Morphological Changes in Epidermal Basal Cells of Different Location Induced by X-Rays

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Exposure to X-rays causes pronounced morphofunctional changes in basal cells and modulates linear cellularity in the epidermal basal layer in guinea pigs. Radiosensitivity of skin basal cells of different location is different: the most pronounced morphofunctional changes were observed in the skin of the head (cheek) and abdomen.

Key Words: *basal epitheliocytes; guinea pigs; X-ray exposure; quantitative morphology*

Since the discovery of X-rays at the end of XIX century and until now their effects attracts much attention. This interest is largely explained by the fact that humans (first of all, the skin) are exposed to this radiation during medical examinations [1,3,4]. However the data on radiosensitivity of different sites of the skin are contradictory, which prompted our investigation.

MATERIALS AND METHODS

The study was carried out on adult male guinea pigs (400-450 g, 51 experimental and 30 control animals). Radiosensitivity of these laboratory animals is close to that of humans [2], which facilitates extrapolation of experimental data on humans. Guinea pigs were kept according to regulations of the European Convention on Protection of Vertebrates Used with Scientific Purposes (Strasbourg, 1986). Experimental animals were exposed to single whole-body X-ray irradiation in a dose of 5 Gy. RUM-17 device served as the source of X-rays. Guinea pigs were decapitated under ether narcosis. Material for examination (skin fragments from the head (cheek), back, abdomen) were collected immediately, 6 h, on days 1, 5, 10, 25, and 60 after exposure. For histological study the fragments were fixed in 12% formalin, Carnoy fluid, and 96% ethanol and embedded in paraffin; 7-μ sections were stained routinely (hematoxylin and eosin, after Van Gieson in Weigert modification). The content of cytoplasmic RNA (cRNA) in epidermal basal cells was studied by cytophotometry on skin sections stained by the method of Einarson.

Cytophotometric study was carried out under a LUMAM-3 microscope. Skin fragments for electron microscopy were fixed in 2.5% glutaraldehyde on 0.2 M cocadilate buffer (pH 7.2) and postfixed in 1% osmic acid. All samples were impregnated and embedded in araldite. Sections were made with an LKB-III ultratome. Semithin sections were stained with toluidine blue, ultrathin sections were contrasted with uranyl acetate and lead citrate, examined and photographed under a JEM-100 CX-II electron microscope. Linear cellularity of the basal layer of the epidermis was evaluated for all skin sites. The content of cRNA in basal cells and linear cellularity were expressed in percent. The data obtained at different stages of the experiment were compared with the corresponding control for each skin site (cheek, back, abdomen) taken as 100%. The results of quantitative cytophotometry were processed using Student's *t* test. The experiments were carried out under hematological control.

RESULTS

Minor morphofunctional changes in the epidermal basal cells in comparison with the control were observed directly after the end of X-ray exposure. Electron microscopy showed vacuolation of the perinuclear

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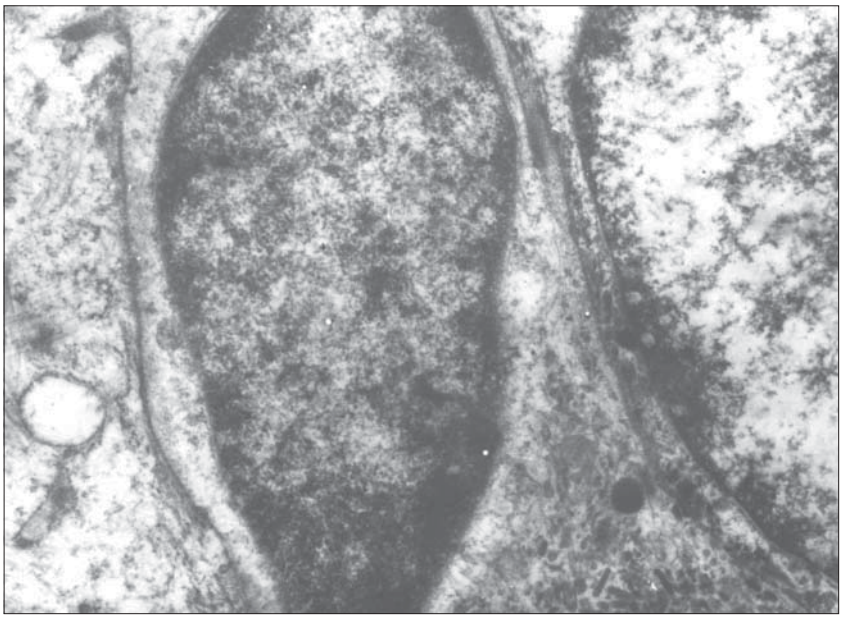

