Reactivity of the Conjunctival Microcirculatory Bed in Students from Various Regions of the World as an Indicator of Adaptation of the Organism

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Microcirculatory vessels of the eyeball conjunctiva were examined during exercise in students from Asia, Africa, and Latin America. The reactivity of microvessels was found to be increased at the early stages of adaptation, which indicates a high-level compensatory potential of the organism. An appreciable reduction of microvessel reactivity after 1 to 2 years of university studies indicates a decrease of the compensatory potential in this period of adaptation. After 4-5 years of studies the reactivity of the microvessels is virtually the same in foreign and Russian students, this indicating the formation of a stable phase of adaptation.

Key Words: *microcirculation; adaptation; conjunctiva; exercise*

Human adaptation to a different climate is an interesting topic due to the intensive industrial development of regions with the extreme natural conditions, when professionals find themselves having to switch from one climatic zone to another. The reserve potential of the organism, which can be assessed from the reaction to various test exposures, is an indicator of the efficacy of adaptation [4-6]. Dosed exercise, which permits assessment of the adaptive mechanisms at the level of the microcirculation by examining the reactivity of microvessels, is one such tests.

Our previous studies [8,9] showed that the migration [to Russia] of students from countries situated in different climatic and geographic zones with a hot climate involves the restructuring of adaptation. Students' health status and performance depend on the efficacy of adaptation.

This research was aimed at investigating the reactivity of microvessels in students in order to assess the reserve potential of the organism at various stages of adaptation.

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MATERIALS AND METHODS

Students from Africa, Asia, and Latin America were examined at various periods of their stay in Central Russia. Native Russian students were examined for control. A total of 480 subjects were examined. The microcirculatory bed of the eyeball conjunctiva was examined as being the most accessible part of the body for *in vivo* analysis of the microcirculation.

Vital microscopy of the conjunctival microcirculation was carried out using a photoslit lamp, followed by morphometry of structural parameters of the microvessels.

Bicycle ergometry (60 rpm pedaling velocity, 1.5-2.0 W/kg power, duration 5 min) was used.

RESULTS

During biomicroscopy of the eyeball conjunctiva, all the compartments of the microcirculatory bed showed up well against the white background of the sclera. In the foreign students pigmentation of different degrees was found, localized in various regions but most frequently in the perilimbic zone (Fig. 1). Pigmentation was more often observed in

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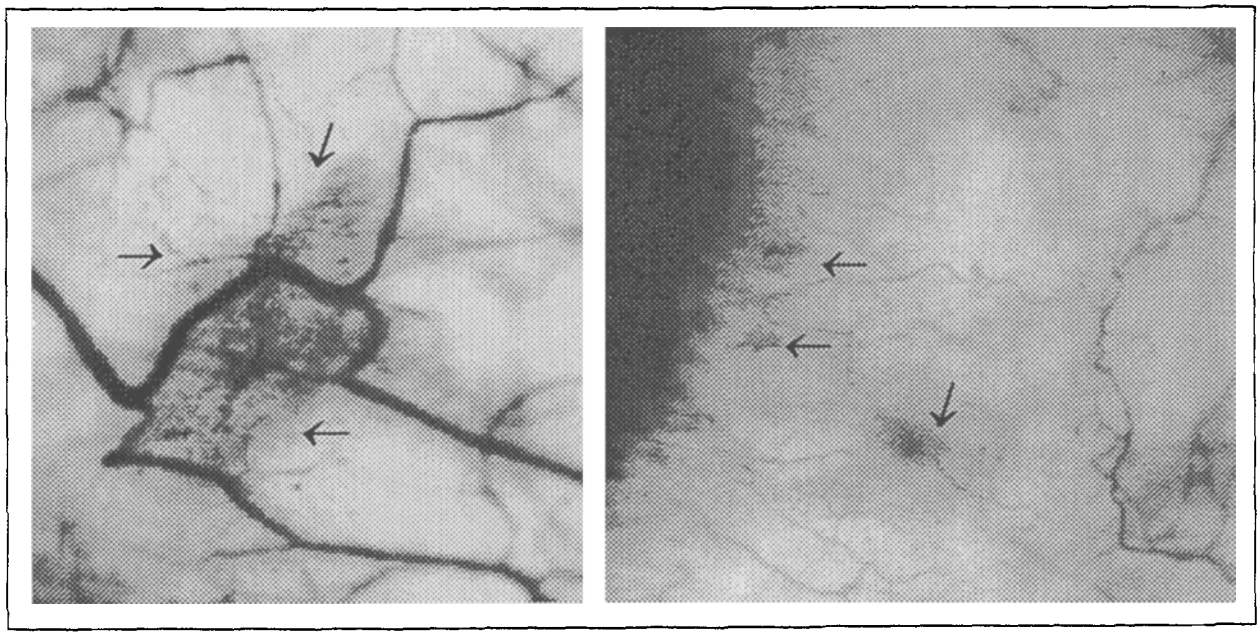

