A., °Domini L., °Monaci A., °Pieragalli
D., °Acciavatti A., °Galigani C., °Forconi S., °Di Perri T.

°Istituto di Patologia Speciale Medica, University of Siena, Siena, Italy.

*Istituto di Radiologia, University of Siena, Siena, Italy.

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ABSTRACT

Twenty patients suffering from peripheral obliterative arterial disease underwent metabolic and haemorheological study. The femoral arteriovenous differences in lactate and oxygen extraction varied with the severity of the ischemic process, as assessed clinically. In patients with claudication lactate release and oxygen extraction were comparable with those in the control group while were significantly increased in Fontaine's III and IV stage patients. Moreover this latter group showed the most relevant changes in whole blood viscosity and filterability. Such findings bring a further contribution to the correlation between the regional circulatory imbalance and changes in haemorheological parameters.

INTRODUCTION

In its natural course chronic peripheral obliterative arterial disease (POAD) shows a progressive evolution of hemodynamic and metabolic disorder induced by flow reduction. Usually, the symptoms and signs can have a progression from claudication to rest pain and finally trophic lesions. Fontaine's clinical classification of POAD was the most useful scheme to follow the course of the disease (2) since reflects the above mentioned progression, which appears associated to definite pathophysiological changes.

For long time the clinical signs of progressive reduction in blood flow is concealed by vascular and metabolic compensatory mechanisms. When blood supply became inadequate a lot of symptoms occur during exercise (claudication intermittens) and successively also at rest (rest-pain).

The supply-demand mismatching is gradually followed by a local metabolic insufficiency and tissue necrosis. It is known that in several clinical si-

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tuations characterized by either diffuse or regional circulatory insufficiency whole blood viscosity is increased (3-4,8,13). To demonstrate that metabolic and haemorheological changes produced in the lower extremity by peripheral obliterative arterial disease (1,7,15) might relate to the clinical degree of ischemia, we have tried to find differences in metabolic and haemorheological parameters between normal subjects and vasculopathic patients in different clinical stage; the study was performed only at rest.

MATERIALS AND METHODS

Twenty patients with chronic peripheral obliterative arterial disease of atherosclerotic origin, assessed by clinical and angiographic criteria, were admitted to the study. In most cases, a history of intermittent claudication existed for more than two years with various degrees of ischemia according to Fontaine's stages. Patients were divided in two groups: first group consisted of ten patients in stage II, with typical history of the intermittent claudication at the calf dependent on a variable walking distance; the second group consisted of five patients in stage III with rest pain and of five patients in stage IV with rest pain and trophic changes of the feet. The ages ranged from 43 to 75 years. Sixteen patients were males and four females.

The control group consisted of ten matched by age and sex volunteers. Blood samples were drawn at rest simultaneously from femoral artery and vein of the more damaged leg. All values obtained at rest refer to supine position.

The following parameters were measured:

- pO₂, pCO₂, pH with Blood Gas Analyzer I.L. 1302;
 - %O₂Hb, VOL%O₂ with I.L. CO-OXYMETER 282;
 - lactic acid with Lactate Analyzer 640 (Roche);
 - blood viscosity using HAAKE Rotovisco RV 100 at 150 s⁻¹ shear rate;
 - whole blood filterability according with method of Forconi et al. (9-12).
- Statistically analysis were performed by means Student's "t" test.

RESULTS

No significant difference was registered in the arterial levels of lactate and pO₂ (data not shown), while the arteriovenous differences for lactate and pO₂ were different among the three groups (fig.1,2 - tab.1).

In the claudication group the degree of arteriovenous lactate difference and oxygen extraction were at the same levels as in control group.

In the rest pain group lactate release and oxygen extraction was significantly increased as compared to the control group values and also to the claudication group values (fig. 1,2,3).

Differences in pH and in pCO₂ were present in the three groups but when tested by Student's "t" analysis these data have not shown a statistical significance (dat not shown).

