FUNCTIONAL ROLE OF INTERCHROMATIN GRANULES OF THE NUCLEUS

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KEY WORDS: interchromatin granules; nucleus; mRNA.

Interchromatin granules (ICG), together with perichromatin granules and perichromatin fibrils (PCF) are extranucleolar ribonucleoprotein particles (RNP particles) universally found in nuclei of eukaryotic cells. ICG are 20-25 nm in diameter and usually form concentrations in the interchromatin zones of the nucleus [6]. Unlike other RNP particles, ICG possess natural contrast in unstained sections, because they contain metallic ions [3]. The main distinguishing features of these particles are the extremely slow incorporation of radioactive label in them [5] and their property of susceptibility to the action of ribonucleases (RNases) only after protease treatment [6, 7]. This last property is evidence that ICG are sensitive to RNases but are protected against them by protein. The metabolic role of ICG has not yet been explained, although there are as yet unconfirmed suggestions that these granules are either nuclear ribosomes or analogous to 30S RNP particles [3].

To study the functional role of ICG, RNP particles in brain tissue cell nuclei were studied from normal animals and after administration of chlorpromazine and during autolysis.

EXPERIMENTAL METHOD

Samples of tissue from the sensomotor cortex of WAG rats weighing 180-200 g were studied. Chlorpromazine was given in a dose of 15 mg/kg. The animals were killed 3 h after injection of the neuroleptic, and for 4 h thereafter the autolytic changes in the nerve tissue cell nuclei were kept under observation. For this purpose samples of tissue were embedded in Epon 812 and ultrathin sections were stained on a Reichert (Austria) ultramicrotome. RNP particles were detected by Bernhard's method [4]. Sections were examined in a Philips (The Netherlands) electron microscope.

EXPERIMENTAL RESULTS

On examination of sensomotor cortical cells from normal animals two or three concentrations of ICG were observed in the nuclei of the neurons (Fig. 1a). Concentrations of smaller ICG were found in nuclei of oligodendroglial cells (Fig. 1b). Only solitary granules of this type were found in the nuclei of endothelial cells (Fig. 1c). During autolysis, against the background of a sharp decrease in the number of PCF, the concentrations of ICG in the nuclei of the various cells remained unchanged (Fig. 2a). In the nuclei of hyperchromic neurons found in brain tissue after administration of chlorpromazine, the dimensions of the ICG concentrations were sharply increased, so that they formed extensive fields (Fig. 2b); under these circumstances the number of PCF was reduced.

Analysis of the results and their comparison with data in the literature [5, 6, 7] suggests that ICG may be a reserve form of nuclear mRNA. The facts supporting this hypothesis can be divided into two groups. The first group is evidence of metabolic stability of the ICG: slow incorporation of radioactive label into ICG during a short incubation time; the high resistance of these particles to RNases, demonstrated in experiments with enzyme treatment *in situ*, and their resistance in the cell nuclei during postmortem autolysis. The second group of facts is evidence of correlation between functional activity of the cells, on the one hand, and the number of ICG, on the other hand. For instance, for normal neurons and hepatocytes whose function is associated with continuous synthesis of a wide range of proteins in considerable quantities, a relatively large number of ICG — the reserve form of

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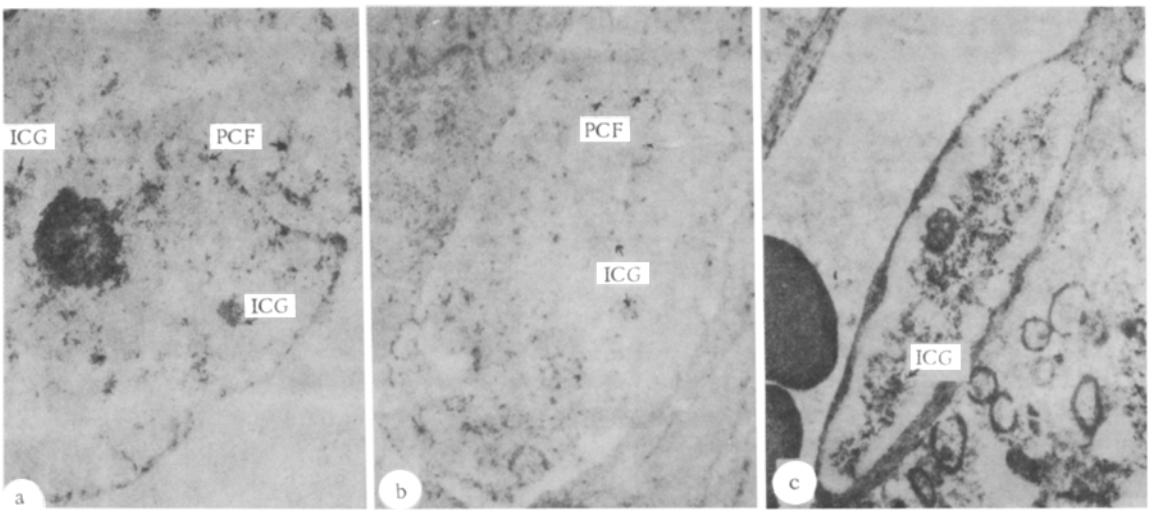

