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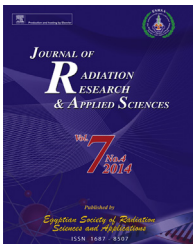

Effects of ultraviolet radiation on the stratum corneum of skin in mole rats

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ABSTRACT

It is likely that the UV rays will affect the epidermis of mammals. All these negative effects justify the studies on the relation between the UV rays and epidermis. The purpose of this study was to investigate the ultrastructural effects of ultraviolet C radiation (UVC) on the stratum corneum of mole rats epidermis. Mole rats were divided into two as the control and experiment groups. The control group did not receive any radiation while the other groups were irradiated with UV radiation for 52, 112 and 168 h. The skin samples were prepared and analyzed by transmission electron microscopy. After the examination, stratum basale, stratum spinosum, stratum granulosum and stratum corneum layers were distinguished. The most drastic effects of UVC were noted in stratum corneum. Lacunae formations and unkeratinized cytoplasmic residues were observed within the horny cells. Depending on dosage and exposal period of the UVC radiation, ultrastructural changes occurred in the stratum corneum on mole rats epidermis.

1. Introduction

Studies of environmental stressors have traditionally included human-produced contaminants such as pesticides, metals and industrial chemicals but have come to include anthropogenic changes to natural features of environments like temperature, salinity and ultraviolet radiation, as well (Mekkawy, Mahmoud, Osman, & Sayed, 2010). The reduction of ozone in the stratosphere as a consequence of human activity led to an increase in the level of ultraviolet radiation (UVR) at the ground.

Ultraviolet (UV) radiation is a part of the spectrum of electromagnetic radiation emitted by the Sun. It is arbitrarily divided into 3 categories at different wavelength as UVA (400–320 nm), UVB (320–290 nm) and UVC (290–200 nm), and has long been known to cause adverse effects on organisms (Dong et al., 2007; Stolarski et al., 1992; WHO, 1994).

UVA rays cause light brown tan in a short time; so, the subsequent darkening is due to melanin, which accumulates in the skin. UVB rays cause could be delayed, but long-term tan mostly results in melanin synthesis in the skin. It causes serious sunburn in association with intensified erythema and edema, ache, and blister formation in less than one day of

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exposure. UVC rays which have sterilization and biocidal properties are especially harmful for the eyes. Generally, they cannot reach the earth surface due to absorption in the ozone layer (Stolarski et al., 1992; WHO, 1994).

UVC radiation is especially important in terms of harmful effects on living beings. Fortunately, majority of this emission is filtered by the ozone (O_3) layer. As the thickness of this layer has been reduced in recent years, it is estimated that skin cancer, cataract and immune deficiency syndrome cases will increase in the near future (Mayer, 1992; McKenzie, Björn, Bais, & Ilyas, 2003).

The ozone layer in the atmosphere significantly absorbs the UV radiation coming from the sun. The discovery, in 1985, of the hole in the ozone layer in Antarctic has disturbed public opinion all over the world. It has been claimed that the most important cause of the ozone hole is the chlorofluorocarbon (CFC) gases. It is also believed that the UV rays coming to earth through the hole in the ozone layer will increase the number of diseases such as skin cancer, cataracts and loss of immunity (Armstrong & Kricker, 2001; De Gruijl, 1999). The UV rays will probably affect the epidermis of mammals as well. All these negative effects justify the studies on the relation between the UV rays and epidermis. The results of such studies will lead the way to the solution of some problems related to the future of human health.

Upon exposure to UV radiation, skin reactions such as pigmentation, lesion, erythema and changes in the ultrastructure of cells in the epidermis and dermis have been examined on *Monodelphis domestica*, hairless mice, guinea pig and volunteer people (Applegate, Stuart, & Ley, 1985; Bivik, Larsson, Kågedal, Rosdahl, & Öllinger, 2006; Brody, 1959; Browman et al., 2003; Chomiczewska-Skóra, Adamus, Trznadel-Grodzka, & Rotsztejn, 2013; Johnston, Oikarinen, Lowe, Clark, & Uitto, 1984; McMillan et al., 2008; Sayed, Ahmed, Imam, & Mekkawy, 2007).

Our aim was to determine the effect of UVC radiation on the stratum corneum of mole rats epidermis by the electron microscope. Although the living organisms on earth are directly exposed to UV radiation coming from the Sun, few underground-dwelling mammal species like mole rats are not under such affects.

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

2. Materials and methods

Twelve adult mole rats of both sexes, weighing 180–200 g were used in this study. All rats were caught within the natural terrain (rural areas). They were kept in the laboratory for 10 days at a stable temperature (20 ± 2 °C) in order to obtain an adaptation to the new environment. The rats were housed individually in special cages called terrarium and a constant UVC dosage was applied (Fig. 1). 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

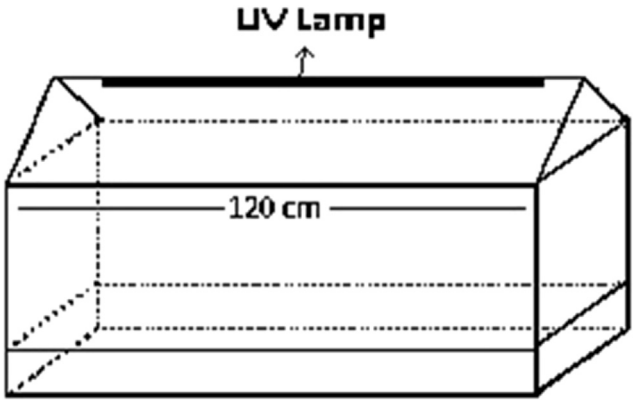

Fig. 1 – The special compartment, where the mole rats were exposed to UVC radiation.

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. Mole rats were exposed to daily artificial UVC radiation depending on sunlight period for 8 h (between 08.00 and 17.00 h) for 14, 28 and 60 days. A feeding interval was given at midday for 1 h. A timer was used to arrange UVC exposure times.

The mole rats were divided into two as the control and experiment groups. Group I (the control group) was not received any radiation while the other groups were irradiated with a noxious dosage of ultraviolet C radiation (254 nm). Group II was irradiated for 52 h (total dosage was 282.24 J/cm^2), Group III was irradiated for 112 h (total dosage was 564.48 J/cm^2) and Group IV was irradiated for 168 h (total dosage was 864.72 J/cm^2).

At the end of the experiments, the animals were anesthetized using ether inhalation and were sacrificed. The skin samples were dissected out, and cut into small pieces. For electron microscopic studies, the small skin pieces were fixed in glutaraldehyde, 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 by ultramicrotome, stained with uranyl acetate and lead citrate. Jeol JEM 100 CX-II electron microscope was used for examination of the specimens.

All experiments were carried out in accordance with the 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

The epidermis is stratified as squamous epithelium. The main cells of the epidermis are the keratinocytes, which synthesis the protein keratin. Protein bridges called desmosomes connect with the keratinocytes, which are in a constant state of transition from the deeper layers to the superficial. The four separate layers of the epidermis, which are stratum basale, stratum spinosum, stratum granulosum and stratum corneum, are formed by the differing stages of keratin maturation.