were evidently connected with their depolymerization under the influence of the pituitary extract injected into the lateral ventricle.

Changes in GAG found in the choroid plexus resemble greatly those observed in the interstitial tissue of the renal medulla during hydration and under the influence of vasopressin. Interaction of GAG and mucolytic enzymes of hyaluronidase type in the kidneys is known to lie at the basis of the function of the concentration mechanism. Through these biochemical reactions vasopressin changes the permeability of the collecting tubules for water, thus enabling the concentration of the urine excreted to be varied [2, 3]. It can be tentatively suggested that the similarity we have found is not accidental. Very probably GAG play the same role in the choroid plexus as in the kidney, participating in the mechanism controlling permeability of the epithelium for water and determining the quantity of CSF formed.

It has been shown that vasopressin travels along axons of the supraoptic and paraventricular nuclei to reach not only the neurohypophysis, but also the CSF in the cerebral ventricles [5]. Inhibition of its secretion during hydration makes the epithelium impermeable for water, because of polymerization of GAG, and maintains the volume of CSF at a constant level despite the developing hydremia. The increase in vasopressin secretion, typical of dehydration and reduction of the blood volume, increases permeability through depolymerization of GAG and thus facilitates the entry of water into the CSF, to keep its volume constant.

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ULTRASTRUCTURAL STUDY OF LYMPH NODE CELLS IN EXPERIMENTAL BURN TRAUMA

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KEY WORDS: lymph nodes; nerve trauma.

Although the greatest importance is attached to the study of the immunology of burns [1, 7, 8], much still remains unexplained. In particular, there is much evidence of the presence, on the one hand, of hyperplasia of cells of the lymphoid and plasma series in lymph nodes [8, 10] and, on the other hand, of the presence of severe secondary immunologic deficiency in burns [5]. Howard et al. [11] concluded from data in the literature that the main role in the development of immunologic deficiency is played by disturbances predominantly of humoral immunity, but there is no information on the structural pathology of the immunocompetent cells and on their fine structure. This makes differentiation of intermediate forms distinguished purely by ultrastructural features and evaluation of the structural and functional dynamics of the blast transformation process impossible.

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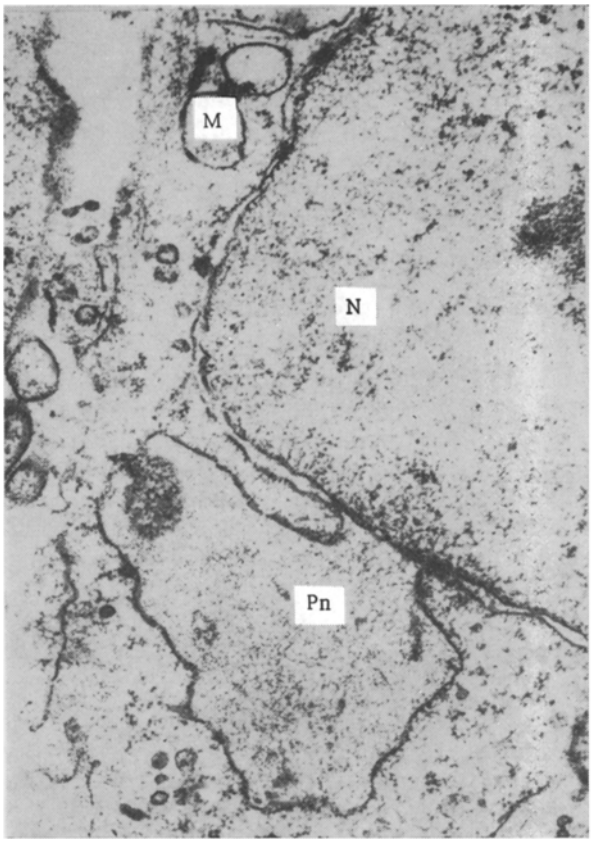