Fig. 1. Nuclei of various rat sensomotor cortical cells stained for RNP (normal conditions). a) Nucleus of normochromic neuron (12,000 ×); b) neuron of oligodendroglial cell (12,000 ×); c) nucleus of endothelial cell (9,000 ×).

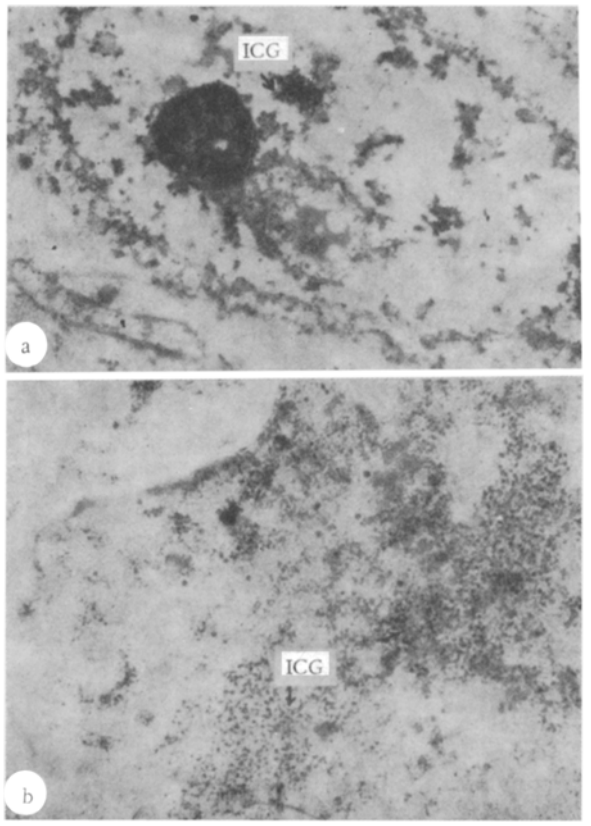

Fig. 2. Nuclei of rat sensomotor cortical neurons stained for RNP. a) 1 h after animal's death (8,000 ×); b) 3 h after administration of chlorpromazine (28,000 ×).

mRNA, is a characteristic feature. For cells of the satellite oligodendroglia, whose activity depends on that of the accompanying neurons, the quantity of reserve RNA ought to be low, as was in fact observed in these cells. Endothelial cells with a very low rate of protein synthesis [2] generally speaking contain only solitary ICG. These facts agree with the results of a study of hyperchromic neurons. Activity of metabolic processes is known to be depressed in the cytoplasm of cells of this type, but RNA accumulates in their nuclei [1]. That is why in hyperchromic neurons during the first few hours after administration of chlorpromazine the newly synthesized RNA, unable to escape into the cytoplasm, must accumulate in the nuclei in its reserve form, namely ICG. The facts examined above thus confirm the hypothesis that ICG has a functional role as the reserve form of mRNA.

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MATHEMATICAL MODEL OF PATHOMORPHOLOGICAL CHANGES IN THE SPINAL CORD DURING PROLONGED COOLING

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No special morphometric investigations or mathematical modeling of the dynamics of adaptive changes in structures of the CNS under the influence of cold could be found in the accessible relevant literature. An important role in adaptation of the body to unfavorable extremal external environmental factors is played by the temperature-sensitive spinal centers [13, 14].

The aim of this investigation was to study and give a mathematical description of pathomorphological changes taking place in structural units (capillary, perineuronal gliocyte, neuron) of the spinal cord of experimental animals during acclimatization to cold.

EXPERIMENTAL METHOD

Altogether 72 experiments were carried out on rabbits weighing 2.5-3 kg. All the animals were divided into two groups (A and B), each of which contained six intact and 30 experimental rabbits. The animals were exposed to cold in a specially equipped chamber at a temperature of between −3 and −5°C and with a relative air humidity of 70-90% for 10-12 h daily for 1, 2, 4, 8, and 12 weeks. At the end of cooling the animals were killed by intravenous air embolism.

After sacrifice of the rabbits of group B their arterial system was injected with a solution of black ink with gelatin [4] in a dose of 50 ml/kg body weight. Autopsy material (segments of the spinal cord) of the experimental and control animals were fixed in 10% neutral formalin solution, and then embedded in paraffin wax in accordance with a unified scheme.

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