Effect of Rotating Electromagnetic Fields on Proteolytic Activity of Pepsin in Rats

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We studied the effect of 37-GHz electromagnetic field on proteolytic activity of pepsin in Wistar rats. The plane of polarization of the electromagnetic fields rotated in either right-handed or left-handed sense (*D*- and *L*-chirality). *D*-Polarization stimulated, while *L*-polarization suppressed pepsin production.

Key Words: *electromagnetic radiation; ultrahigh-frequency electromagnetic radiation; pepsin; proteolytic activity*

Recently, much attention in experimental medicine and biophysics was given to the effect of nonthermal ultrahigh frequency electromagnetic radiation (UHF EMR) on various biological substrates and living organisms [4]. The study of the interaction between nonthermal physical fields and living organism revealed several effectors that are characterized by positive or negative reactions of biological substrates, metabolic processes, and functional systems. The general concept postulates that the structure of a whole living organism is intimately associated with its functions. Any functional manifestation of vital activity at various levels of organization depends on structural changes produced by exogenous and endogenous factors (*e.g.*, UHF EMR). It is important to study individual functional and morphological changes and estimate the relationships in the sequence of events occurring in the system and whole organism. This approach allows us to evaluate the stage for initiation of the organism's response and accurately interpret positive and negative changes [3,4].

Here we studied organism's response to nonthermal UHF EMR. We evaluated the relationship between changes in proteolytic activity of pepsin and morphological characteristics of the gastric mucosa produced by nonthermal electromagnetic fields with the plane of polarization rotating in either right-handed or left-handed sense (*D*- and *L*-chirality) [1,3].

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MATERIALS AND METHODS

Experiments were performed on Wistar rats aging 6-8 months. The animals were divided into 3 groups (10 rats per group). Group 1 rats not exposed to UHF EMR served as the control. Group 2 and 3 rats were exposed to *D*-UHF EMR and *L*-UHF EMR with a frequency of 37 GHz, respectively. The animals were examined on days 1-6 of irradiation. The duration of daily exposure was 15 min. The total time of UHF EMR over 6 days was 1.5 h.

Proteolytic activity of pepsin was estimated by 2 methods. The method of Tugolukov is bases on the ability of pepsin to cleave blood plasma proteins. The method of Adisson—Mirskii with Chernikov's modifications is based on the ability of pepsin to cleave hemoglobin. Morphology the gastric mucosa was studied. Samples were taken from the antral portion of the stomach, fixed with 10% formalin, and embedded in paraffin. Histological sections were stained with hematoxylin and eosin. PAS reaction was conducted.

RESULTS

Under control conditions digestive activity of pepsin in relation to blood plasma proteins and hemoglobin was 0.032-0.050 and 0.66-0.75 mg, respectively.

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Morphological examination of the gastric mucosa in control rats revealed no pathological changes or signs of functional overload of glandular secreting cells.

Exposure to *D*-EMR increased digestive activity of pepsin in relation to blood plasma proteins and hemoglobin (0.053 and 1.29 mg, respectively).

Morphological examination revealed progressive hypertrophy of glands and hypertrophy of chief and parietal cells on days 1-6 of exposure to *D*-EMR. These changes reflected high-intensity secretion of pepsin and HCl, which is responsible for conversion of non-active pepsinogen into pepsin. We observed a decrease in functional activity of goblet cells and suppression of mucin production (Fig. 1).

During exposure to *L*-EMR mean digestive activity of pepsin in relation to the plasma and hemoglobin was 0.05 and 0.75 mg, respectively. In the follow-up period mean digestive activity of pepsin in relation

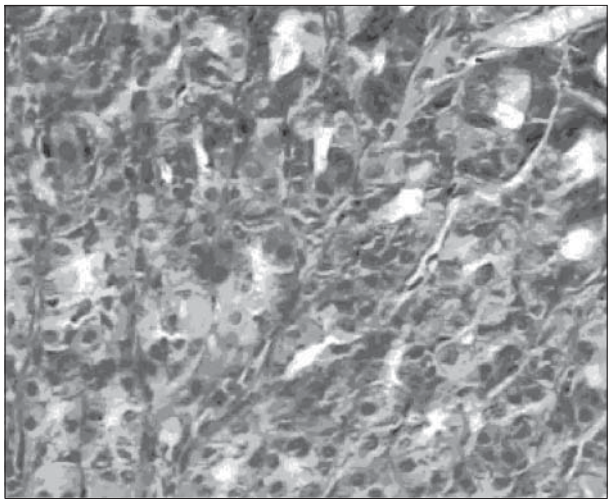

Fig. 1. Hypertrophy of chief and parietal cells in the antral portion of the stomach (×300).