OXYGEN EXTRACTION

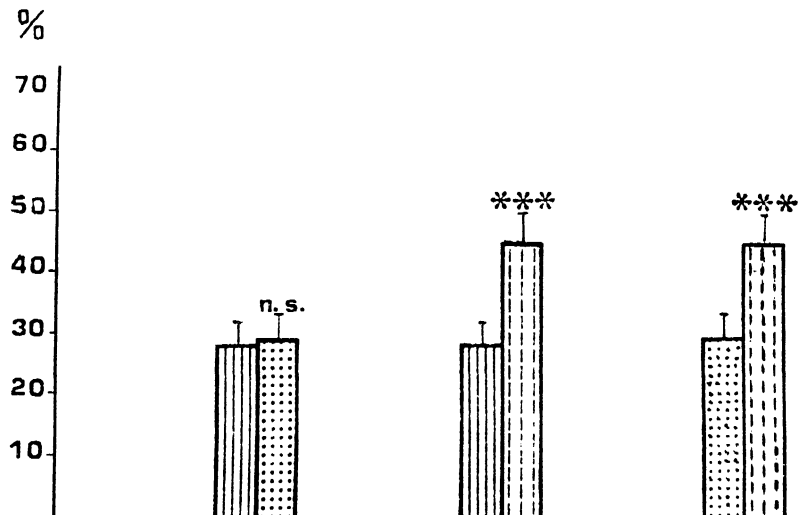


FIG. 1

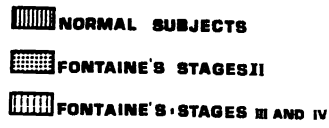
Behaviour of oxygen extraction in the three groups studied. Oxygen extraction was calculated by means of the following formula:

$$\frac{\text{arterial VOL\%O}_2 - \text{venous VOL\%O}_2}{\text{arterial VOL\%O}_2}$$

On the right the symbols used in this paper. *** = $p < 0.001$

As regard haemorheological data an increase of whole blood viscosity and a decrease of blood filterability was registered in POAD patients as compared to normal subjects (fig. 4,5).

Moreover in Fontaine's III and IV stage patients a significant reduction of filterability with respect to Fontaine's II stage patients was observed while not statistically significant arteriovenous differences in haemorheological parameters were found.



FEMORAL VENOUS LACTATE

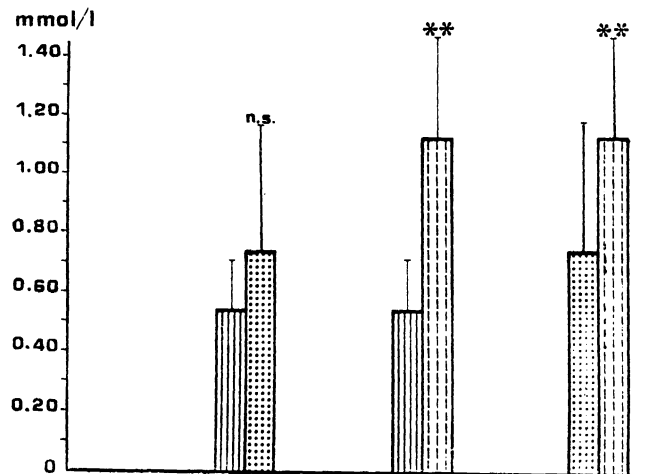


FIG.2 . Behaviour of femoral venous lactate in the three groups studied. For symbols see figure 1. * * = $p < 0.01$

FEMORAL A-V LACTATE DIFFERENCE

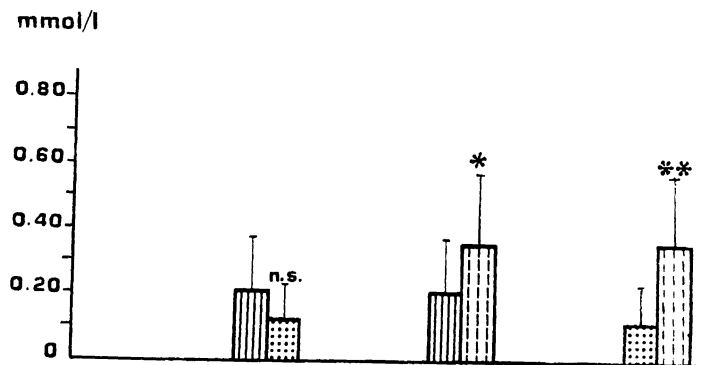


FIG.3 . Behaviour of femoral A-V lactate difference in the three groups. For symbols see figure 1. * = $p < 0.05$

