

Regional and Sexual Differences in Corneocytes among Young Korean Adults

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The number and sizes of corneocytes in 10 different sites on young, healthy adults of both sexes were estimated, using the detergent scrub technique and an automatic cytographic counter. At all collection sites the count was higher in the males—significantly so at all sites except the palm and cubital fossa. At all collection sites except the popliteal fossa and the heel, the corneocytes were larger in the females—significantly so at the cubital fossa, medial upper arm, abdomen, and back sites.

Key Word: Corneocyte.

During the past half century we have learned much about the functions of the stratum corneum, but very little has been proven. The actual anatomy of the stratum corneum is not represented in the usual formalin-fixed histological preparation. Several techniques have been developed over the past decades for the study of the desquamating portion of the human stratum corneum. Jan Wolf (1939) described the removal of surface cells by adhesive tape stripping. Goldschmidt and Kligman (1967) improved this procedure by the use of the adhesive slide technique. McGinley *et al.* (1969) introduced the detergent scrub technique for visualization and quantification of the desquamating portion of the human stratum corneum. In 1970 Plewig and Marples measured corneocyte size with the use of a filar micrometer eyepiece. Hölzle and Plewig (1977) estimated corneocyte size with the use of a projection microscope with a projection mirror and a planimeter, after separating the corneocytes by using the 'detergent scrub technique.

Previously, data on regional and sexual differences in the size and count of corneocytes were available for Caucasians and Negroes, but none were available for Orientals (McGinley *et al.* 1969; Plewig and Marples 1970; Plewig 1970). The purpose of this study was to determine the regional and sexual differences in corneocytes in young Korean adults.

MATERIALS AND METHODS

Subjects

Twenty healthy male and twenty healthy female students, aged 19 or 20, with no skin problems, served as subjects.

Collection and preparation of samples

Corneocytes were collected from ten different sites on the body: palm, anterior forearm, cubital fossa, medial upper arm, axilla, abdomen, back, medial thigh, popliteal fossa, and heel, using the method of McGinley *et al.* (1969), as follows: An open-ended glass cylinder with a cross section area of 3.8 cm² was placed on the skin; 1 ml of 0.1% Triton X-100 in 0.075 mol/L phosphate buffer with a pH of 7.9 was added with a glass pipette. The skin surface within the area of the cylinder was rubbed with a Teflon scrubber for 1 min. The fluid was removed by pipette and replaced with another 1 ml of clean fluid. After another minute of scrubbing, this fluid was removed as the other had been. These two samples were pooled. The cells contained in the resulting new sample were stained with rhodamine B and methylene blue.

Measurements

After vigorous shaking for 30 sec., an aliquot of the suspension was introduced into the chamber of a hemocytometer, and the corneocytes were counted in the same manner as white blood cells. To assess

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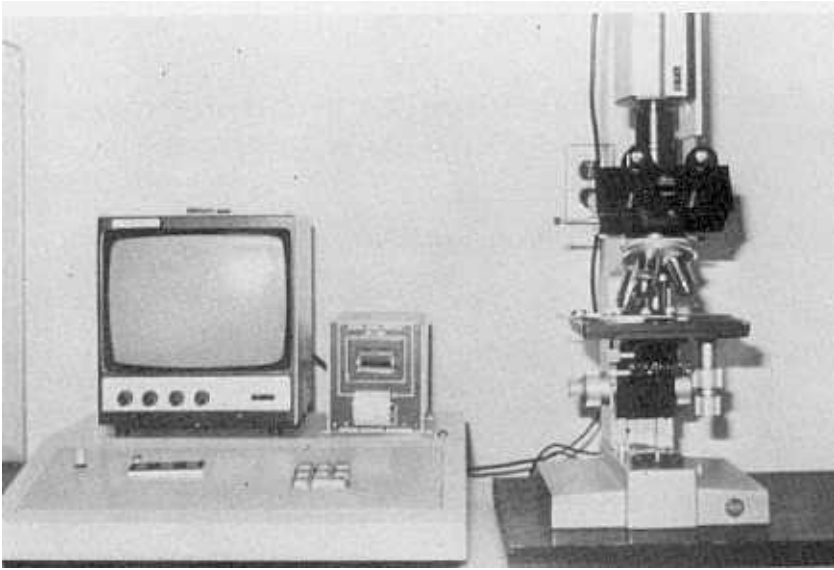