Fig. 1. Ultrastructure of epidermal basal cell from the skin of the guinea pig head (control), ×19,000.

cytoplasm in some basal cells of the epidermis from the head and abdomen. Eosinophilia of the cytoplasm decreased in some cells of the epidermal basal layer at all skin sites. Basal cell nuclei were oval or round and lied in the apical part of the cells. Chromatin lumps in these nuclei were evenly distributed in the karyoplasm and were moderately stained with basic stains. The content of cRNA in the epidermal basal cells was reduced in all skin sites, especially on the head (cheek) and abdomen (Table 1).

Six hours after the exposure the affinity of many epidermal basal cells for acid stains decreased. Electron microscopy showed numerous sites of cytoplasm vacuolation in some basal cells from the abdominal and head skin. The nuclei of some basal cells were round and had one, sometimes two hyperchromatic nucleoli in the karyoplasm; the linear cellularity of the basal layer and cRNA content decreased in comparison with the control in all skin sites (Table 1).

On day 1 after X-ray exposure we observed increased basophilia and affinity for hallocyanine (Einarson staining) of the cytoplasm of epidermal basal layer cells (compared to previous term). The nuclei of some epitheliocytes were deformed and pyknotic. The nucleoli in the basal cell nuclei were often enlarged, showed increased affinity for hematoxylin, and were shifted towards the karyolemma. The linear cellularity of the basal layer and the content of cRNA in the epidermal basal cells were below the initial values in skin specimens of all locations, but somewhat were higher than at the previous term (Table 1). The most pronounced decrease in these parameters was observed in epidermal basal layer cells from the skin of the head (cheek) and abdomen (Table 1).

TABLE 1. Changes in Linear Cellularity and cRNA Content in Epidermal Basal Cells of Different Location after X-Ray Exposure ($M \pm m$, %)

Time after exposure	Head skin (cheek)		Back skin		Abdominal skin	
	linear cellularity	cRNA content	linear cellularity	cRNA content	linear cellularity	cRNA content
Control	100.0±0.3	100.00±0.33	100.00±0.27	100.00±0.56	100.0±0.3	100.00±0.34
1 min	99.50±0.35	84.4±0.5*	90.40±0.37*	92.70±0.57*	100.10±0.31	85.00±0.51*
6 h	85.70±0.55*	82.60±0.33*	95.40±0.33*	88.40±0.56*	94.70±0.24*	83.40±0.51*
Day 1	86.7±0.2*	87.6±0.5*	96.3±0.3*	90.70±0.56*	95.00±0.28*	88.70±0.51*
Day 5	83.40±0.46*	73.1±0.5*	85.50±0.31*	85.00±0.56*	86.90±0.33*	66.40±0.51*
Day 10	83.30±0.24*	64.2±0.5*	88.10±0.22*	77.80±0.37*	77.40±0.37*	59.00±0.51*
Day 25	79.4±0.3*	110.40±0.84*	90.10±0.24*	108.20±0.56*	88.70±0.37*	109.20±0.34*
Day 60	94.90±0.35*	80.8±0.5*	93.00±0.37*	96.80±0.37*	81.30±0.33*	87.90±0.51*

Note. *$p<0.05$ compared to the control.