Fig. 1. Pigmentation of the eyeball conjunctiva (indicated by arrows). Here and in Fig. 2: biomicrophotograph, photoslit lamp, ×6.

students from Africa (95%) and South-East Asia (65%), less so in students from the Middle East (42%) and Latin America (21%). In Latin American students pigmentation was seen only in those of African or Asian origin. It is possible that the high degree of isolation of these regions of the world is one of the causes of the increased content of pigment. We focused on the presence of pigment because pigmentation in the conjunctiva is a pathological sign [2], often associated with changes in the microvessels: irregular diameter, microaneurysms, and increased tortuosity at sites of pigmentation. Matrix analysis of correlations between pigmentation and conjunctival microcirculation showed a high correlation between pigmentation, diameter of second-order capillaries and venules, and, last but not least, the transverse deformation coefficient.

Analysis of the findings of biomicroscopy of the conjunctiva during exercise demonstrated a reaction to it in all portions of the microcirculatory bed in newly arrived students (Fig. 2), the arteriolar vessels being the least reactive (resistive). Figure 3 shows that first- and second-order arterioles

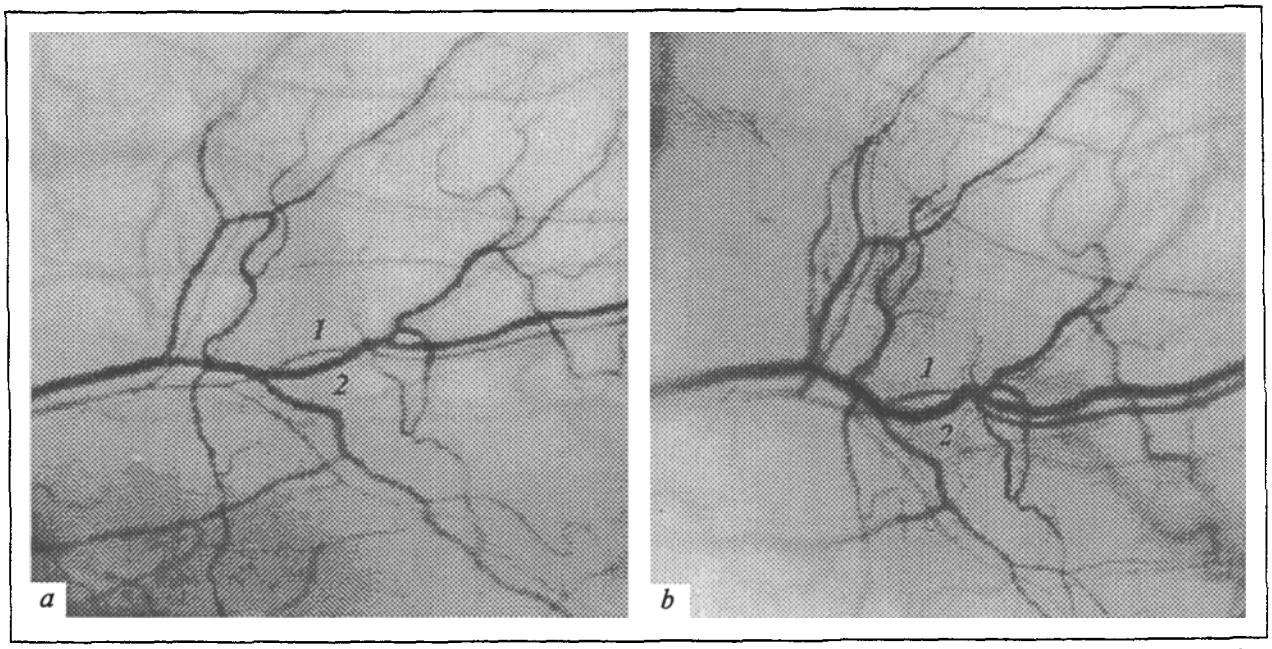

Fig. 2. Dilatation of microcirculatory vessels of the eyeball conjunctiva in response to exercise. *a*) before exercise; *b*) after exercise; *1*) arteriole; *2*) venule.