Fig. 1. Automatic cytographic counter (Model YK-1)

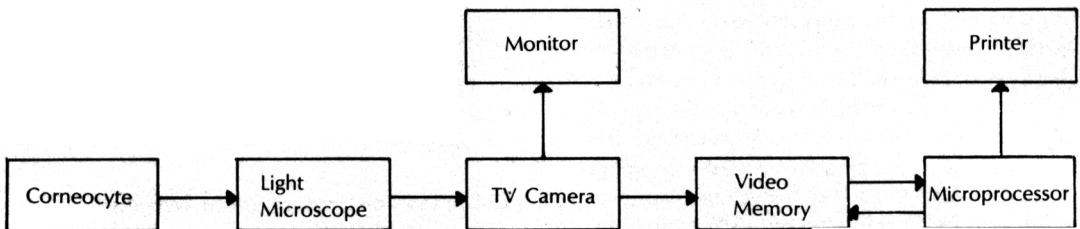


Fig. 2. Block diagram of automatic cytographic counter system

the cell size and morphology, a few drops of the suspension were placed on a glass slide, covered with a cover glass, and air-dried for 1 day. The cell surface and shape were determined, using an automatic cytographic counter (Model YK-1). The mean absolute percentage of error of this equipment for the measuring of cell surface is 0.5% (Lee and Lee 1985).

Automatic cytographic counter system

The appearance of a corneocyte, magnified under a microscope, is changed to an electrical signal by a TV camera and then is converted into computer language and stored in the computer's video memory. Digitalized video data is sent to a monitor, and if the result is acceptable, a microprocessor reads the stored data, finds the size, and displays the number for the operator. The above manipulation is repeated, based on the number of corneocytes included in the data. A printout provides the shape, size, and mean of

standard deviation of each corneocyte stored in the data memory bank (Fig. 2).

RESULTS

Corneocyte count

Males: Of all collection sites, the smallest number of corneocytes was obtained from the epidermis of the palm ($44,672 \pm 4,818/\text{cm}^2$), and the largest number was obtained from the epidermis of the medial thigh ($198,225 \pm 21,302/\text{cm}^2$) (Table 1.).

The corneocyte count of the anterior forearm was 3.7 times greater than the count of the palm, and that of the heel was 2.5 times greater than that of the palm. More corneocytes were obtained from the medial upper arm than the anterior forearm, but the difference was not statistically significant ($P < .05$). The corneocyte counts were increasingly greater in the

Table 1. Comparison of corneocyte counts at different sites, by sex

Site	Male	Female	P-value
Palm	44,672± 4,818	27,698± 3,690	NS
Anterior forearm	166,580±14,596	98,422± 8,406	<.005
Cubital fossa	135,198±10,241	118,948±12,382	NS
Medial upper arm	188,883±18,738	143,027±17,423	<.025
Axilla	178,225±15,222	109,738±15,438	<.005
Abdomen	196,975±19,511	140,725±16,295	<.005
Back	157,172±11,988	112,567±16,547	<.025
Medial thigh	198,225±21,302	117,106±12,736	<.005
Popliteal fossa	191,186±17,108	119,804±17,993	<.005
Heel	112,764±13,667	69,343± 6,396	<.025

Values are mean±SE (/cm²).

P-value obtained by using Student's t-test.

NS: not significant

sequence: the popliteal fossa, axilla, and cubital fossa, but the difference in count between the popliteal fossa and the axilla was not statistically significant. The differences in count between the popliteal fossa and the cubital fossa, and the cubital fossa and the axilla were statistically significant ($P<.005$, $P<.005$). There were more corneocytes obtained from the epidermis of the abdomen than from that of the back, and the difference in count between the two sites was statistically significant ($P<.05$). There were more corneocytes obtained from the epidermis of the medial thigh and popliteal fossa than from that of the heel ($P<.005$, $P<.005$).

