

Improving the Appearance of Facial Pores

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Conspicuous pores are a perennial problem for women of various ages and concern about them is increasing. In our own survey of 1,781 women in Japan, more than half of women in their twenties or thirties complained of conspicuous pores. An international attitude survey of women in their twenties revealed that enlarged or highly visible pores are also a major concern among women outside of Japan^a.

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^aShiseido survey of 50 women in New York and Paris in 2002. More than 70% of women answered to concern about conspicuous pores in both cities.

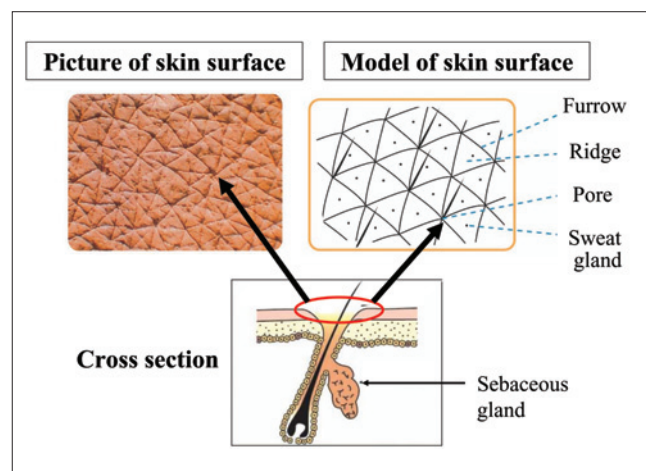


Figure 1. Model of a pore

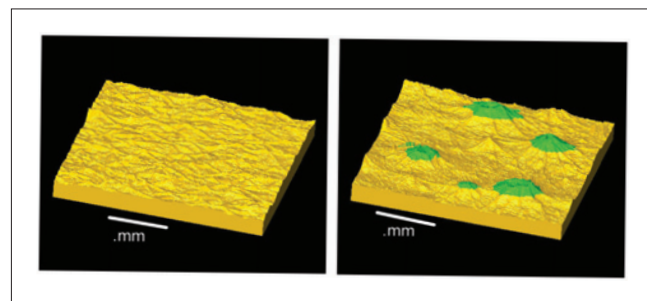


Figure 2. Skin replicas of inconspicuous facial pores (left) and conspicuous facial pores (right) with large pores shown in green

In general, people who secrete a large amount of sebum have large facial pores. However, there has been little scientific study of noticeable facial pores. Therefore, we investigated the physiological characteristics of the cheek skin of healthy women volunteers in their twenties and thirties.

Structure of Conspicuous Pores

Skin texture is created by furrows and ridges. Pores are located where furrows intersect. Each pore is linked with a sebaceous gland as shown in Figure 1, and sebum is secreted through it. It is probable that pore size is directly related to sebaceous gland size. Large pores indicate larger glands, which will produce more oil. It has been known that women with larger pore size may make more oil than women with smaller pore size.

Pores are found all over the skin surface of the body, except for the palm and sole. By examining conspicuous pores and inconspicuous pores under a magnifying glass or microscope, we concluded that large cone-shaped hollows around sebaceous ducts seem to be shadowed and consequently appear as conspicuous pores. To confirm the structure, we made replicas of cheek skin. In the replicas, the large pores resemble mountains or barnacles (Figure 2).

Next, we compared the condition of corneocytes around pores to that of corneocytes in other areas. When nuclei were stained with hematoxy-

Key words

pore, parakeratosis, unsaturated fatty acid, polyoxyethylene/polyoxypropylene dimethyl ether

Abstract

In this study of pore size and sebum composition, the authors report that topical application of polyoxyethylene/polyoxypropylene dimethyl ether improves skin texture and reduces parakeratosis in facial skin, making large pores less visible.

lin or bisbenzimidazole H 33342^b, nucleated cells (see sidebar) were frequently found only in the corneocytes around pores.

The significance of this finding will be described in a moment. In general, approximately 90% of nucleated cells seem to be located around pores among tape-stripped corneocytes.

