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The effect of ultraviolet radiation of pancreatic exocrine cells in mole rats: An ultrastructural study

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ARTICLE INFO

Article history:
Received 16 September 2014
Accepted 24 October 2014
Available online 29 November 2014

Keywords:
Ultraviolet radiation
Pancreatic exocrine cells
Ultrastructure
Mole rats

ABSTRACT

The purpose of this study was to investigate the ultrastructural effects of ultraviolet C (UVC) radiation on the pancreatic exocrine cells of mole rats. The mole rats were divided into two groups as control and test groups. Control group did not receive any radiation. The other group was irradiated with UV radiation for 14 and 28 days. The pancreatic tissue samples were prepared and then analyzed through transmission electron microscope. Depending on the radiation exposure, it is likely to say that the zymogen granules decreased to more than 70 per cent for the control group and the dilation of rough endoplasmic reticulum and vacuolization of mitochondria increased in the pancreatic exocrine cells at the 14 days of radiation as compared with the control group; however, they were easily observed in the 28 days of radiation exposure. Particularly in the 28 days of radiation, the zymogen granules decreased and vacuolated, and the rough endoplasmic reticulum was frequently shortened and dilated. These findings clearly demonstrated the effects of UVC radiation on pancreatic exocrine cells in an exposure-period dependent manner.

1. Introduction

Living organisms are continually exposed to radiation in nature as well as from nuclear weapons testing, occupations, consumer products and medical procedures (Hall & Giaccia, 2006; Nias, 1998; Sharma, Parmar, Sharma, Verma, & Goyal, 2011). Radiation effects on the living beings are generally divided into two categories: deterministic and stochastic effects. Deterministic effects are those whose severity increases as dose increases. The level of damage on the cell structure particularly depends on the radiation dose received. Stochastic effects of radiation are independent of absorbed dose and under certain exposure conditions, the effects may or may not occur. There is no threshold and the probability of having the effects is not proportional to the dose absorbed. Curability of the effect has little to do with the dosage of radiation received. Stochastic effects modify a limited number of cells after the radiation exposure (Alexandra, Merriline, Shilpa, & Thomas, 2006; Buckley, Bines, Kemball, & Williams, 1998; Chodick et al., 2008; NCRP, 2009).

Solar ultraviolet radiation is a part of the spectrum of electromagnetic radiation emitted by the sun. It is arbitrarily divided into 3 categories of different wavelength: Ultraviolet A (UVA) 400–320 nm, Ultraviolet B (UVB) 320–290 nm and Ultraviolet C (UVC) 290–200 nm (Dong et al., 2007; WHO, 1994).

UVA rays cause light brown tan in a short time; the subsequent darkening is due to melanin, which accumulates in

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Peer review under responsibility of The Egyptian Society of Radiation Sciences and Applications.
http://dx.doi.org/10.1016/j.jrras.2014.10.006

the skin. UVB rays cause is delayed but long-term tan mostly resulting in melanin synthesis in the skin. It causes serious sunburn, associated with intensified erythema and oedema, ache, and blister formation in less than one day of exposure. UVC rays, which have sterilization and biocidal properties and are especially important in terms of harmful effects to living beings. Fortunately, majority of this emission is filtered by the ozone (O3) layer (Steel, 2002; Stolarski et al., 1992; WHO, 1994).

Decrease in ozone layer leads to increase in the amount of dangerous UV radiation that reaches the earth's surface (Thiele, Dreher, Maibach, & Packer, 2003). As the thickness of this layer has been reduced, it is estimated that skin cancer, cataract and immune deficiency syndrome cases will be increased in near future (Mayer, 1992; McKenzie, Björn, Bais, & Ilyas, 2003; Verma et al., 2011).

The effects of UVC radiation as a noxious environmental agent on the pancreatic exocrine cells have not been studied despite the fact that it comprises the main component of solar ultraviolet radiation. For this reason, the effects of UVC radiation on the pancreatic exocrine cells of mole rats were examined by the electron microscope.

For this reason, the mole rats were selected for this study as these animals live in underground galleries and have no UV exposure in their habitat. That's why, they exposed to artificially produced UVC radiation in lab and pancreatic cells changes were compared to control group.