Females: Of all collection sites, the smallest number of corneocytes was obtained from the palm (27,698±3,690/cm²) and the largest number was obtained from the medial upper arm (143,027±17,423/cm²) (Table 1).

The corneocyte count for the anterior forearm was 3.6 times greater than the count of the palm, and the count for the heel was 2.5 times greater than the count for the palm. There were more corneocytes obtained from the epidermis of the medial upper arm than from that of the anterior forearm ($P<.025$). The corneocyte counts of the popliteal fossa, axilla, and cubital fossa were almost the same ($P>.05$).

There were more corneocytes obtained from the epidermis of the abdomen than from that of the back, but the difference between the two sites was not statistically significant. There were more corneocytes obtained from the epidermis of the medial thigh and popliteal fossa than from that of the heel ($P<.025$, $P<.01$).

Summary comparison: At all collection sites the corneocyte count was higher in the males than in the females, and statistically there was a significant difference between them at all sites except the palm and cubital fossa (Table 1).

Corneocyte size

Males: The smallest corneocytes were obtained from the palm (1,000±17μm²), and the largest, from the medial thigh (1,184±17μm²) (Table 2).

The sizes of the corneocytes of the upper extremities were larger in the proximal sites, medial upper arm, but the sizes of those of the anterior forearm and palm were almost the same. The size of the corneocytes of the anterior forearm was 91% of the size of those of the heel. The sizes of the corneocytes of the axilla, abdomen, and back were almost the same. The corneocytes obtained from the cubital fossa were larger than those obtained from the axilla and popliteal fossa ($P<.005$, $P<.005$), but the difference in size between the corneocytes of the axilla and popliteal fossa was not statistically significant ($P>.05$). The sizes of the corneocytes of the axilla, abdomen, and back were almost the same. The sizes of the corneocytes of the lower extremities were larger in the proximal sites. The difference between the medial thigh and the heel, and the difference between the popliteal fossa and the heel were both statistically significant ($P<.005$, $P<.005$).

Females: The smallest corneocytes were those taken from the palm (1,005±11μm²) and the largest were those taken from the medial thigh (1,188±14 μm²) (Table 2). The sizes of the corneocytes of the upper

Table 2. Comparison of corneocyte size at different sites, by sex

Site	Male	Female	P-value
Palm	1,000±17	1,005±11	NS
Anterior forearm	1,004±12	1,018±21	NS
Cubital fossa	1,026±12	1,096±16	<.005
Medial upper arm	1,098±12	1,145±14	<.025
Axilla	1,148±11	1,176±11	NS
Abdomen	1,130± 8	1,180±18	<.01
Back	1,123±12	1,178±15	<.005
Medial thigh	1,184±17	1,188±14	NS
Popliteal fossa	1,176±15	1,094±13	<.005
Heel	1,104±12	1,101±12	NS

Values are mean±SE (μm^2).

P-values obtained by using Student's t-test.

NS: not significant

Table 3. Comparison of regular cell counts at various sites, by sex

Site	Male			Female			P-value
	Pentagon	Hexagon	Total	Pentagon	Hexagon	Total	
Palm	19.2±1.5	11.8±1.3	30.7±2.3	19.4±1.6	11.4±1.5	30.8±2.2	NS
Anterior forearm	25.2±2.2	15.7±2.9	40.9±4.2	25.7±2.0	17.2±3.0	42.9±4.1	<.05
Cubital fossa	26.1±2.4	16.0±2.2	42.3±3.4	26.1±2.8	17.7±1.5	43.8±2.8	NS
Medial upper arm	24.4±3.3	15.1±2.5	39.8±4.7	26.3±2.7	18.6±2.9	44.9±4.5	<.005
Axilla	26.2±2.8	15.9±2.2	42.1±4.0	25.9±1.9	17.7±2.5	43.6±3.2	NS
Abdomen	27.5±1.8	16.6±2.1	44.1±2.5	27.0±2.6	18.0±2.6	45.9±3.6	NS
Back	27.5±1.2	16.7±2.2	44.2±2.4	28.7±2.3	18.7±1.9	47.4±3.4	<.005
Medial thigh	24.2±2.5	14.5±2.8	38.7±4.4	27.0±1.9	18.5±2.2	45.4±2.8	<.005
Popliteal fossa	23.4±2.1	15.2±2.4	38.5±3.4	26.6±2.2	18.4±2.1	44.9±3.4	<.005
Heel	19.7±2.0	11.4±2.1	31.0±3.8	19.3±1.7	11.5±1.8	31.0±3.1	NS