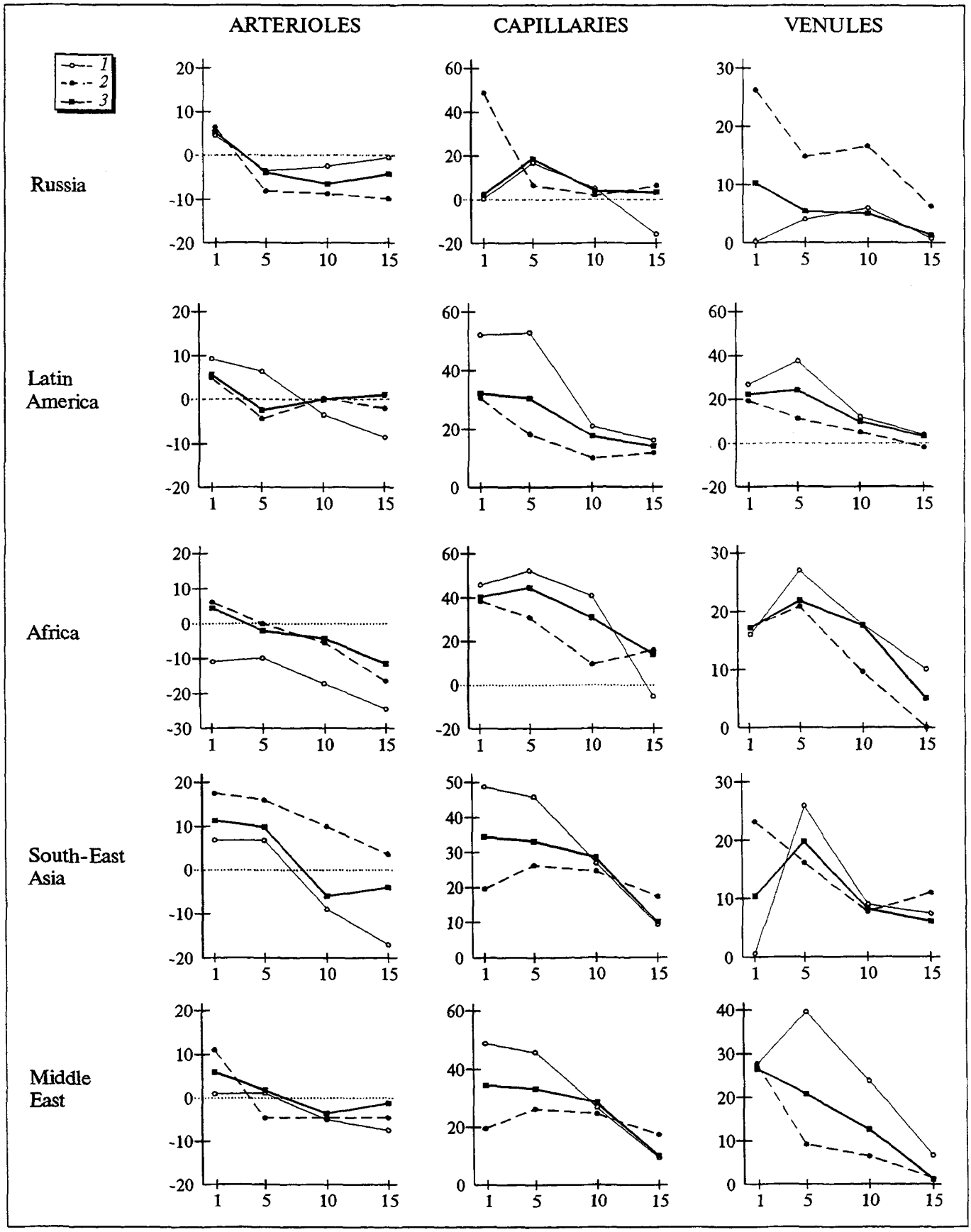

Fig. 3. Reactivity of the eyeball conjunctiva microcirculatory vessels in students in response to exercise soon after their arrival in Russia (*1*), after 1 year (*2*), and after 5 years (*3*) of studies. Abs.: time postexercise, min; ord.: vessel diameter, % of the initial.

