THE INFLUENCE OF CORTICAL FACTORS ON PHAGOCYTOSIS

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The effect of the cerebral cortex on phagocytosis of structural elements of blood (neutrophil granulocytes) is related to the problem of influencing the vegetative functions of the central nerve system although a direct neural connection between the stated functions is non existant.

Numerous data prove that strong emotions influence the phagocytosis of neutrophil leukocytes and opsonification properties of the serum (11, 12). An increase of phagocytosis is established after excitation of the central nervous system with caffeine and thyroiodine and accordingly — reduction following inhibition with bromine and luminal (20). The presence of central nerve mechanisms in the regulation of phagocytosis has been proved through experimentation after the method of „tête isolée" (26), whereas the role played by the vegetative nerve system — by extirpation of the superior cervical sympathetic ganglion and blocking of the sympathicus with dehydroergotamine (1, 27). The importance of the cerebral cortex for phagocytosis is demonstrated by means of data obtained according to the method of conditioned reflexes (1, 23, 26, 27). Moreover, in the literature there is a vast number of publications proving the cortical influence upon structural elements of the blood and on a number of vegetative functions in the organism (6, 7, 8, 29, 30, 31). Our goal in the present work is to follow up the influence of strong cortical excitation during examination, exerted upon phagocytosis of neutrophil granulocytes, proceeding from already established facts in literature and from the fact established by us, namely, that in strong cortical excitation excitability as regards adrenalin in the priphery is strongly raised (29).

Method

The studies were carried out on a series comprising 36 male university students during the period of the June session of 1965, in the morning between 8 and 9 o'clock, during examination. As a control group 12 males were used which were not going for examinations. The individuals studied were clinically healthy, aged between 21 and 40 years.

Phagocytosis was studied according to the method of Wright and Douglas as modified by Valchanov (4,5). A killed 24-hour-old agar culture of staphylococcus aureus, strain 209, density 2 milliards per ml was utilized as material subject to phagocytosis; manipulations were carried out under aseptic conditions (free of microorganisms), perfoming all investigations

with the same citrate solution and bacterial culture. After keeping it in a thermostat for 20 min, bacteria smears were prepared from the suspension citrate blood, and following fixation in methyl alcohol, they were stained after Romanovski — Gimsa. The phagocytized bacteria were counted in 100 clearly outlined neutrophil granulocytes, and thereby the phagocytic index was figured out. In addition, the instances of nuclear participation in the phagocytosis were likewise recorded; the data were elaborated after the method of variation statistics.

Results and Discussion

The results of the investigations on the phagocytic activity of neutrophil leukocytes, obtained from the blood of the experimental group, demonsrtate that the phagocytic figure in all 36 investigated individuals is within the limits of 5.26 to 10.47 (mean 8.49), while the phagocytic number in the control group fluctuates within the 3.24 to 4.84 range (mean 4.24) (Table 1). The differences established in the phagocytic number between the experimental and control groups are statistically reliable (P (t) > 0.999). Thus, an increase of phagocytosis was established among individuals during examination with an average of 200 %, with index of the control group accepted for 100%.

In our opinion, this elevated phagocytic activity of neutrophils is believed to be due to the hyperadrenalinemia (23), characteristic for anxiety reactions, activated through the hypothalamus on account of strong cortical excitation. Therefore, we support the hypothesis postulated by most of the

Table 1

Experimental group				Control group			
№	Phagocytic number	№	Phagocytic number	№	Phagocytic number	№	Phagocytic number
1	8,98	13	7,44	25	10,42	1	4,91
2	6,99	14	6,99	26	7,97	2	4,84
3	9,05	15	7,44	27	8,20	3	4,48
4	7,82	16	9,03	28	7,22	4	4,69
5	10,06	17	9,09	29	9,19	5	4,52
6	10,74	18	5,99	30	13,38	6	4,64
7	9,10	19	8,11	31	8,15	7	4,05
8	5,26	20	7,92	32	7,58	8	3,52
9	8,58	21	8,78	33	9,61	9	4,62
10	6,62	22	8,63	34	8,43	10	3,25
11	10,30	23	8,79	35	10,61	11	4,14
12	7,81	24	8,17	36	7,29	12	3,24
	Mean arithmetical				8,49		4,24
	Standard deviation			±	1,48	±	0,60
	Average error			±	0,24	±	0,17

$P_{(t)} > 0.999$

authors that the sympathicus and adrenalin stimulate phagocytosis (1, 11, 14, 15, 17, 23, 26, 27) and furthermore, that this stimulation results from the direct effect of adrenalin exerted upon the neutrophils, and is not dependent on opsonins (1). We believe moreover, that the increased phagocytic activity

Fig. 1. Nuclear phagocytosis in neutrophil granulocyte (× 16 000)

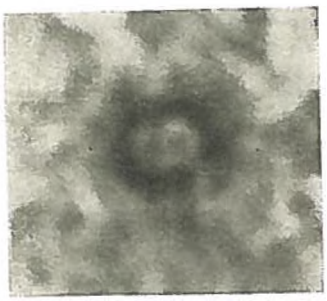

Fig. 2. Nuclear phagocytosis in monocyte (× 16 000)

of neutrophils might very likely be also due to their raised sensitivity to adrenalin, being the increased sensitivity to adrenalin previously established by the authors of the paper in relation to other peripheric structures during intense cortical excitation (29). Possibly, the stated increased sensitivity of the peripheric structures to adrenalin is conditioned by other factors in instances of „stress", as corticoadrenal hormones, anterior portion of the hypophysis, histamine etc. (12).