Values are mean±SD (%).

P-values obtained by using Student's t-test.

NS: not significant

extremities were, for the most part, larger in the proximal than in the distal sites, but the sizes of the corneocytes of the anterior forearm and palm were almost the same.

The size of the corneocytes of the anterior forearm was 87% of the size of those of the axilla, and the size of the corneocytes of the palm was 91% of that of those of the heel. Although the size of the corneocytes was increasingly larger in the sequence: the axilla, cubital fossa, and popliteal fossa, the difference between the size of those of the cubital fossa and those of the popliteal fossa was not statistically significant. The difference in size between those of the axilla and those of the cubital fossa, and those of the

axilla and those of the popliteal fossa were statistically significant ($P<.005$, $P<.005$).

The size of the corneocytes of the axilla, abdomen, back, and medial thigh was almost the same. The size of the corneocytes of the lower extremities was increasingly larger in the sequence: the medial thigh, heel, and popliteal fossa, but the difference in size between those of the heel and the popliteal fossa was not statistically significant. The difference in size between those of the medial thigh and those of the popliteal fossa and between those of the medial thigh and those of the heel was statistically significant ($P<.005$, $P<.005$).

Summary Comparison: The size of the corneocytes

taken from any one of the collection sites on the females was larger than the size of the corneocytes taken from any one of the collection sites on the males, except where those taken from the popliteal fossa and the heel were concerned. The difference in size between those taken from the cubital fossa, medial upper arm, abdomen, and back of the males and those taken from the same sites in the females were statistically significant (Table 2).

Corneocyte shape

The ratio of the total number of regular cells to the total number of corneocytes secured from all of the collection sites was higher in the females than in the males, but the differences found in the anterior forearm, medial upper arm, back, medial thigh, and popliteal fossa were statistically significant (Table 3). The percentage of regular cells found among the cells taken from the palm and heel was 31% (pentagonal cells, 19-20%; hexagonal cells, 11-12%), which was lower than that related, to the other sites. The percentage of regular cells taken from other sites was 39-44% (pentagonal cells, 23-28%; hexagonal cells, 15-17%) in males and 43-47% (pentagonal cells, 26-29%; hexagonal cells, 17-19%) in females.

DISCUSSION

In 1969 McGinley *et al.* introduced the detergent scrub technique for visualization and quantification of the desquamating portion of the human stratum corneum which resulted in a corneocyte count of glabrous skin of 10^5 cells per cm^2 . In subjects with dandruff the scalp count is nearly twice as great as in normal subjects and exceeds three times the normal value in clinically severe cases. Roberts and Marks (1980) estimated the stratum corneum turnover time with the use of dansyl chloride and observed that there were differences in the turnover time of the stratum corneum according to the parts of the body tested. They also determined that a negative correlation exists between corneocyte count and turnover time.

The difference in corneocyte count according to the part of the body tested might be due to a difference in stratum corneum turnover time and intracorneal cohesion (Nicholls and Marks 1977). In this experiment, it was assumed that the main cause of a low corneocyte count in the palm and heel in both sexes was due to an increase of intracorneal cohesion.

