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The effect of laser irradiation on the rat thyroid gland morphology

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The present study was undertaken with the aim to evaluate the morphological response of the thyroid gland to laser action. Two different types of laser rays were used: Helium-Neon (He-Ne) and Argon (Ar) lasers. The histological and ultrastructural analysis indicated a stimulated functional activity of the thyroid gland after He-Ne application. In the case of irradiation with Ar laser, the signs of diminished gland activity were more pronounced.

Key words: thyroid gland, laser irradiation, morphology, ultrastructure.

Introduction

The coherent and monochromatic laser radiation has found many applications in various areas of biology and medicine. The use of laser rays of low and medium intensity for the treatment of skin and rheumatic diseases is becoming common practice, but there is not always a clear understanding of the possible side-effects. Exposure to Helium-Neon (He-Ne) gas laser contributes to a rapid wound-healing in the skin and tissues damaged mechanically, by X-rays, burning, etc [1, 3, 7]. There are not many data concerning the effect of laser beam on thyroid gland morphology. Zaragoza et al. [11] have shown that therapeutic doses of soft laser radiation can immediately produce tissue changes of mild intensity in the thyroid gland and that the tissue changes are less intense when regeneration was stimulated by exogeneous thyroid-stimulating hormone. The histological changes in the thyroid gland of rat are similar to those seen in hypophysis [6] and retinal cells [8, 10] in the same conditions.

The present study evaluates the effect of He-Ne or Ar laser radiation on rat thyroid gland morphology defining by light and electron microscopy.

Material and methods

Infantile 24-day-old female Wistar rats were used in our experiments. The sources of laser radiation were Helium-Neon or Argon gas laser from Institute of Electronics at

the Bulgarian Academy of Sciences (Sofia). The animals were irradiated for 2 min daily with He-Ne (wavelength 632.8 nm and power density 54 mW/cm^2) or for 1 min with Argon (Ar) laser (wavelength 488 nm, power density 2600 mW/cm^2) in the course of 10 days. The animals were killed 24 h after the last treatment. One thyroid lobe was fixed in Bouin's solution and embedded in paraffin for histological study; 5μm thick sections were stained with haematoxylin and eosine. The other thyroid lobe from each animal was fixed in 2% glutaraldehyde in 0.1 M sodium cacodylate buffer, pH 7.4, postfixed in 1% osmium tetroxide in the same buffer, dehydrated and embedded in Epon 812. Ultrastructural observations were made on an EM Opton 109.

Results

Histological study

In haematoxylin-eosin stained slides, the thyroid glands of control rats had a homogeneous structure with follicles bordered by cubic or cylindrical cells surrounding the colloid lumen (Fig.1).

In the specimens from animals irradiated with He-Ne laser, sacrificed after 24 h, the majority of follicles were formed by double layers of follicular cells (Fig. 2) and posed a diminished lumen. The colloid was more clear with the zone of resorption, the height of thyrocytes was augmented, i.e. morphological signs of an increased functional activity were present. The slight interfollicular oedema, vascular congestion and some hydropic changes in the cytoplasm of the follicular cells were also observed. The pathological changes were more obvious after irradiation with Ar laser rays. Follicles with stored dense colloid and debris of desquamated cells were dominant; the thyrocytes were flattened (Fig.3). The affected follicles were scattered throughout the whole gland.

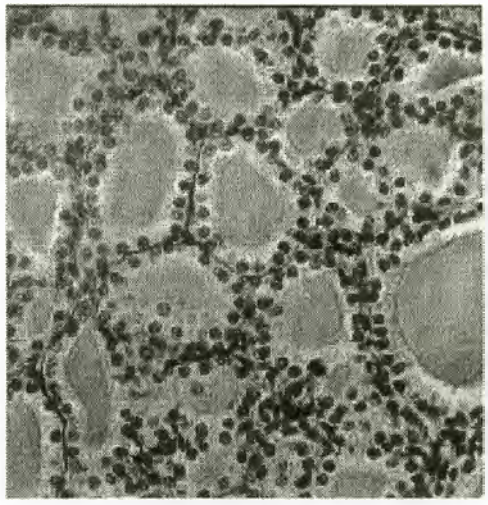

Fig. 1. Histological sections of the rat thyroid. Haematoxylin-eosin staining. Control rat. The histological picture corresponds to moderate functional activity of the gland (× 320)

