COMPARATIVE STUDY OF CAPILLARY BLOOD FLOW IN HYPERTENSION OF VARIED ORIGIN

I. M. Belen'kaya

UDC 616.12-008.331.1-07:616.16-008.1-07

KEY WORDS: arterial pressure; hypertension; capillary circulation.

The comparative study of the capillary circulation in primary and secondary arterial hypertension, especially of renal genesis, has been the subject of few investigations [6, 8, 10].

The object of the present investigation was to compare the capillary circulation in essential hypertension (EH) and in chronic diffuse diseases of the kidneys accompanied by hypertension (renal hypertension – RH). Parallel with this, the constituents of the plasma with a known effect on the suspension stability of blood (fibrinogen, globulins, β-lipoproteins) were determined. The heparin activity of the blood plasma and the presence of fibrinogen B, the effect of which on the capillary circulation had not previously been studied, also were investigated.

EXPERIMENTAL METHOD

The method of contact microscopy, by means of a modified mass-produced MLK-1 contact luminescence microscope, was used for the investigation [1]. Capillaries of the buccal mucosa served as the test object. Altogether 33 persons with EH and 68 patients with RH were investigated. A control group consisted of 30 subjects.

To analyze the dependence of the capillary blood flow on the arterial pressure level the two groups of patients were divided into three subgroups depending on the severity of the hypertension, in accordance with the criteria used to divide EH into stages in accordance with the WHO 1972 classification. The character of the blood flow (CBF) in the capillaries was assessed by the classification of Bloch and Ditzel, in V. F. Bogoyavlenskii's modification: K_0) fast and uniform blood flow; K_1) fast, bead-like blood flow; K_2) interrupted, dots and dashes, pulsatile blood flow in places; K_3) granular, to-and-fro blood flow with signs of stasis, and with the presence of empty capillaries.

The fibrinogen concentration in the blood plasma was determined by a nephelometric method, the blood protein fractions by electrophoresis on paper, β-lipoproteins by the method of Burstein and Samaille, the fibrinogen B concentration by means of β-naphthol, and heparin activity by Sirmai's method.

EXPERIMENTAL RESULTS

The capillaroscopic pictures in the two types of pathology were found to have much in common (Table 1). In patients of subgroup 1 edema of the pericapillary tissues already was observed. The capillaries were constricted, lengthened, twisted into figures of eight, corkscrews, and spindles, and microaneurysms appeared. CRF was characterized as K_0-K_1. As the disease progressed, these phenomena became intensified. The blood volume in the capillaries decreased. CRF corresponded to K_2-K_3 in degree II hypertension and K_3 in degree III hypertension. However, differences also were found (Table 1), primarily in the form of unequal changes in the arteriolar and venular limbs of the capillary loops in the two types of hypertension. In RH the two limbs were constricted simultaneously and about equally. In EH the diameter of the arteriolar limb was sharply reduced in stage I and thereafter showed practically no change. These venular limbs, on the other hand, gradually became narrower (Fig. 1). As the diseases progressed, these differences tended to disappear. For instance, whereas in stage I of EH the difference between these indices was highly significant ($P < 0.01$), in

Group for Experimental and Clinical Hematology, I. P. Pavlov Institute of Physiology, Academy of Sciences of the USSR, Leningrad. (Presented by Academician of the Academy of Medical Sciences of the USSR V. N. Chernigovskii.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 91, No. 1, pp. 16-18, January, 1981. Original article submitted January 18, 1980.

Fig. 1

Fig. 2

Fig. 1. Capillaroscopic picture in stage I of EH. Magnification 11.6 × 3.

Fig. 2. Capillaroscopic picture in stage III of EH. Magnification 11.8 × 3.

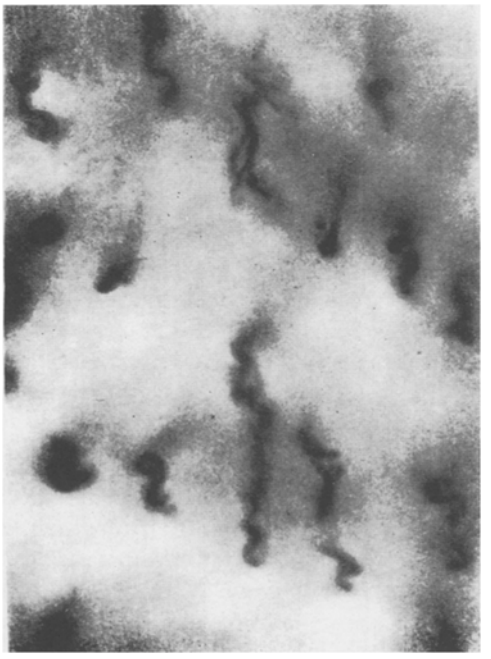

Fig. 3. Capillaroscopic picture in RH with a level of hypertension of the III degree. Magnification 11.6 × 3.

stage II the level of significance was lower ($P < 0.05$), and the difference disappeared completely in stage III. The background of the surrounding tissues was brighter in EH than in RH, but the intensity of the pericapillary edema was less.