A great deal of progress was made in the study of the size of corneocytes after Plewig and Marples (1970) and Hölzle and Plewig (1977) estimated the size

of corneocytes by means of the detergent scrub technique, by using a projection microscope with a projection mirror. Plewig and Marples (1970) estimated the size of the corneocytes in various parts of the body in 4 men from 21 to 31 years of age. The results showed that the smallest were those of the forehead ($746 \mu\text{m}^2$), and the largest were those of the axilla ($1,222 \mu\text{m}^2$).

The size of the corneocytes of the upper extremities was larger in the proximal parts in both sexes. Plewig (1970) reported that the size of the corneocytes in females was larger than in males and that the corneocytes increased in size with aging. In this experiment, it was also found that the size of the corneocytes in females was larger than the size of those in the males at all of the collection sites except the popliteal fossa and the heel. The cause of the difference in size according to the site of the body might be due to the difference in: (1) the turnover time of the stratum corneum, (2) intracorneal cohesion, and (3) the thickness and shape of the corneocytes (Marks and Barton 1983).

Plewig and Marples (1970) indicated that there is a relationship between corneocyte size and the turnover time of the stratum corneum, according to the parts of the body tested, as estimated by Baker and Kligman (1967) with the use of tetrachlorsalicylanilide.

Hölzle and Plewig (1977) reported that a 15% decrease in corneocyte size and a tripling of the corneocyte count in allergic contact dermatitis had reduced the turnover time of the epidermis, and had changed the size of the corneocytes to nearly normal after treatment with a topical corticosteroid. Hölzle *et al.* (1980) reported that topical corticosteroids reduced the size of corneocytes in normal skin, and Park *et al.* (1984) observed a decrease in the size of corneocytes in normal skin in sites being treated by applications of topical corticosteroids. Goldschmidt (1979) reported that the size of corneocytes obtained from the desquamating portion of psoriatic lesions was much smaller (27%) than that of corneocytes obtained from noninvolved normal skin in the same patients and suggested that rapidly proliferating epidermal cells have smaller surface areas than normal cells.

Lee *et al.* (1983) also reported an increase in corneocyte count and a decrease in corneocyte size on the chronically irritated skin of operating room nurses. Grove and Kligman (1983) also studied the relationship by means of dansyl chloride and reported a 50% reduction in stratum corneum turnover time and a 20% reduction in corneocyte size and maintained that this parameter can indeed serve as

a sensitive indication of alterations in the rate of epidermopoiesis.

As a rule, since corneocytes obtained from regions of high proliferative activity are smaller than normal, it is assumed that the corneocyte size is in reverse proportion to the proliferative activity, i.e., the longer the turnover time of the stratum corneum, the larger the corneocyte size and the lower the corneocyte count. Furthermore, low corneocyte surface areas are associated with higher numbers of removable corneocyte per cm² of skin surface (Herrmann *et al.* 1983). In this study the significant reverse relationship between corneocyte count and size was not observed, but there were more corneocytes in males than in females at 8 sites on the body, excluding the popliteal fossa and the heel. Also, there were larger corneocytes in females than in males at all of the collection sites.

In 1977 Hölzle and Plewig divided corneocytes by shape into regular cells (pentagonal and hexagonal cells) and irregular cells and reported the percentage of regular cells of the abdomen to be 54% (pentagonal cells, 31%; hexagonal cells, 23%). Lee *et al.* (1983) reported the percentage of the same to be 46% (pentagonal cells, 26%; hexagonal cells, 20%), and Park *et al.* (1984), 48% (pentagonal cells, 29%, hexagonal cells, 19%). These are similar to regular cell percentages by body site in this study.

Plewig and Marples (1970) divided the corneocytes into small cells, intermediate cells, and larger cells and reported that they could see small cells on the forehead and lower arm, intermediate cells on the heel, and large cells on the abdomen, thigh, and axilla. In this study, relatively small corneocytes were observed on the palm and anterior forearm (1,000–1,018 μm^2), medium corneocytes were observed on the heel (1,101–1,104 μm^2), and relatively large corneocytes were observed on the abdomen, axilla, and medial thigh (1,130–1,188 μm^2).

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