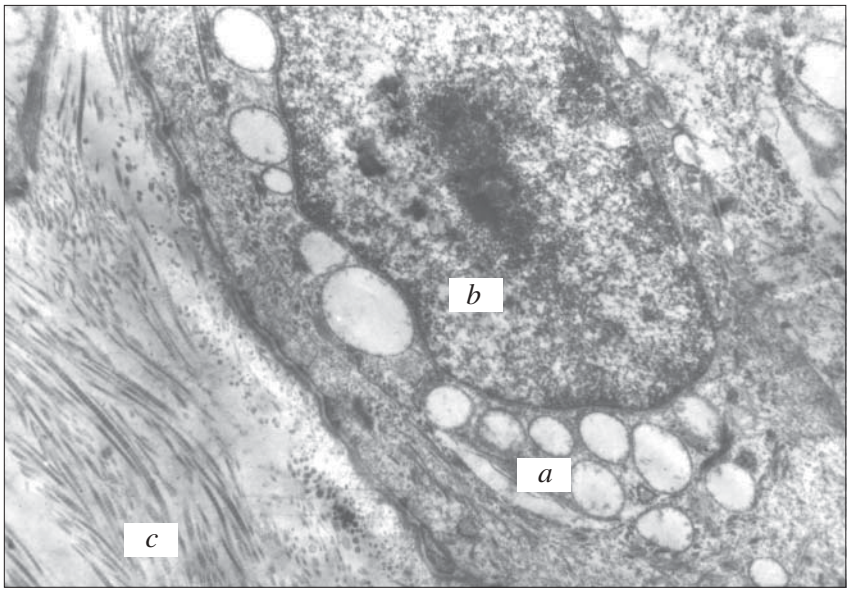

Fig. 2. Ultrastructure of the skin of the guinea pig head on day 5 after X-ray exposure. *a*) vacuolation of the basal cell cytoplasm; *b*) basal cell nucleus is oriented parallel to the basal membrane; *c*) hypo-osmiophilic collagen fibers of the derma, ×19,000.

On day 5 many swollen cells with blurred interface were seen in the epidermal basal layer. Cytoplasm vacuolation was seen in the skin basal cells in all skin sites in comparison with the control (Fig. 1); basal cell nuclei lost their normal palisade disposition and were arranged parallel to the basal membrane; they were often enlarged, the number of chromatin lumps decreased, the remaining lumps concentrated near the karyolemma (Fig. 2). The linear cellularity of the epidermal basal layer and cRNA content in these cells in all skin sites were lower compared to day 1 (Table 1).

On day 10 after exposure the majority of epidermal basal layer cells were swollen with blurred interface. Their nuclei were enlarged and chromatin lumps were arranged along the nuclear membrane. The nuclei in basal cells lost their normal characteristic palisade disposition and were arranged parallel to the basal membrane. They were often deformed and pyknotic, numerous sites of vacuolation were seen in the cytoplasm. Linear cellularity of the epidermal basal layer and cRNA content in basal cells were below the initial and previous values (Table 1). However, changes in epitheliocytes in the skin on the back were least pronounced at this term, too.

On day 25 after exposure affinity of the cytoplasm in the majority of cells of the basal and prickly layers to eosin increased. Electron microscopy showed numerous and extensive sites of cytoplasm vacuolation in many epitheliocytes. The linear cellularity of the epidermal basal layer was below the control in all skin sites (Table 1). At the same time, the intensity of hallocyanine staining of the skin basal cell cytoplasm in all skin sites little differed from the control, which indicated increased content of cRNA.

On day 60 after exposure low affinity of part of the germinal layer cells for eosin was noted in the skin epidermis. Oval basal cell nuclei, weakly stained with hematoxylin and normally arranged (palisade pattern) were seen more often. On the other hand, some nuclei were hyperchromatic and enlarged. The cytoplasm and nuclei of granular layer cells were characterized by enhanced affinity for hematoxylin and eosin and for hallocyanine (Einarson staining). Cytophotometry showed low cRNA content in epidermal basal cells in all skin sites, especially on the head (cheek) and abdomen, where it was below the control (Table 1). Linear cellularity of the epidermal basal layer increased in comparison with the previous term in the greater part of skin sites (Table 1).

Thus, our data indicate different radiosensitivity of the epidermal germinal layer after X-ray exposure of different skin sites. The most pronounced changes in epitheliocytes were observed in the skin of the head (cheek) and abdomen.

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