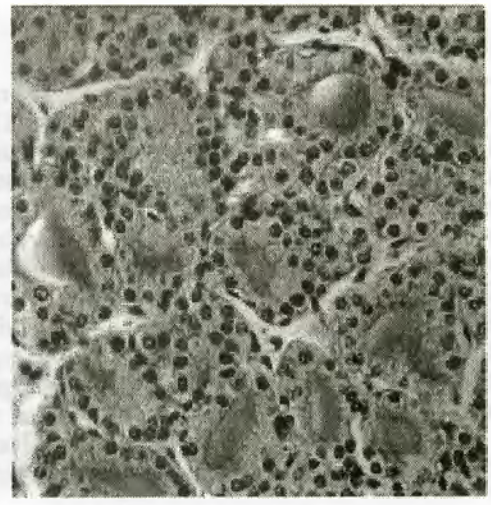

Fig. 2. Histological sections of the rat thyroid. Haematoxylin-eosin staining. Thyroid gland after He-Ne irradiation. Follicles with double layers of the thyrocytes are dominant (× 320)

Ultrastructural study

The control glands had thyrocytes with prominent rough endoplasmic reticulum (Fig. 4), well developed Golgi complex, vesicles and secretory droplets, numerous mitochondria, microvilli. The nucleus, with 1-2 small nucleoli, was usually situated in the basal area.

Specimens from rats sacrificed 24 h after He-Ne irradiation had follicles with a high number of thyrocytes with an enlarged rough endoplasmic reticulum, vacuoles, tumefaction of the mitochondria, many elements of the Golgi complexes, numerous lysosomes and vesicles in the cytoplasm (Fig. 5). These changes were more pronounced in animals irradiated with Ar laser where immense vacuoles were observed (Fig. 6). The follicles with a high number of necrotic cells were present.

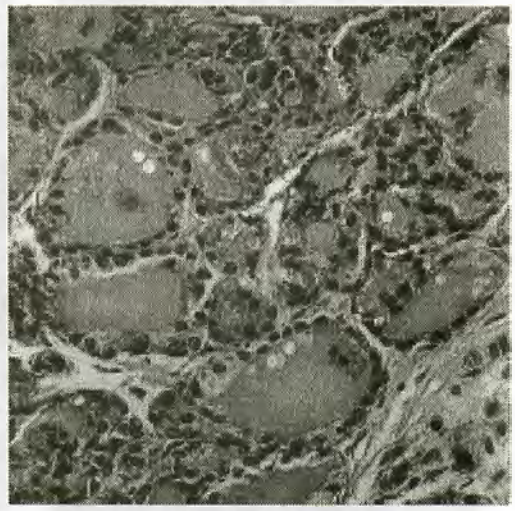

Fig. 3. Histological sections of the rat thyroid. Haematoxylin-eosin staining. Thyroid gland after Ar irradiation. Presence of affected follicles with desquamated cells in colloid (× 320)

Discussion

Ionizing radiation has noxious effects on the thyroid gland, including development of tumours [2]. The biological effects of laser irradiation particularly are a function