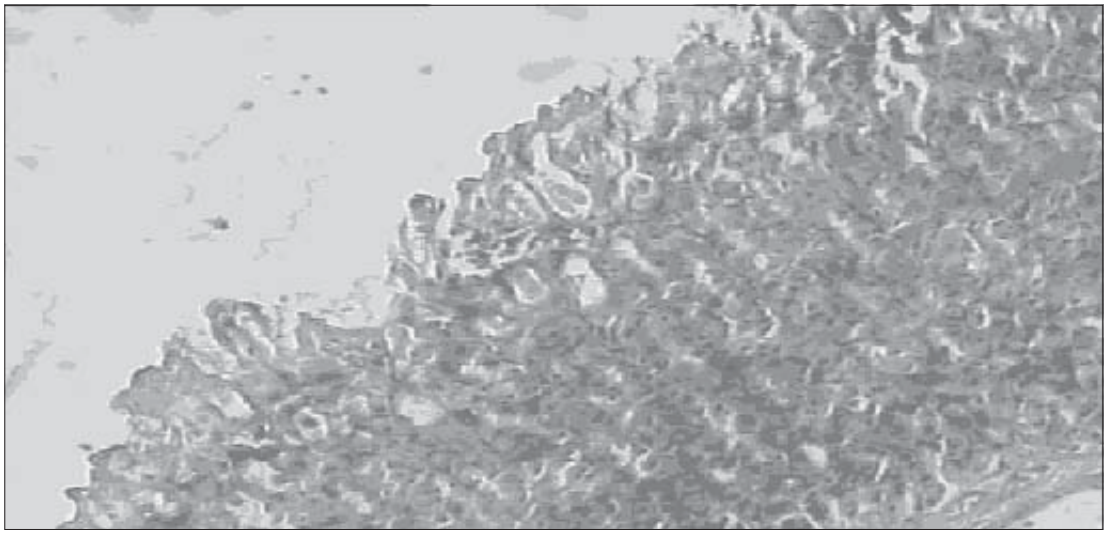

Fig. 2. Dystrophic and necrobiotic changes in the gastric mucosa (×150).

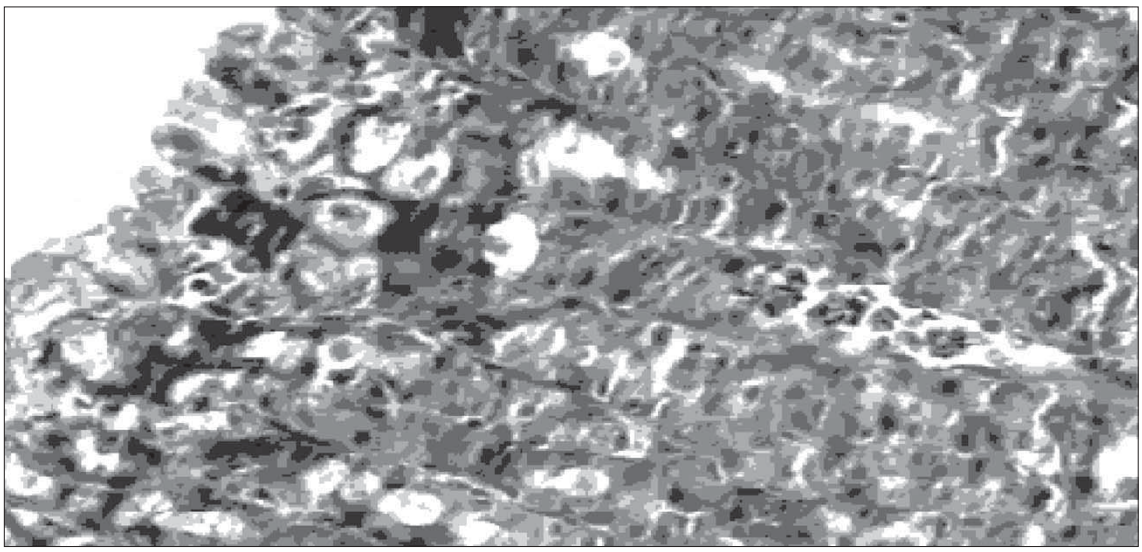

Fig. 3. Venous plethora and numerous hemorrhages in the gastric mucosa (×300).

to the plasma and hemoglobin was 0.044 and 0.63 mg, respectively.

L-EMR induced morphological changes in the gastric mucosa. They included progressive necrobiotic changes. Gradual increase in the count of goblet cells resulted in mucoid transformation of glands. The gastric mucosa was covered with mucus. The surface epithelium underwent exfoliation. Secretory activity of glands was suppressed (Fig. 2).

Pronounced necrotic changes characterized and primarily determined by microcirculatory disturbances developed on day 6 of treatment. Numerous hemorrhages (including subepithelial hemorrhages) were found in the mucosa. Capillaries were dilated, and glands were necrotic. The epithelium was exfoliated. We revealed morphological signs of "bald microvilli" (Fig. 3).

The observed morphological changes are consistent with the results of biochemical analysis. *D*-EMR produced a direct stimulatory effect on chief and parietal cells of the gastric mucosa. Previous studies confirmed the hypothesis that *D*-EMR has a direct activating effect on the molecule of pepsinogen-pepsin. This conclusion agrees with the observed morphofunctional interaction. Pathomorphological changes in the gastric mucosa produced by *L*-EMR contribute to low digestive activity of pepsin. It cannot be excluded that *L*-EMR directly inhibits this enzyme.

Good agreement was revealed between morphological and biochemical changes in the organism after exposure to low-intensity electromagnetic and magnetic fields of *D*- and *L*-chirality (with regard to specific activity of pepsin) [2]. Therefore, chiral asymmetry typical of all living organisms [1,3] determines an adequate response to external fields. High-efficiency medical devices for wave therapy of patients with nosologically different diseases can be constructed taking into account chirality of external electromagnetic fields [3,4].

Another important aspect is organism's reaction to geomagnetic perturbations. Disturbances in the natural magnetic field of the Earth can be accompanied by a right-handed or a left-handed sense of magnetic rotation. The organism's response is manifested in variations of pepsin proteolytic activity. These data are not considered by gastroenterologists during the therapy of patients with peptic ulcer disease or gastritis.

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