As regards the intimate mechanism by way of which phagocytosis is directly altered under the effect of adrenalin, it might be assumed that it implies an increase of oxygen consumption in the cells (9) and stimulation of anaerobic gluco- and glycogenolysis (19, 21, 32), as the main energetic source of the neutrophils is the splitting of glucose and glycogen (2, 10, 14, 16, 22, 25). Furthermore, it is quite possible that desintegration products as well, in addition to adrenalin, account for stimulation of phagocytosis. In accordance with investigations carried out by Utevskii (21), certain products of the quinoid desintegration of adrenalin exert an influence on a number of enzymatic processes, included glucolysis.

During investigation of phagocytosis in the experimental group, nuclear phagocytosis was also noted in some cases (Fig. 1, 2). As clearly illustrated in the photographs enclosed, made with rather great magnification (× 16 000), in the nucleus, around the streptococcus, a bright vacuole can be observed, proving that in this case really nuclear phagocytosis is concerned.

Of the total number of investigated in the experimental group, participation of the nucleus in phagocytosis was recorded in 44.63% of the cases, whereas in the control group such was not disclosed in any of the cases. Nuclear phagocytosis was established in the neutrophil granulocytes, monocytes and lymphocytes. In 80% of the total number of cases with nuclear phagocytosis the sitting for examination was made for the third, fourth and fifth time. Very likely, the more frequent cortical excitation and its product —

hyperadrenalinemia — lead to a more intensive stimulation of metabolic processes in the phagocytes, as a result of which the nucleus too is included in the phagocytosis.

Table 2

	Age groups	
	21—30	31—40
Number of individuals investigated	29	7
Mean phagocytic number	8,60	8,03

$P_{(f)}0,90$

Regardless of the explanation offered, data indicating the participation of the nucleus of leukocytes in the state of severe cortical excitation were not encountered in literature reports.

An other fact was also demonstrated by our investigations, namely, that with advance of age the phagocytosis in the experimental group was decreased (Table 2). The phagocytic index for the individuals in the 31—40 years age-group is lower than that of subjects aged 21—30 years, with a guaranteed probability amounting to $P>0.90$.

Possibly, the latter finding is conditioned by the stabilization of the basic cortical processes in adult age, reflected upon the sympathetic-adrenal reactivity, as a result of which the neutrophil granulocytes react by a weaker increase of phagocytosis.

Inferences

1. The state of strong cortical excitation accounts for stimulation of phagocytosis in neutrophils from × 126.41% to 315.56%, with an average of 200%.
2. Participation of the leukocyte nucleus is observed in phagocytosis, most frequently recorded in individuals subjected for the III, IV and V time to strong cortical excitation (80%).
3. Phagocytosis in the experimental group is rendered weaker with increase of age.
4. The increased phagocytosis and participation of the nucleus in it is effected most probably with the parallel participation of the stimulated by adrenalin gluco- and glycogenolysis.

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ВЛИЯНИЕ КОРКОВЫХ ФАКТОРОВ НА ФАГОЦИТОЗ

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РЕЗЮМЕ

Авторы исследуют влияние сильного возбуждения коры головного мозга (экзамен) на фагоцитоз нейтрофильных гранулоцитов и участие в этом процессе ядра у 36 мужчин. Устанавливается наличие увеличения

фагоцитоза в нейтрофилах в сравнении с контрольной группой на 126,41—315,56%.

У 44,66% исследованных лиц из подопытной группы наблюдается и ядерный фагоцитоз, причем в 80% случаев он встречается у лиц, подвергавшихся 3, 4 и 5 раз сильному корковому возбуждению (экзамен). Исследованные лица в возрасте 31—40 лет из подопытной группы показывают более слабо выраженное увеличение фагоцитоза, что объясняется стабилизацией основных процессов в ц. н. с. в зрелом возрасте.

Принимается, что интимный механизм увеличения фагоцитоза является результатом непосредственного влияния адреналина на анаэробные гликогенолиз и гликолиз, вероятно, по пути стимуляции при помощи циклической формы адениловой кислоты образования фосфорилазы А.

Ядерный фагоцитоз объясняется также гиперадреналинемией, которая наступает при сильном возбуждении коры головного мозга, причем считается, что под воздействием адреналина усиливаются некоторые звенья метаболизма ядра.