We visually examined the cheeks of 20 healthy Japanese women and classified them into two groups: those with conspicuous pores and those with inconspicuous pores. We counted nearly five times as many nucleated cells around the conspicuous pores as we counted around the inconspicuous pores (3500 versus 700 in an area 23 mm x 34 mm around each measured pore). These results confirm that skin with conspicuous pores has abundant nucleated cells compared to that with inconspicuous pores.

This skin condition of abundant nucleated cells is called advanced parakeratosis. This is a condition in which inflammation, stimuli or other causes accelerate the keratinization process, giving rise to abundant incomplete corneocytes in which the nucleus is retained. Namely, the skin condition around such pores is relatively poor. Parakeratosis around pores is found especially in the cheek and forehead

Nucleated cells

The term nucleated cells refers to cells that have nuclei. As described, parakeratosis is a condition in which inflammation, stimuli or a similar cause accelerates the keratinization process, giving rise to incomplete horny cells with the nucleus retained. Horny cells developed through normal keratinization do not have a nucleus.

area, and is less frequent in other places such as the arm, where pores are inconspicuous.

Effect of Sebum Components

We recruited 94 healthy volunteers (59 Japanese females and 35 Caucasian females living in Japan) in their twenties and thirties and classified them into three groups on the basis of apparent facial pores: A - inconspicuous pores; B - ordinary pores; C - conspicuous pores (Figure 3).

The relationships between noticeable pores and skin parameters such as transepidermal water loss (TEWL) value or the amount and composition of sebum were investigated instrumentally^c. Because similar results were obtained in both Caucasians and Japanese, only typical data obtained from Japanese are shown here. The data were mainly analyzed by using the unpaired t-test.

Average TEWL values of subjects with inconspicuous and average pores were slightly lower than those of subjects with conspicuous pores (22.3, 21.3 and 23.9 g/m² per hr for groups A, B and C, respectively).

Sebum was collected with glass filter paper and extracted with acetone, and the amount and components of sebum were analyzed by gas-chromatography^d.

^bHoechst 33342 is a product of Sigma, St. Louis, MO USA.

^cTM210 TEWA meter, Courage & Khazaka, Cologne, Germany

^dHP6890 gas chromatograph, Hewlett Packard Co., Palo Alto, CA USA.



Figure 3. Classification on the basis of pore visibility

Class A = Inconspicuous

Class B = Ordinary

Class C = Conspicuous

The amount of sebum increased in parallel with the pore size (53, 100 and 135 µg of sebum for groups A, B and C, respectively). This result is consistent with suggestions in cosmetics magazines and technical books that excessive sebum may be related to noticeable pores.¹ However, it is not known which component of sebum is most associated with conspicuous pores.

We found no marked differences in components such as triacylglycerol, squalene, wax and saturated fatty acids. However, unsaturated free fatty acids, such as oleic acid and palmitoleic acid, were more abundant in sebum of women with conspicuous pores (2.3, 3.4 and 4.4% unsaturated free fatty acids in the sebum for groups A, B and C, respectively).

Oleic acid (C18:*cis*-9) is one of the major components among unsaturated fatty acids in sebum. This may be synthesized from saturated fatty acid by desaturases or it may also be produced from triacylglycerides by lipases as palmitoleic acid (C16:*cis*-9). These substances are known to cause roughness of the skin surface, inflammation, acne and comedo.^{2, 3} Although the composition of fatty acids on human face has been reported,⁴ this is the first finding on the relationship between pore size and the sebum composition.

Effects of Unsaturated Fatty Acids on Human Skin

We next examined the effects of unsaturated free fatty acids on human skin by applying 30% oleic acid to the human forehead for three days to induce parakeratosis. This concentration is very high compared to the content of the skin surface lipid. Parakeratosis in the horny layer was then examined by tape-stripping corneocytes and staining the nucleosomes. Many nucleated cells, stained purple, were seen only in the forehead to which oleic acid had been applied. The TEWL value also increased.