In hypertension of degree III the differences increased once again. Whereas in EH in this stage a sharp decrease in tissue perfusion was observed (Table 1, Fig. 2), in RH the picture was quite different (Fig. 3). The

TABLE 1. Comparative Data on Changes in Indices of Capillary Circulation in EH and RH (M ± m)

Index	Normal value	Disease	Hypertension		
			I degree	II degree	III degree
No. of capillaries in field of vision	18±1,2	EH	22±1,3*	20±1,1	16±1,3†
		RH	24±1,0*	19±1,2†	23±2,3
Diameter of arteriolar limb, μ	5,7±0,2	EH	4,0±0,2*	3,5±0,2	3,4±0,2
		RH	4,3±0,2*	3,7±0,2†	3,8±0,2
Diameter of venular limb, μ	6,1±0,2	EH	5,7±0,3*	4,7±0,2†	3,9±0,3
		RH	4,6±0,2*	4,0±0,2†	4,0±0,2
Length of capillary, μ	130±10,5	EH	168±9,1*	201,9±14,2†	218,3±9,5
		RH	161,6±6,2*	183,2±8,9	168,8±13,8

Legend. Here and in Table 2: *) significance of differences from normal; †) significance of differences from corresponding value in previous group.

TABLE 2. Comparative Changes in Blood Biochemistry in EH and RH depending on Level of Hypertension (M ± m)

Index	Normal value	Disease	Hypertension		
			I degree	II degree	III degree
Fibrinogen B, %	0,22±0,025	EH	0,34±0,028*	0,46±0,03†	0,46±0,04
		RH	0,42±0,03	0,46±0,04	0,48±0,02
Total protein, %	6,5±0,3	EH	6,4±0,2	6,8±0,2	6,9±0,2
		RH	6,4±0,2	6,8±0,2	6,9±0,2
A/G ratio, %	1,5±0,04	EH	1,47±0,08	1,4±0,05	1,34±0,05
		RH	1,24±0,05*	1,17±0,05	1,14±0,06
β-Lipoproteins, mg %	600±72,3	EH	775,0±129,0	856,0±99,0*	943,6±82,4
		RH	775,0±99,1	947,0±107,5	992,0±157,0
Heparin activity, sec	6,3±1,7	EH	7,9±0,7	8,3±0,6	9,7±0,8*
		RH	8,8±0,8	9,3±1,9	11,2±1,4*

background of the surrounding tissues was pink and the pericapillary edema was sharply defined. The diameter and number of the functioning capillaries were increased. Correspondingly their degree of deformation was reduced, the loops were shortened, and they were more completely filled with blood.

The direction of the changes in the biochemical indices was the same in both cases (Table 2). Fibrinogen B appeared. It was found in the patients with hypertension of the II (in 40% of cases) and III degree (in 50%). Its presence in the blood of patients with RH was detected as early as in degree I hypertension (in 22% of cases), and thereafter the frequency of its detection increased (in 45% of cases with degree II of hypertension and in 65% of cases with degree III). Direct correlation was found between the degree of disturbance of CRF (the intensity of the sludging phenomenon) and the fibrinogen B concentration ($r = 0.46$, 0.67, and 0.65 for hypertension of the I, II, and III degrees, respectively, in patients with EH and $r = 0.46$, 0.52, and 0.61, respectively, in patients with RH) and between CRF and the β-lipoprotein concentration ($r = 0.21$, 0.30, and 0.52 in EH and $r = 0.26$, 0.52, and 0.61 in RH). A relationship of the opposite kind was observed between CRF and the blood heparin activity ($r = -0.26$, -0.37, and -0.46 in EH and $r = -0.42$ and -0.49 in RH). The detection of fibrinogen B also was accompanied by marked erythrocyte aggregation.

The negative effect of an increase in the fibrinogen B concentration and β-lipoproteins on the capillary circulation in hypertensive states is in agreement with data in the literature [2, 11-13]. In the present investigation a negative effect of fibrinogen B, an indicator of intravascular clotting [4], on the capillary circulation and the positive effect of elevation of the blood heparin level, counteracting erythrocyte aggregation, were established.