Fig. 1

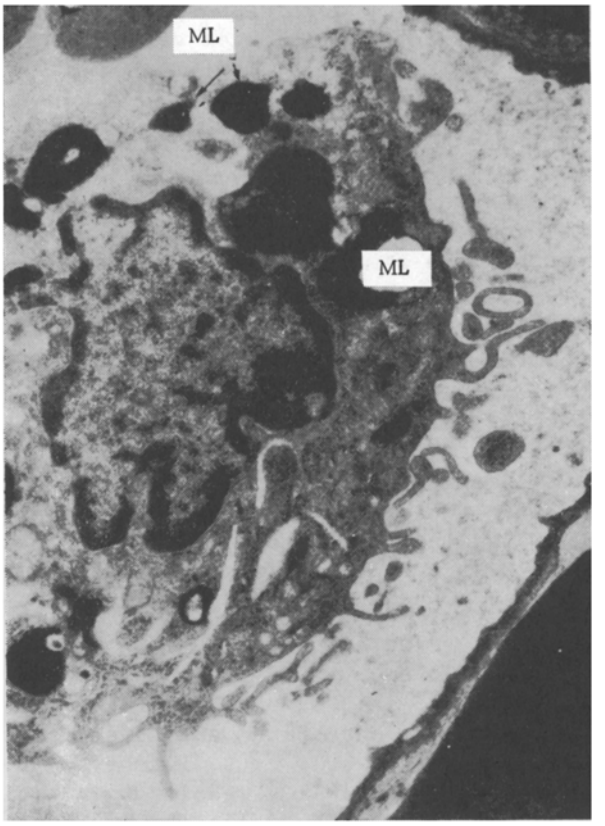

Fig. 2

Fig. 1. Widening of perinuclear space (Pn) and translucency of mitochondria (M) in lymphocytes in burns. N) Cell nucleus. 32,000 ×.

Fig. 2. Increase in number of lysosomes (ML) in macrophage of lymph node. 22,000 ×.

The contradictory nature and inadequacy of the available morphological data were the grounds for undertaking the present investigation.

EXPERIMENTAL METHOD

Experiments were carried out on 22 male rats weighing 250 g on which thermal burns of the IIIB degree covering 18-20% of the body surface were inflicted on the depilated skin of the back. The animals were killed between 6 and 16 days later. The inguinal and axillary lymph nodes were chosen for study, and pieces of them were prefixed in 2% glutaraldehyde and then postfixed in cold buffered OsO_4 solution for 1.5 h, dehydrated, and embedded in the usual way in a mixture of Epon and Araldite. Activity of acid phosphatases, determined by the method of Eriksen and Trump, was used as indicator of lysosomal activity of the cells. Ultrathin sections were examined in the EM-100 CX microscope under a magnification of 10,000-60,000.

EXPERIMENTAL RESULTS

On the first few days after burns of the skin, besides phenomena of hyperplasia of cells of the lymphoid—plasma—cell series, alternating during the first 24 h with plasmacytolysis, the appearance of many juvenile forms of cells of the lymphoid series, with conspicuous and marked widening of the perinuclear space, arising as a result of detachment of the outer nuclear membrane, and constituting the morphologic reflection of disturbance of nucleo-cytoplasmic relations, was observed in the lymph nodes. In some cases widening of the perinuclear space led to the formation of very large "perinuclear cisterns," filled with scanty finely granular contents, occupying a considerable part of the cell. Large lipid inclusions, Gall's granules, and, occasionally, lysosome-like structures were observed in the cytoplasm of the large lymphocytes. Swelling, translucency of the matrix, and reduction and destruction of the cristae were observed in many mitochondria (Fig. 1).

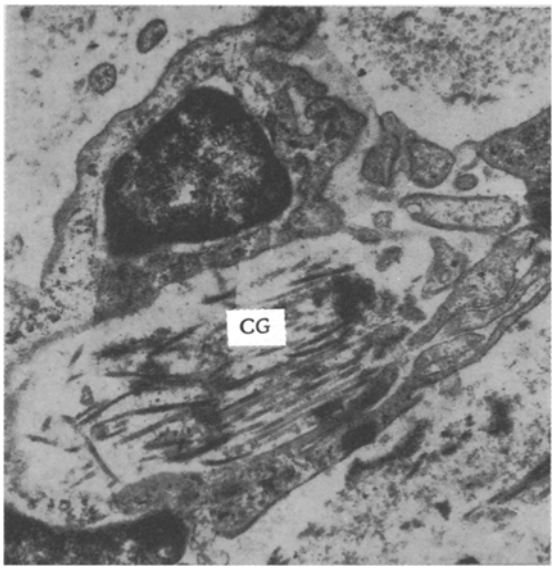

Fig. 3. Vacuoles containing collagen fibers (CG). 20,000 ×.