Next, we applied 3% oleic acid to human cheek for four weeks (twice a day); this concentration is equal to that in sebum. The degree of parakeratosis of corneocytes in the skin to which oleic acid was applied was greater than that in the skin to which ethanol was applied (1100 versus 800 nucleated cells in a 12 mm by 34 mm area). Because oleic acid was resolved in the final concentration 3%, not in water, we used ethanol as a negative control. Similar results were obtained with palmitoleic acid, which also contains a single double-bond in its structure, like oleic acid.

Other components, including squalene, triolein (a kind of triacylglycerol), cholesterol and saturated fatty acids such as palmitic acid (C16) and stearic acid (C18), did not cause parakeratosis or an increase of TEWL value. Linoleic acid (C18: *cis*-9, 12), which has two double-bonds, caused weak parakeratosis. These results suggest that fatty acids that contain one double bond, such as oleic acid and palmitoleic acid, cause parakeratosis around pores on the cheek after being secreted from sebaceous glands. The reason for this is now under investigation.

Table 1. VC1 and TEWL values raised by the application of oleic acid

	VC1 value	TEWL value
Oleic acid	0.094	2.33
Oleic acid +POP/POE-14/7	0.043	-0.45

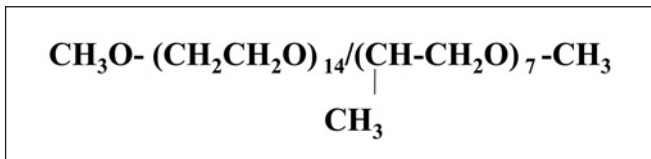


Figure 4. Structure of POE/POP-14/7 dimethyl ether

Unsaturated fatty acids cause damage to the skin texture. We applied 30% oleic acid on human arm skin for six days (n=4), then took a replica of the applied area and measured^c VC1 (a measure of skin homogeneity).⁵

Compared to ethanol, oleic acid increased the value of VC1 compared

^c Confocal microscope HD100D, Lasertec, Yokohama, Japan.

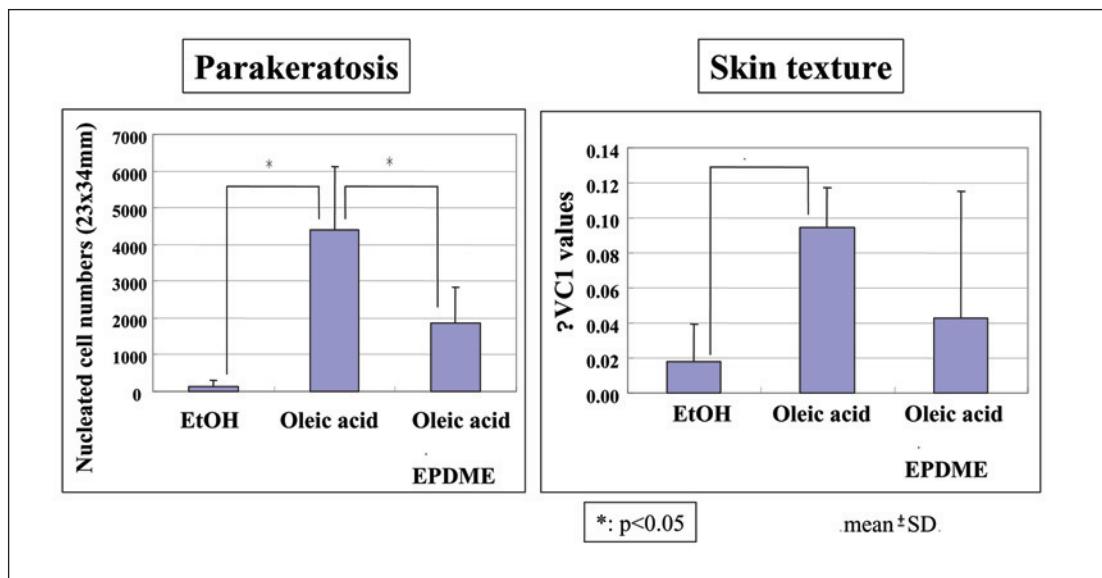


Figure 5. Improvement of skin condition after topical application of 5% POE/POP-14/7 dimethyl ether solution (EPDME) for four weeks

to similar ethanol treatment (VCI readings of 0.017 for ethanol versus 0.093), which reflects increased anisotropy of the skin furrows, i.e., a deterioration of skin texture.

