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SCANNING ELECTRON MICROSCOPY OF RAT BLOOD MONOCYTES DURING LONG-TERM EXPOSURE TO ETHANOL

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Long-term exposure to ethanol leads to lowering of the body's resistance to unfavorable factors [3, 8, 11]. However, the mechanisms of interaction of the body with ethanol and of maintaining its optimal level of resistance have not been adequately studied. Hence the need for an experimental study of the unfavorable action of ethanol on the structural and functional state of the cellular systems that play an important role in maintaining homeostasis. One such system is that of the mononuclear phagocytes (MPS), a single cell line in the process of differentiation from monocytic bone marrow precursors to tissue macrophages [2, 11]. Great importance is attached to the study of disturbances of the structure and function of the blood monocytes — the only cells of the human MPS accessible for clinical-laboratory investigation.

The aim of this investigation was to study the trend of changes in the structural and functional state of blood monocytes during long-term peroral exposure of rats to ethanol.

EXPERIMENTAL METHOD

Experiments were carried out on noninbred male rats weighing initially 180-230 g and receiving ethanol continuously for 2, 5, and 10 months with their drinking water (ad libitum) in a concentration of 100 g/liter. The reason why females were chosen for the experiments was that according to data in the literature, the unfavorable effect of ethanol develops earlier in females [5]. Six groups of animals were used (six rats in each group), and of this number three groups were controls. The structural and functional state of the blood monocytes was analyzed by scanning electron microscopy of cell monolayers obtained on coverslips during culture of mononuclear cells (monocytes and lymphocytes), isolated from blood by centrifugation in a Ficoll-Verografin density gradient [1, 10], for 1 h. Blood (4 ml) was taken from the abdominal aorta of the rats, anesthetized by intraperitoneal injection of Medinal in a dose of 50 mg/kg. Specimens for scanning electron microscopy were prepared as described previously [6, 7]. The preparations were studied and photographed on a Hitachi N-3010 scanning electron microscope (Japan), with an accelerating voltage of 20 kV.

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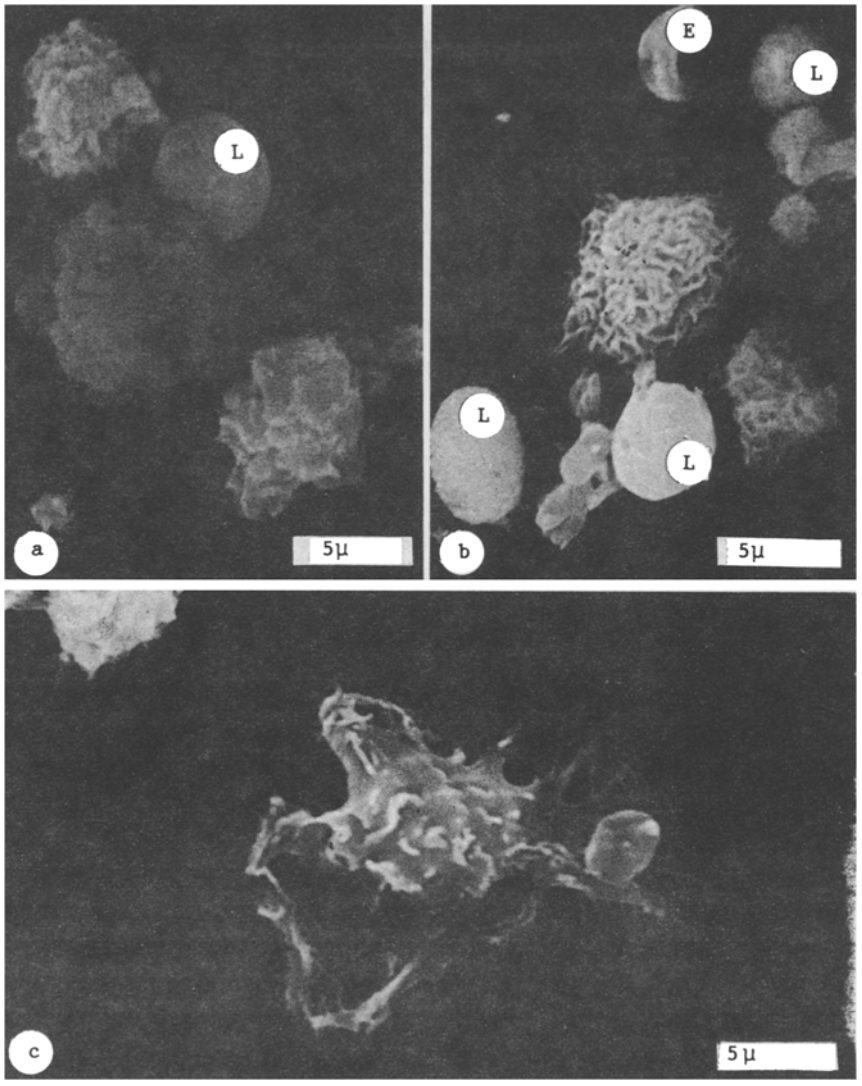

Fig. 1. Blood monocytes from intact rats (a) and rats exposed for 2 months to ethanol (b, c).
Here and in Fig. 2: L) lymphocyte-like cells, E) erythrocytes.