Considerable changes were observed even in the early stage of trauma in macrophages: widening of the perinuclear space, accumulation of large quantities of lipid inclusions and small myelin-like structures in the cytoplasm, and an increase in the number of ribosomes and polysomes. Meanwhile many mitochondria in various stages of degeneration, and phagolysosomes containing various cellular derivatives, appeared at the same time in the cytoplasm of the macrophages. Even more marked changes in the macrophages were observed in the late stages of burn trauma. The numerous lysosomes and, in particular, phagolysosomes, in which all phases of destruction of the phagocytosed material could be traced, attracted attention. Electron-histochemical investigation revealed marked heterogeneity of acid phosphatase activity in secondary lysosomes and phagolysosomes, evidence of their functional heterogeneity. However, predominance of lysosomes and phagolysosomes with low acid phosphatase activity and with a considerable degree of filling with cell debris (mainly fragments of destroyed mitochondria) in the macrophages at all times of investigation evidently indicated that the macrophages had weak digestive and lytic activity. Frequently lamellar bodies and large vacuoles containing fragments of erythrocytes and ferritin granules (phagocytosis of erythrocytes, according to Bessis' observations) were found in the cytoplasm of the macrophage. Phases of lysis of mitochondrial structures could be clearly seen in some phagolysosomes. In some macrophages, on the other hand, the number of lysosomes was appreciably increased (Fig. 2).

Changes taking place in the lymph node also spread to other cells. Large vacuoles containing fragmented collagen fibers could be seen in the cytoplasm of some neutrophilic leukocytes. These digestive vacuoles evidently perform the role of phagolysosomes, and occupy a considerable part of the cell cytoplasm. Very few neutrophilic granules were present in these cells (Fig. 3). A similar function of macrophagocytosis, just as untypical of neutrophilic leukocytes, has been observed by other workers as a compensatory reaction to the entry of derivatives of destroyed dermis into the lymph nodes: lysis of fibrin by leukocytes, or thrombus formation [13], uptake of antigen–antibody complexes by eosinophilic leukocytes in anaphylactic shock [15], etc.

Much debris, including collagen fragments, was observed in the lumen of the sinuses of the lymph nodes. Uptake of this debris by macrophages is achieved mainly by ropheocytosis: A large invaginate is formed in the cell membrane of a macrophage, which ingests collagen fibers, with the subsequent formation of ropheocytotic vacuoles.

The results of this investigation indicate that marked changes in the cells participating in the process of immunogenesis are observed in the lymph nodes. These changes proceed in two opposite directions. On the one hand, the response to burn trauma in the form of hyperfunction of cells is intensified, as shown by increased activity of the functional structures of the cells: enlargement of the nucleus, widening of the perinuclear space, an increase in the number of ribosomes, enlargement of lysosomes in macrophages [3, 4, 6, 7]. On the other hand, marked degenerative changes are observed in cell organelles, and are

evidently due to their high functional strain and rapid wearing out; primary damage to lymphocytopoiesis and plasmacytopoiesis also is found in severe burn trauma.

The changes in the macrophages listed above play a definite role in the development of immunologic deficiency in burns. According to data of Yarygin et al. [9], enzymic lysis of antigen in the cytoplasm of macrophages precedes the immunologic cellular response and is an essential condition for its development. Delay in degradation of the antigen and disturbance of this process leads to deficiency of the immunologic response. In the present experiments an "overload block" of cells of the macrophage series also was observed. Similar phenomena have been described in the literature [2, 14]. Degenerative changes in lymphocytes, which are transmitters of the immune response and the sources of the blast-transformation reaction [12], also probably play a definite role in the development of immunologic deficiency in burn trauma.

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