Changes in the capillary circulation were phasic in character in each type of hypertension. The differences were revealed most clearly in stages I and III and were considerably reduced in stage II. In all probability this reflects the dynamic character of the pathogenetic disturbances in the two forms of hypertension as well as the closeness of the pathogenetic mechanisms at a particular stage of the disease [3, 5, 7, 9]. The unequal changes in the arteriolar and venular limbs of the capillary loops detected at important stages of the disease evidently reflect differences in their regulation that exist also under normal conditions.

LITERATURE CITED

1. I. M. Belenkaya, I. L. Zarubina, and L. V. Spitkovskaya, Arkh. Anat., No. 1, 72 (1977).
2. L. I. Berezinskaya and L. S. Baiteryakova, Vestn. Oftal'mol., No. 1, 11 (1963).
3. V. F. Bogoyavlenskii, Kazan. Med. Zh., No. 4, 306 (1976).
4. É. I. Daktaravichene, in: Abstracts of Proceedings of a Scientific Conference of Cardiologists of Lithuania [in Russian], Kaunas (1964), p. 29.
5. I. M. Zaalishvili, "Investigations of the peripheral circulation in essential hypertension," Author's Abstract of Doctoral Dissertation, Tbilisi (1952).
6. D. M. Zubairov, I. V. Litvinov, I. V. Soboleva, et al., Kazan. Med. Zh., No. 3, 60 (1975).
7. N. D. Kitaeva and M. M. Porotikova, Kazan. Med. Zh., No. 4, 23 (1974).
8. F. Ya. Primak, Med. Zh., No. 1, 79 (1949).
9. Yu. D. Romanov, Klin. Med., No. 8, 39 (1958).
10. A. I. Strukov and A. M. Vorob'eva, Kardiologiya, No. 11, 8 (1976).
11. A. M. Chernukh, P. N. Aleksandrov, and A. V. Alekseev, The Microcirculation [in Russian], Moscow (1975).
12. A. M. Chernukh, P. N. Aleksandrov, and D. I. Shagal, Kazan. Med. Zh., No. 4, 302 (1976).
13. E. Maggio, Microhemocirculation: Observable Variables and Their Biologic Control, Springfield (1965).
14. T. Suzuki, S. Tominaga, and T. Nakamura, Microcirc. Res., 12, 319 (1976).
15. R. Wells (ed.), The Microcirculation in Clinical Medicine, New York (1973).

EFFECT OF ELECTROACUPUNCTURE ON MANIFESTATIONS OF EMOTIONAL STRESS DUE TO PAIN

B. V. Andreev, Yu. N. Vasil'ev, Yu. D. Ignatov, A. T. Kachan, and N. N. Bogdanov

UDC 615.814.1.015.4:613.863

KEY WORDS: acute emotional stress; electroacupuncture; diazepam.

An important factor in the search for methods of correcting emotional stress is the study of mechanisms of formation and triggering of endogenous stress-protective systems, to which, in the modern view, the positive-reinforcing and antinociceptive systems of the brain belong [4]. It can be tentatively suggested that one possible way of triggering these antistressor systems may be by acting on specific acupuncture points, for the data already obtained are evidence that the use of acupuncture, in certain situations, can abolish a state of distress [8].

The object of the present investigation was to study the stress-protective action of acupuncture and to compare it with the effect of a typical antistressor agent from the group of benzodiazepine tranquilizers, namely diazepam, which has a distinct action on positive reinforcement systems and on antinociceptive mechanisms [2, 5].

EXPERIMENTAL METHOD

Experiments were carried out on 73 male rats weighing 250-300 g. Stress was induced by a modified Zabrodin's [7] technique, under conditions of immobilization, by electrical stimulation of the base of the tail (20 Hz, 10 msec, 30 V) with needle electrodes for 3 h, for periods of 30 sec every 2.5 min.

Electroacupuncture was carried out by means of standard acupuncture needles corresponding to the Da-Chui (TM-14) acupuncture point, throughout the period of stressor stimulation. This point was chosen on

Department of Pharmacology, Academician I. P. Pavlov First Medical Institute, and Course in Reflex Therapy, S. M. Kirov Postgraduate Medical Institute, Leningrad.

(Presented by Academician of the Academy of Medical Sciences of the USSR V. G. Baranov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 91, No. 1, pp. 18-20, January, 1981. Original article submitted February 12, 1980.