Furthermore, when the VCI value is

higher, the pores of the cheek are more conspicuous. Among the 94 members of our three classifications based on pore visibility, the VCI values averaged 0.275, 0.330 and 0.425 respectively, for A, B and C classifications. A possible explanation is that when the skin is plumped and the skin texture pattern is well aligned, pores are inconspicuous.

When the ridges are flat and furrows are shallow, the skin texture is irregular, and the pores look conspicuous.

The above results suggest that unsaturated free fatty acids, such as oleic acid, may be one of the main causes of conspicuous pores through induction of parakeratosis around the pores and impairment of skin texture (increase of VCI value).

A Treatment for Conspicuous Pores

To treat conspicuous pores, we looked for compounds that suppress the effect of oleic acid on the skin. Among more than 50 kinds of substances examined, polyoxyethylene (POE)/polyoxypropylene (POP)-14/7 dimethyl ether was the most effective.⁶ Its structure is shown in Figure 4. This compound contains both hydrophobic and hydrophilic regions, and decreases the VCI and TEWL values raised by the application of oleic acid (Table 1).

The mechanism of the repression of parakeratosis and the improvement of skin texture is not yet clear, but POE/POP-14/7 dimethyl ether may

absorb oleic acid, thereby suppressing the interaction between oleic acid and corneocytes.

Next, we prepared a solution of 5% POE/POP-14/7 dimethyl ether and applied this for four weeks to the cheeks of 34 women volunteers in their twenties or thirties. After the application, a decrease of nucleated cells and improvement of cheek skin texture were again detected Figure 5. Visual examination was also carried out and the rate of persons judged as having conspicuous

pores was decreased from 21% to 3%, and those judged as having inconspicuous pores increased from 6% to 29%.

POE/POP-14/7 dimethyl ether was found to be an effective substance against conspicuous facial pores. However, it did not produce a clear decrease of the area of cone-shaped hollows. Further investigation to find more effective compounds is in progress.

Summary

Conspicuous pores are one of the most frequent skin problems for women of various ages. A study of the relationship between the extent of conspicuous pores and the skin condition revealed that females with conspicuous pores have

a slightly increased transepidermal water loss (TEWL) value, and a high skin sebum content, especially in regards to unsaturated fatty acids. Experimental application of oleic acid, an unsaturated fatty acid, to the forehead of humans promoted parakeratosis and increased the TEWL value.

Polyoxyethylene (POE)/polyoxypropylene (POP)-14/7 dimethyl ether was effective in improving the parakeratosis caused by oleic acid, and reducing skin roughness. Application of a solution containing POE/POP-14/7 dimethyl ether improved skin texture and parakeratosis on human cheek, resulting in skin with less obvious pores.

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References

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1. G Plewig and AM Kligman, *Acne and Rosacea*, 3rd edn, T Jansen, ed, Berlin: Springer-Verlag pp 32-33 (2000)
2. T Maeda, An electron microscopic study of experimentally-induced comedo and effects of vitamin A acid on comedo formation, *J Dermatol* 18 397-407 (1991)
3. RE Kellum and K Strangfield, Studies in pathogenesis: Fatty acids of human surface triglycerides from patients with and without acne, *J Invest Dermatol* 58 315-318 (1972)
4. A Kotani and F Kusu, HPLC with electrochemical detection for determining the distribution of free fatty acids in skin surface lipids from the human face and scalp, *Arch Dermatol Res* 294 172-177 (2002)
5. MTakahashi, Image analysis of skin surface contour, *Acta Derm Venereol Suppl* 185 9-14 (1994)
6. T Omori et al, Development of new multifunction cosmetic raw materials and its applications, In: *IFSCC Proceedings Book II* (2003) pp 149-162

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