BEHAVIOUR OF THE ERYTHROCYTE DEFORMABILITY AND NITRIC OXIDE METABOLITES IN UNPROFESSIONAL ATHLETES / COMPORTAMENTO DA DEFORMABILIDADE ERITROCITÁRIA E DE METABOLISMOS DO MONÓXIDO DE AZOTO EM ATLETAS AMADORES

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ABSTRACT

We examined, in 81 athletes subdivided into three groups according to the practised sport (endurance, mixed, power), erythrocyte deformability and nitric oxide metabolites (NOx). In the whole group and in athletes that practised endurance and mixed sports we observed, in comparison with sedentary controls, an increase in erythrocyte deformability. In the same groups we found an increase in plasma NOx level although we did not note any significant correlation between these parameters.

Physical training induces significant effects on the haemorheological pattern[1] of which the major components are haematocrit, plasma viscosity, red cell aggregation and deformability. Each of these rheological parameters acts in a specific area of the circulatory system in relation to the velocity gradient and so pointing out the strong link between non-newtonian blood viscosity and haemodynamic profile.

Red cell deformability, that together with plasma viscosity plays a pivotal role in the microcirculation, physiologically depends on the surface-volume ratio, internal viscosity and membrane dynamic properties but also by pH, osmolarity, mechanical factors and nitric oxide (NO). The influence of NO on red cell deformability is related to dose[2,3] and partly dependent on guanylate cyclase activity[4]; its influence is significantly reduced by the employment of NO synthesis inhibitors[4,5].

Up to now the literature data show that in several sports at rest an increase of red cell deformability has

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been observed in comparison with sedentary controls[6-12] as well as in athletes a greater percentage of younger cellular elements has been found[9,10,13]. On the other hand the exercise training causes a significant increase in NO production[14-17].

Considering these aspects we examined erythrocyte deformability and NO metabolites ($NO_2^- + NO_3^- = NOx$) in 81 athletes (55 men and 26 women; mean age 31.5 ± 8.7 years) subdivided into 3 subgroups. The first group included 28 subjects (23 men and 5 women; mean age 35.9 ± 10.0 years) who practised endurance sports (14 cyclists, 14 endurance swimmers). The second group included 30 subjects (20 men and 10 women; mean age 28.5 ± 7.8 years) who practised mixed sports (11 basket players, 10 judoists, 9 water polo players). The third group included 23 subjects (19 men and 4 women; mean age 30.6 ± 6.1 years) who practised power sports (4 sprint runners, 5 weightlifters, 14 sprint swimmers).

The control group included 27 healthy sedentary subjects (20 men and 7 women; mean age 33.2 ± 5.6 years).

The erythrocyte deformability was examined using the diffractometer Rheodyn SSD of Myrenne[18,19]. This instrument measures the diffraction pattern of a laser beam passing through erythrocytes suspended in a viscous medium and deformed by a force with defined shear stresses. A measure of erythrocyte deformation is the Elongation Index (EI) = (L-W)/(L+W)×100, where L = length and W = width of the erythrocytes. We considered the EI at the shear stress of 60 Pascal (Pa).

The NO production was evaluated by a micromethod which measures the concentration of both NO metabolites (nitrite plus nitrate). At first nitrate was converted into nitrite by a nitrate reductase, then nitrite was assessed by spectrophotometry after addition of the Griess reagent[20].

The values were expressed as means ± standard deviation. The difference between sedentary controls and athletes was evaluated according to the Student's t test for unpaired data.

Erythrocyte deformability, expressed as EI, was significantly increased in athletes (Controls: 43.85 ± 4.48; Athletes: 47.21 ± 4.46; $p < 0.01$). Subdividing the whole group of athletes into three subgroups according to the practised sport, we noted (Fig. 1) in the endurance athletes an increase in erythrocyte deformability (EI: 46.98 ± 4.03; $p < 0.05$ vs controls); the same behaviour was even more evident in the mixed athletes (EI: 49.52 ± 3.42; $p < 0.001$ vs controls) while in the power athletes no difference was evident in comparison with control subjects (EI: 44.45 ± 4.66).

The evaluation of NOx showed an increase in the whole group of athletes (controls: 26.67 ± 18.63 micromol/l; Athletes: 41.16 ± 24.87 micromol/l; $p < 0.01$); this increase (Fig. 2) was statistically significant only in endurance and mixed athletes (endurance athletes: 43.01 ± 23.08 micromol/l; $p < 0.01$ vs controls; mixed athletes: 45.85 ± 30.63 micromol/l; $p < 0.01$ vs controls) and not in power athletes (33.00 ± 16.45).