2. Materials and methods

Ten adult Mole rats (*Spalax leucodon*) of both sexes, weighing 180–200 g were used in this study. All rats were caught within the rural areas of Ankara in Turkey. They were kept at the laboratory for 10 days at a stable temperature (20 ± 2 °C) in order to obtain adaptation of the new environment. The mole rats were housed individually in special cages called terrarium and a constant UVC dosage was applied from the upper. All animals were fed with carrot, potato, plant roots and no special diet was given.

A "Mazda TG" ultraviolet lamp in 30 W powers and in 90 cm length was placed to the upper cover of the terrarium. The intensity of the UV emitted from the lamp was measured to be 254 nm in wavelength and the energy in 1 s was found to be 0.0014 J/cm^2.

The mole rats were divided into control and test groups. Group I was separated as the control, and was not received any radiation. Taking into account of sunlight period, the other groups were exposed to artificial UVC radiation for 8 h daily (between 08.00 and 17.00 h). A feeding interval was given at midday for 1 h. A timer was used to standardize UVC exposure times. Group II was irradiated for 14 days (Total dosage was 564,48 J/cm^2) and Group III was irradiated for 28 days (Total dosage was 1.128,96 J/cm^2).

At the end of the experiments, the animals were anesthetized using ether inhalation and were sacrificed. The pancreas tissues were dissected out, and cut into small pieces that were taken and prepared for electron microscopic studies. The small pancreas pieces were fixed in glutaraldehyde, then washed in buffer and post-fixed in 1% osmium tetroxide, dehydrated in ethanol, cleared in propylene oxide and embedded in Araldite CY-212. Ultrathin sections were prepared, stained with uranyl acetate and lead citrate and then examined on Jeol JEM 100 CX-II electron microscope.

All experiments were carried out in accordance with the Ankara University guidelines for the care of experimental animals. Also, guiding principles for experimental procedures found in Declaration of Helsinki of the World Medical Association regarding animal experimentation were followed in the study.

3. Results

3.1. *Group I (control group): pancreatic exocrine cells from controlled mole rats*

The pancreatic exocrine cells were formed of serous cells which were pyramidal in shape and they were lined around a central lumen forming an acinus. Each pancreatic acinar cell was enveloped by a plasma membrane which showed distinct regional variation. The basal and lateral plasma membrane was straight and unfolded. The acinar lumen, the surface of which formed varying numbers of microvilli, often contained secretory material (Fig. 1).

The nuclei were smoothly rounded in general and tended to be slightly eccentric toward its basal portion. Each nucleus contained a nucleolus. The pancreatic exocrine cells were characterized by numerous zymogen granules (smoothly rounded formations with a homogeneous content of high density) in the apical region of the cytoplasm. They consisted of electron dense material surrounded by a limiting membrane. Some condensing vacuoles containing secretory material of low density were seen in the zymogen granules. Oval and rod-like mitochondria were present in both the apical and basal parts of the acinar cells (Fig. 1).

A well developed rough endoplasmic reticulum which was distributed basally and laterally to the nucleus. The rough

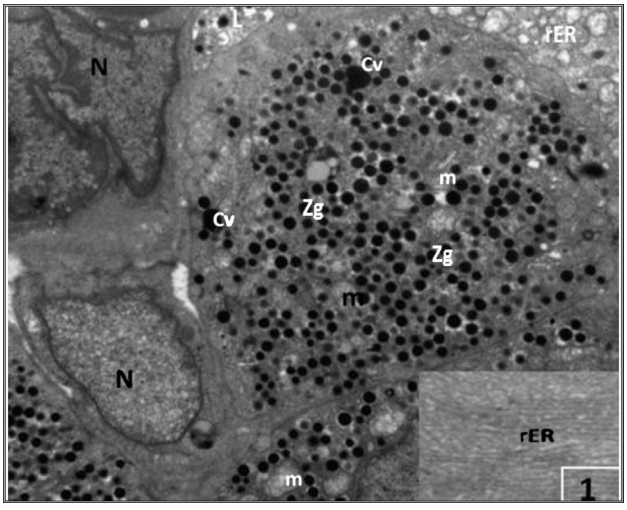

Fig. 1 – Electron micrograph of pancreatic exocrine cells from control mole rats. Showing normal architecture of pancreatic exocrine cells. Nucleus (N), zymogen granules (Zg), condensing vacuole (Cv), mitochondria (m), acinar lumen (L) and rough endoplasmic reticulum (rER). ×5000.