Yonsei Medical Journal
Vol. 23, No. 1, 1982

The Experimental Study of Corneocytes After Acute Skin Irritation (I)

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This study was designed to investigate the effects on count, size, and morphology of human corneocytes when the skin is irritated with a rough towel. The desquamating portion of the stratum corneum was sampled with the detergent scrub technique every other day for 12 days.

The following parameters were measured; numerical count, size (surface μ^2), and shape (regular, irregular). Corneocytes from skin irritated with a rough towel differed from those of normal skin in that they were diminished by about 60% in count and were 14% smaller in size on the first experimental day. These parameters became normalized in count after 10 days and in size after 5 days respectively.

On the morphological classification of the cell outlines, there were no significant differences from the control groups except that there were slightly increased numbers of irregular cells in the experimental groups.

Key Words: Corneocytes - Acute Irritation.

The part of the epidermis which is in direct contact with the external environment is the stratum corneum. The stratum corneum has about 15 to 20 cell layers except on the hands and feet. The cells of the stratum corneum are compact and tightly interdigitated but they are not a perfect barrier. Studies have emphasized that the entire stratum corneum, not just its lower portion, is a uniformly good diffusion barrier and presents the major resistance to absorption (Scheuplein, 1972).

East Asian people have the habit of rubbing their skin with a special rough towel when they bathe, after which, significant skin symptoms are caused by the irritation of the towel such as dryness of the skin, itching sensation and papular eruptions especially on the extremities. The purpose of this study was to investigate the effect of count, size, and morphology of the human corneocytes when the skin is rubbed with a rough towel.

Received April 30, 1982

MATERIALS AND METHODS

Subjects. Eight healthy men, aged 23 to 25 years, with no skin problems, participated. After immersion in warm water at 40°C for 5 minutes,

the flexor surface of the right forearm was rubbed 20 times with a special rough towel, as is usually done in the bathroom. The uninvolved contralateral areas (left forearms) served as controls. Preparation of sample. The method of McGinley et al.(1969) was used: A glass cylinder with an area of 3.8 cm^2 was placed on the skin. One ml of 0.1% Triton X-100® in 0.075 M phosphate buffer at PH 7.9 was added with a glass pipette. The skin surface within the cylinder was rubbed with a teflon scrubber for one minute. The fluid was removed by pipette and replaced with a further 1 ml of clean fluid. After a second minute of scrubbing the fluid was again removed. These two samples were pooled. The cells contained in the sample were stained with rhodamine B and methylene blue.

Measurements. Changing the site on each experimental day, cell counts were made from the right forearm skin. After vigorous shaking for 30 seconds, an aliquot of the suspension is introduced into the chamber of a hemocytometer and the corneocytes counted in the same manner as for white blood cells. For measurents of cell size and outlines we have applied the method of Hölzle and Plewig (1977). To assess the cell size and morphology, a few drops of the suspension were placed on a glass slide, covered with a coverslip, and air dried for one day. We compared experimental groups with controls for cell counts and cell size.

Cell surface was determined by projection microscopy with a projection mirror (Leitz, tracing device) using a microscope and a 100 x oil immersion lens. Cell outlines were projected on drawing paper and the surface was measured with a fixed arm planimeter (SHANDON SCIENTIFIC CO. ALLBRIT 40449).

RESULTS

Cell counts. In the control groups, the cell count ranged from 134,920 ± 8,670 to 138,180 ± 7,780 per sq cm. There were no significant differences among the control groups. Immediately following rubbing, the cell counts were about 52,300 per sq cm and slowly increased day by day. On the tenth day the cell counts had returned to 127,340 ± 7,680 per sq cm. As compared with controls there were significant decreases in corneocyte counts, about 61% ($P<0.005$) on the

Table 1. Corneocyte counts in acute irritated skin and from control groups

Subject	Control	irritated skin		Control	irritated skin		Control	irritated skin	
		1st day	3rd day		5th day	8th day		10th day	12th day
1	180230	82680	132550	182870	155540	154210	178060	170490	176990
2	137230	51140	88670	140340	100620	112420	141200	131030	138090
3	104520	36150	60560	115430	68860	92340	102120	107880	114830
4	130120	49570	79800	136240	85850	101630	128450	123490	126670
5	147530	56840	86900	145430	109950	118880	144910	133490	143670
6	131210	50130	81360	120320	97180	110760	128450	114650	126910
7	136010	52490	79970	130510	100660	116420	143550	130550	132210
8	112480	39360	57380	134290	72130	89170	123290	107130	114170
M ± SE	134920 ±8670	52300 ±5320	83400 ±8670	138180 ±7780	98850 ±10230	111970 ±7640	136250 ±8280	127340 ±7680	134190 ±7600
P-value		< 0.005	< 0.005		<0.05	< 0.05		> 0.05	> 0.05

Table 2. Corneocyte size in acute irritated skin and from control groups (μ^2)