From the obtained data it was evident that erythrocyte deformability, at rest, distinguished sedentary controls only from athletes that prac-

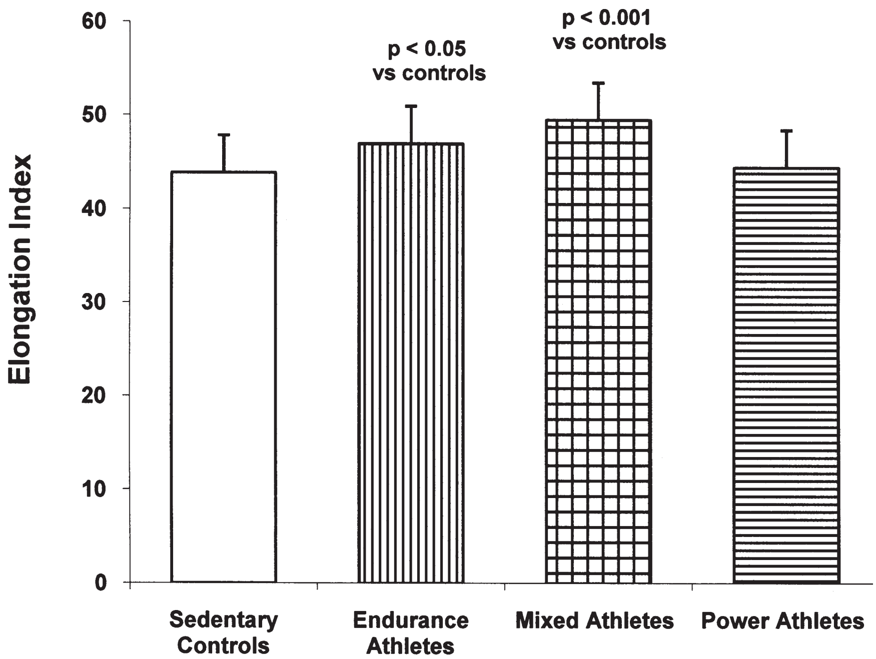

Fig. 1 – Erythrocyte deformability, expressed as elongation index, in sedentary controls and in the three subgroups of athletes

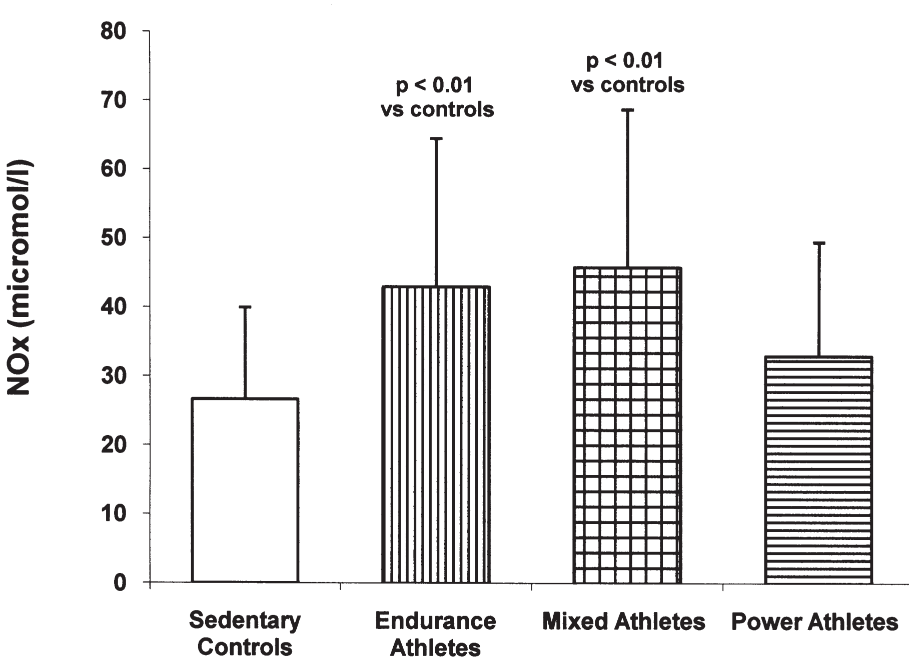

Fig. 2 – Nitric oxide metabolites (NOx) in sedentary controls and in the three subgroups of athletes

tised aerobic and mixed sports. Also a NOx increase was present in these groups of athletes, although we did not find, using linear regression, any correlation between NOx values and elongation index. Our observations confirm several findings concerning the behaviour of erythrocyte deformability found in athletes[6-12], also considering that, in athletes who practise power sports, the erythrocyte turnover is not particularly accelerated, differently from endurance athletes[21]. Our data also underline the role of training on the NOx level. The datum in fact confirms the strong link between exercise and endothelium and in particular how regular exercise seems to upregulate eNOS expression, even if up to now it is not sure if this upregulario is due to the shear stress or metabolic factors[17].

In conclusion, these data show that in athletes that practise aerobic and mixed sports the increase of NOx plasma level is accompanied by an increase of erythrocyte deformability; the latter, as it is known, plays a pivotal role in the microcirculation system and influences the tissue oxygen transport. These results may contribute to explain the significant role of the aerobic exercise in the cardiovascular prevention.

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