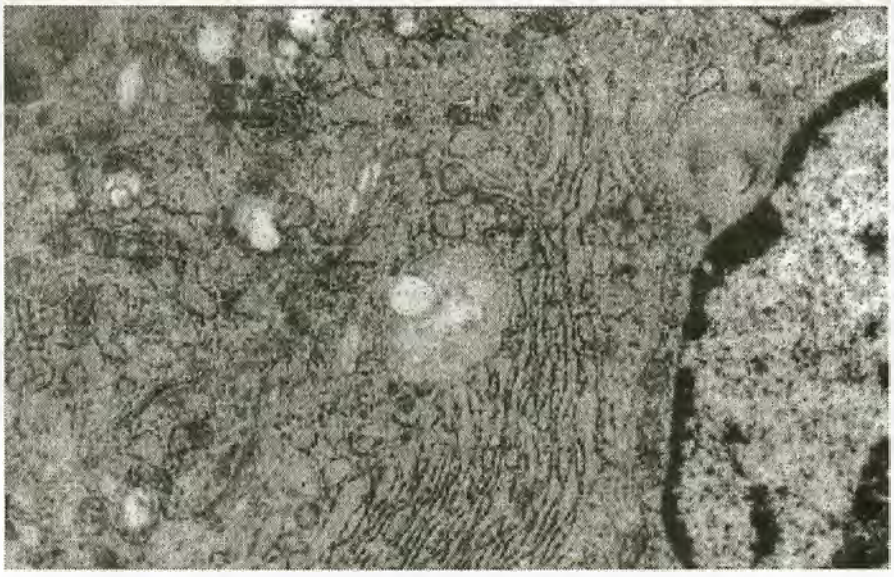

Fig. 4. Electron micrograph of thyrocyte in control rat (×7200)

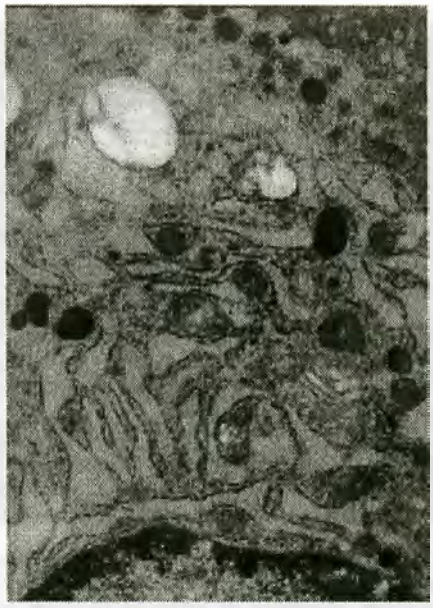

Fig. 5. Electron micrograph. Part of the cytoplasm from thyrocyte after He-Ne irradiation: enlarged endoplasmic reticulum with numerous lysosomes are presented (× 10000)

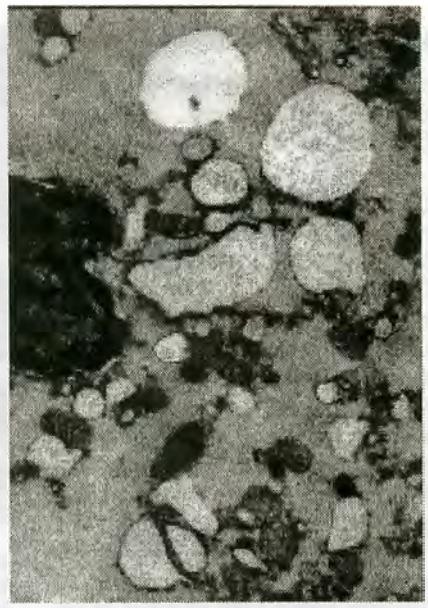

Fig. 6. Electron micrograph. More pronounced alterations in the ultrastructure of thyrocytes after Ar irradiation. In the cytoplasm large vacuoles are observed (× 10000)

of several parameters: the cell type irradiated, the total dose and the intensity of the energy applied [4, 10]. Lerma et al. [5] have shown that He-Ne laser of low intensity doses (similar to ours) provokes multifocal degenerative changes in rat's thyroid gland. These lesions reached their peak after 3 weeks, diminished by 2 months and the thyroid glands had considered to be histologically normal 3-6 months after irradiation. The same authors suppose that the morphological destructions are mainly hydropic changes than an increasing cell metabolism because the levels of T_3 and T_4 have not altered.

Our results indicate that He-Ne laser, in the doses applicated, provokes morphological changes corresponding to an intense functional activity. In the case of Ar irradiation an inhibited thyroidal function was observed. The same influence of Ar rays was shown in our previous study on the rat gonads [9]. This effect may be due to the higher cellular sensibility to short-wavelength radiation [12] resulting in more profound morphological alterations. Similarly to X-radiation, laser rays have dose-dependent effect on the biomembranes and cellular organelles. Further complex studies, morphological as well as bio- and cytochemical ones, are needed to clarify the mechanism of laser on the thyroid gland structure and function.

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