BLOOD FILTERABILITY

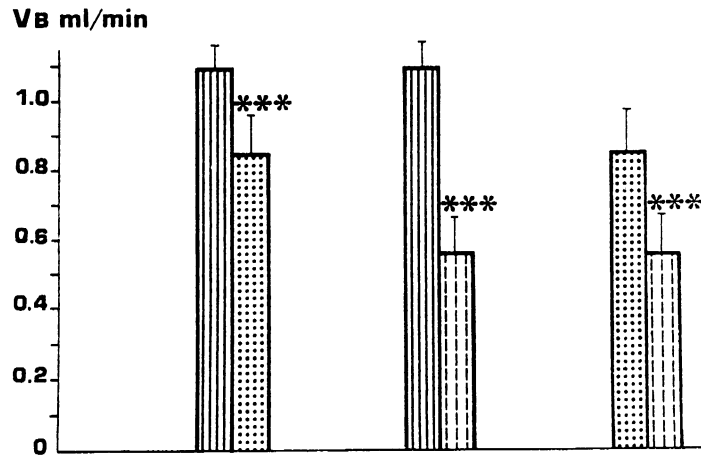


FIG. 4. Behaviour of blood filterability in the three groups studied. For symbols see figure 1. * * * = $p < 0.001$

BLOOD VISCOSITY

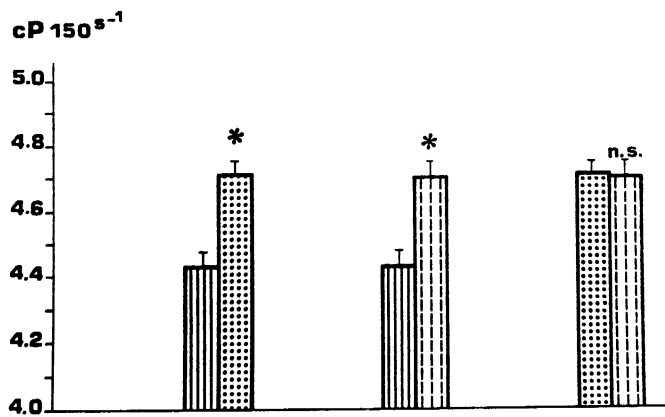


FIG. 5. Behaviour of whole blood viscosity in the three groups. For symbols see figure 1. * = $p < 0.05$

DISCUSSION

Our findings are in agreement with the hypothesis of the progressive evolution of the obliterative arterial disease.

Since symptoms only arise in patients with claudication when blood flow cannot cover the metabolic demand of contracting muscle, lactate release and oxygen extraction at rest were expected to be comparable to control group.

In contrast the patients with rest pain and trophic lesions have impaired nutritional blood flow even at rest. At the same time in this group lactate release and oxygen extraction was significantly enhanced. To compensate for diminished blood flow, oxygen extraction increased proportionally to the severity of the ischemic process and, therefore, to the symptoms.

All this metabolic data support the hypothesis of the presence of a local metabolic imbalance also at rest in Fontaine's III and IV stage patients. Several studies have shown alterations of haemorheological parameters in vascular patients where whole blood viscosity was increased at all shear rates tested. Also in our patients an increase of blood viscosity was present when compared with controls.

TABLE I

Metabolic and Hemorheological parameters in Control subjects (A), in Fontaine's II stage (B) and in Fontaine's III and IV stage (C).

	A	B	C	p(A-B)	p(A-C)	p(B-C)
Oxygen extraction %	27.7 \pm 3.65	29.2 \pm 4.33	44.7 \pm 5.35	n.s	***	***
A- \dot{V} pO ₂ mmHg	41.2 \pm 3.48	37.5 \pm 7.66	65.0 \pm 4.80	n.s	***	***
Venous lactate mmol/l	0.55 \pm 0.17	0.74 \pm 0.43	1.12 \pm 0.35	n.s	**	**
Hematocrit %	41.6 \pm 1.77	44.3 \pm 4.23	40.8 \pm 2.44	n.s	n.s	n.s
Blood Viscosity cP	4.25 \pm 0.37	4.71 \pm 0.45	4.80 \pm 0.41	*	*	n.s
Filterability ml/min	1.0963 \pm 0.071	0.8498 \pm 0.123	0.5520 \pm 0.113	***	***	***
A-V lactate mmol/l	0.18 \pm 0.09	0.12 \pm 0.11	0.36 \pm 0.23	n.s	*	**

* = p<0.05

** = p<0.01

*** = p<0.001

n.s = not significant

TAB.1

Such findings underline a possible relationship between circulatory impairment and blood viscosity changes.

The problem of the mechanism leading to rheological changes is not easy to determine. Without doubt the hypothesis that a metabolic influence on the internal viscosity of the erythrocytes could play a role in these situations arise. In fact in rest pain and trophic lesions group decreased values of whole blood filterability were observed either when compared to controls or when compared to claudication group.

Moreover just the rest pain patients showed a more advanced local metabolic imbalance.

Our findings suggest the existence of a correlation between tissue circulatory imbalance and changes un haemorheological parameters, the latter been also a consequence or a self-maintaining factor of the ischemic process.

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