Subject	Control	irritated skin		Control	irritated skin		Control	irritated skin	
		1st day	3rd day		5th day	8th day		10th day	12th day
1	1208	1102	1126	1224	1241	1112	1192	1241	1188
2	1160	977	1032	1210	1106	1165	1131	1097	1176
3	1264	1139	1201	1306	1231	1237	1353	1340	1288
4	1152	932	1008	1132	1071	1163	1138	1080	1132
5	1130	1041	1024	1107	1036	1084	1087	1052	1104
6	1228	1070	1010	1215	1157	1198	1167	1149	1194
7	1204	1021	1080	1247	1150	1182	1220	1220	1203
8	1158	919	932	1139	1056	1152	1062	1053	1036
M ± SE	1188	1025	1052	1198	1131	1162	1169	1154	1165
	±17	±30	±31	±25	±29	±19	±34	±39	±28
P-value		< 0.05	<0.05		> 0.05	> 0.05		> 0.05	> 0.05

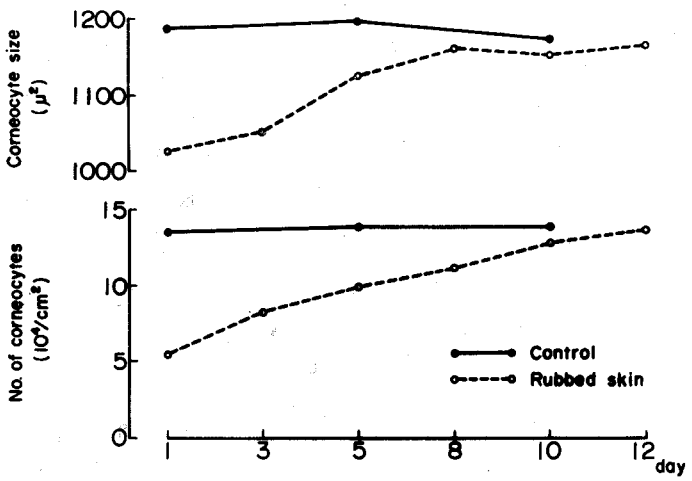

Fig. 1. The changing patterns of corneocytes size and number.

first experimental day. After ten days of skin irritation there were no significant differences statistically between the two groups (Table 1).

Cell size. In the control groups, the cell size ranged from 1,169 ± 34 to 1,198 ± 25 μ^2. There were no significant differences among the control groups. Immediately following rubbing, the corneocyte size fell to 1,025 ± 30 μ_2 and there was also a tendency to a slow increase in cell size (Table 2). On the first experimental day, there was a 13.7% diminution in size ($P<0.05$) but after the fifth experimental day, there were no significant differences between the control and experimental groups (Fig. 1).

Cell shape. From the normal skin of the left forearms (control), 46% of the corneocytes were of regular shape, 26% pentagonal, 20% hexagonal, and 54% of irregular shape. In the experimental groups, there were slightly increased numbers of irregular shaped cells. However, there was no significant differences from the control groups.

DISCUSSION

Because of the interest in the horny layer as a barrier to water loss and to chemical and physical injuries, new ways of studying this tissue continue to be developed. In 1939 Jan Wolf described the removal of surface cells by adhesive coated transparent tape. Subsequently, Goldschmidt and Kligman (1967) improved this by the adhesive slide technique. Later, McGinley et al. (1969) introduced the detergent scrub technique for visualization and quantification of the desquamating portion of the human stratum corneum which had been used for other purposes by Williamson and Kligman (1965). Thereafter, Hölzle and Plewig (1977) developed a method for measurement of cell size and morphological classification of horny cells.

The present study describes measurements of corneocytes obtained from the desquamating portion of the stratum corneum following injury to the epidermis by friction with a rough towel. There were remarkable changes in quantitative cell counts and cell size. These results are similar to the study of Hölzle and Plewig (1977), in which they reported that after cellophane stripping, the cell count was decreased markedly and returned to normal after 16 to 18 days because their type of stripping is more vigorous than the towel. This explains that rubbing with a rough towel to clean the skin injures the stratum corneum with large amounts of corneocytes being removed.

The size of corneocytes in the desquamating portion of the horny layer is related to the speed of transit of these cells through the living epidermis and horny layer. The greater decrease of cell size in psoriatic cells could be explained by the more rapid transit time in psoriasis (Goldschmidt, 1979).

A similar mechanism could also be responsible for regional differences in corneocyte size. The forehead has small cells and a rapid turnover (Plewig and Marples, 1970; Plewig, 1970). Furthermore, regional variations in permeability of human stratum corneum (Barker and Kligman, 1967) and percutaneous absorption (Feldman and Maibach, 1967) could be related to the size and morphology of individual horny cells of the human stratum corneum. In our experiment, significant decrease of cell size was seen immediately after rubbing and the cell size returned to normal 5 days after rubbing. We do not think this decrease of the corneocyte size in the initial phase is due to increased epidermopoiesis.

The towel removes several layers of corneocytes. Are the corneocytes in mid or lower stratum smaller than the ones on top? It seems this way. However, we have no exact explanation why rubbing in the initial phase causes a decrease in corneocyte size. Morphologically, there were no significant differences of the cell outlines from controls except for slightly increased numbers of irregular cells in the early experimental days. From these points of view, it may be concluded that severe rubbing with a rough towel causes damage to the stratum corneum of human skin.

ACKNOWLEDGEMENT

The authors are grateful to Prof. Gerd Plewig, Dept. of Dermatology, University of Munich, West Germany for helpful criticism.

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