EXPERIMENTAL RESULTS

Ethanol, after an exposure of 2 months, caused enlargement of the folds on the surface of the monocytes and increased their adhesive and phagocytic activity (Fig. 1). Adhesion and spreading of the monocytes from the experimental rats over the glass took place mainly with the aid of a large number of filopodia and lamellopodia, of varied diameter, whereas in the case of intact animals, spreading of the cells took place in the form of a single lamelloplasm. Interaction of monocytes with lymphocytes also was intensified in the experimental rats.

After 5 months of exposure to ethanol, marked smoothing of the surface of the monocytes took place, and they frequently seized erythrocytes and lymphocytelike cells with the aid of small filopodia Craterlike "holes" and vesicular formations could be seen on the surface of the monocytes (Fig. 2). The cells were elongated in shape and their adhesive activity was depressed.

After exposure to ethanol for 10 months, large monocytes, often as much as 50 μ in diameter, appeared in the blood. The cells possessed strong adhesive powers, but on spreading they did not form a complete thin circular disk, but continued to have formations resembling vesicles on their dorsal surface, with holes and lacunar invaginations among them.

Thus after all periods of exposure studied, ethanol induced activation of the phagocytic function of the blood monocytes. Strengthening of interaction of monocytes with lymphocytes, observed at the 2nd month of the experiment, probably reflected

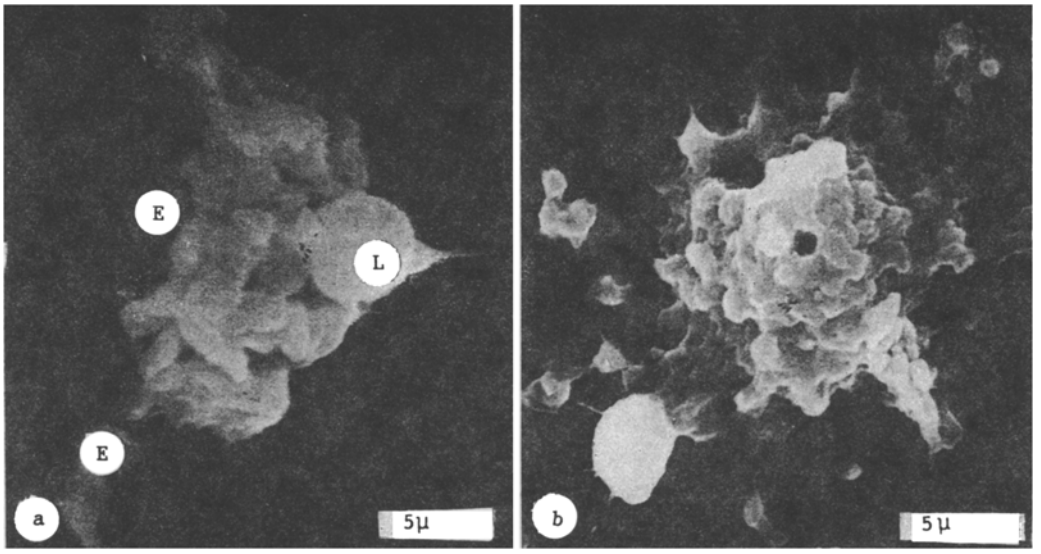

Fig 2. Blood monocytes of rats exposured to ethanol for 5 (a) and 10 (b) months.

the development of immune reactions, aimed at securing nonspecific and specific protection of the body against the unfavorable action of ethanol. The holes and invaginations on the surface of the cells discovered at the 5th and 10th months of the experiment were possibly the result not only of phagocytosis of large particles, but also of activation of receptor-mediated phagocytosis [4]. These holes may also have been the result of damage to the cytoskeleton of the monocytes [7].

Activation of the phagocytic function of the monocytes at the 2nd and 10th months of exposure, accompanied by strengthening of their adhesive activity, evidently led to inhibition of the migration of these cells from the blood into the tissues [8]. The latter undoubtedly caused a decrease in the number of tissue macrophages and facilitated the disturbance of homeostasis of the organs.

Changes in the surface architectonics of the monocytes discovered after an increase in the duration of exposure to ethanol demonstrated damage to their structural organization [7], which rendered this cell population functionally inactive.

It was concluded from the results that changes in the structural and functional state of the blood monocytes during exposure to ethanol reflect inhibition of the functional capacity of the MPS. This may be one condition for the development of alcohol addiction, namely systemic involvement of various organs and lowering of the resistance of the body to the action of pathogenic agents.

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