react to exercise least of all. It is interesting that spasm is observed after a 10-15-min recovery period following a negligible dilatation. This indicates an increased tone of resistive vessels in the recovery period. The arterioles are responsible for maintaining the tone in the microvascular networks and for redistributing the blood flow in them [6,10,13]. A marked increase of the tone leads, as a rule, to the development of pathological processes [11]. Capillaries (exchange vessels) and venules (volumic vessels) are characterized by the highest lability and elasticity of the vascular wall [10,13]. Our findings also evidence that capillaries are the most labile (Fig. 3), dilating by as much as 42-64% after exercise in foreign students but only by 15% in native Russians. Venules are highly labile, too, particularly the postcapillary ones (Fig. 3).

Hence, dilatation of the volumic and exchange vessels, increased blood flow in arteriovenular anastomoses, and increased rate of the blood flow are indicative of a high reactivity of microcirculatory vessels, this, in turn, being evidence of a high-level compensatory potential of the organism drawing from reserves present at the earliest stages of adaptation.

After a year of studies the pattern of changes of microvessel reactivity in response to exercise changed. It is worth noting that the reactivity increased in Russian students, which may be regarded as adaptation to increased intellectual activity at a higher institution [14]. In foreign students the reactivity of microvessels dropped, i. e., the diameter of capillaries was 31% increased in the Russian students, as compared to the period when studies had just begun. In students from Latin America capillary diameter was 40% lower, in Africans 14% lower, in students from South-East Asia 24% lower, and in those from the Middle East 20% lower than at the time of their arrival.

A similar tendency for the conjunctival microcirculation to change was observed in foreign students after 2 years of studies.

Hence, the reactivity of the microcirculatory vessels is lowered in foreign students after 1-2 years in Russia, which is indicative of a reduced reserve potential of the organism in this period of adaptation. An increased incidence of diseases during this period is further proof of the decline of the compensatory potential in students from Asia, Africa, and Latin America.

The reactivity of the microvessels gradually increases after 3-4 years in Russia and attains the level observed in Russian students after 5-6 years of studies, when we may speak of the establishment of a stable phase of adaptation.

During the 6th year of studies an increase of microvessel reactivity in response to exercise is observed in many foreign students in comparison with Russians. Many reports indicate that the body's resistance to various environmental factors increases in the course of adaptation [1,3,4,11]. Our study is one more confirmation of this assumption.

REFERENCES

1. R. I. Asfandiyarov, A. E. Laz'ko, M. V. Laz'ko, and S. B. Motalin, *Morfologiya,* № 2, 64-70 (1992).
2. G. S. Zefirova, G. V. Ibragimova, and A. V. Kondrat'eva, *Vopr. Endokrinol.,* № 8, 43-45 (1983).
3. V. P. Kaznacheev, *Current Aspects of Adaptation* [in Russian], Novosibirsk (1980).
4. V. P. Kaznacheev and L. E. Panin, in: *Human Adaptation to Various Climatic, Geographic, and Industrial Conditions* [in Russian], Vol. 1, Novosibirsk (1981), pp. 7-9.
5. V. I. Kozlov and T. M. Soboleva, *Teor. Prakt. Fiz. Kul'tury,* № 6, 29-31 (1979).
6. V. I. Kozlov and I. O. Tupitsyn, *The Microcirculation during Muscular Activity* [in Russian], Moscow (1982).
7. V. I. Kozlov, O. A. Terman, and L. M. Likhacheva, *Morfologiya,* № 2, 78-85 (1992).
8. N. V. Krylova, T. M. Soboleva, and S. V. Kolobov, *Arkh. Anat.,* № 8, 54-61 (1985).
9. N. V. Krylova and T. M. Soboleva, *The Human Microcirculatory Bed* [in Russian], Moscow (1986).
10. V. V. Kupriyanov, *Arkh. Anat.,* № 1, 5-11 (1987).
11. F. Z. Meerson, *Pathogenesis and Prevention of Stress-Induced and Ischemic Damage to the Heart* [in Russian], Moscow (1984).
12. N. V. Timushkina, *Zdravookhr. Kirgizii,* № 3, 22-25 (1986).
13. A. M. Chernukh, P. N. Aleksandrov, and O. V. Alekseev, *The Microcirculation* [in Russian], Moscow (1984).
14. A. G. Shchedrina, *Gig. San.,* № 5, 18-21 (1981).