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SKIN SURFACE LIPIDS IN INFANTS AND ELDERLY PEOPLE

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Synopsis

The lipid on the surface of human skin is composed of wax esters and squalene from the sebaceous glands, cholesterol and cholesterol esters arising predominantly from the superficial epidermis, and glycerides plus free fatty acids from both sources. The activity of the sebaceous glands goes through a number of phases and is largely dependent on underlying endocrine factors. It is high immediately after birth, low in childhood, rises in advance of puberty, becomes high in adolescence and early adult life, declines steadily with age, perhaps more steeply in females after the menopause, and becomes low in old age. These changes affect the amount and composition of the skin surface lipid and may be important in relation to the physiological properties, susceptibility to disorders, and cosmetic attributes of the skin.

Riassunto

I lipidi presenti sulla superficie cutanea sono rappresentati da esteri di cere e squalene secreti dalle ghiandole sebacee, da colesterolo ed esteri del colesterolo provenienti prevalentemente dall'epidermide e da gliceridi e acidi grassi liberi provenienti dall'una e dall'altra fonte. L'attività delle ghiandole sebacee si sviluppa attraverso diverse fasi ed è strettamente connessa a fattori endocrini.
Tale attività è alta subito dopo la nascita, bassa nell'età infantile, aumenta nella pubertà, si eleva di più durante l'adolescenza e nella prima età adulta, si riduce notevolmente con l'età forse più rapidamente nelle donne dopo la menopausa e diventa bassa nella vecchiaia. Questi cambiamenti influenzano la quantità e la composizione dei lipidi di superficie e possono risultare importanti sia in relazione alle proprietà fisiologiche della cute che agli aspetti delle diverse patologie cutanee ed all'utilizzazione dei cosmetici.

The lipid on the human skin surface (Table 1) is composed of glycerides plus free fatty acids, wax esters, squalene, cholesterol esters and cholesterol (7,15). These materials arise from two sources, the superficial epidermis and the sebaceous glads. Both of these tissues manufacture glycerides but the wax esters and squalene are produced only by the sebaceous glands, and the cholesterol and cholesterol esters come largely, though not exclusively, from the epidermis. Thus in areas, such as the face, where sebaceous glands are numerous and active the proportion of wax esters to cholesterol i high, whereas in other regions, such as the calf, where sebaceous glands are sparse the proportion is low (7).

It has long been recognized that the levels of surface lipid change with age. Emanuel, in 1936 (5), found it to be lower in children than in men and woman, although it was even higher in neonates than in adults. It is generally agreed that the lipid decreases in old age. Little appears to be known about age differences in the production of lipid by the epidermis, but data on secretion of sebum are available from several sources.

Sebum production is principally under the control of androgens, though the interaction of other hormones may also be important (for review see 4). The sebaceous glads are holocrine, and androgens act to stimulate both cell proliferation and intracellular lipid synthesis. The overall action was first demonstrated experimentally in pre-pubertal boy by Strauss and Pochi (16), but the component effects can only be disengaged by the use of an animal model sucb as the rat (5).

The questions which need to be considered are whether the levels and composition of the surface lipid and the rates of sebum production differ between infants, children, middle-aged adults, and the aged, and the extent to which any differences can be related to endocrine or other underlying factors.

The rate of sebum secretion does not appear to have measured in neonates, nut Emanuel's finding that they have more surface lipid than adults has been confirmed by Agache and his coworkers (1). At the age of four days the levels were found to he around 400 $\mu g/cm^2$ in males and females alike. The figures remained fairly high for three months, but then subsided by about 75%. A low level of about 100 $\mu g/cm^2$ was maintained throughout childhood.

Is the high sebum level related to a high plasm testosterone?

According to Forest et al (6) the male levels rise to about 250 ng/100 ml at 50 days after birth, more than seven times that in the umbilical cord, and fall to the low level of childhood by ahout 6 months. They favour the explanation that the testosterone is of testicular origin.

In females the maximum concentration occurs immediately after birth, falls within days, and never exceeds that of the cord. The pattern of cortisone is similar, so the authors concluded that in the female the testosterone is of adrenal origin, and their data suggest that it is maternal.

However, in both males and females, the pattern of dehydroepiandrosterone closely follows the casual sebum levels. It is high immediately after birth, starts to fall within days, and reaches the low childhood within about three months (3).

The pioneer studies of sebum production were carried out by placing cigarette papers on the forehead for 3 days and then extracting the lipid with diethyl ether. Data from Pochi, Strauss and Downing (14) indicated that in both males and females sebum excretion is low in childhood, rises sharply at puberty, remains at a plateau throughout middle life, and falls in old age, gradually in males, but sharply in females after the menopause.

The first indication of any rise in sebaceous ex-

cretion occurs between the age of 9 and 11 years and there is a steep increase thereafter (14). In one girl tested twice yearly over a three-year period, average sebum production was doubled between 10 and 11, and similar rise started even earlier in nine boys. Similar trends were found by Constans et al. (2) in measurements of casual levels of skin surface lipid.
The most striking evidence that the sebaceous glands become active substantially in advance of other clinical signs of puberty comes from the study of the composition of the skin surface lipids. A study of samples taken from birth to puberty disclosed a dramatic fall in the ratio of cholesterol to was esters between the ages of 8 and 9 years in males and females alike (15). This indicates a steep rise in production of sebum relative to epidermal lipid. It seems possible that this stimulation of the sebaceous glands could result from an increase in the output of adrenal androgens.

The original finding of Pochi and Strauss (13) that sebum excretion falls sharply in women after the menopause has been exactly confirmed, using identical methods, by Yamamoto et al (17). However, when Downing and his coworkers (9) developed a procedure for absorbing the lipid on Bentonite clay instead of cigarette papers, they came to believe that the sustainable rates of secretion declined steadily from puberty to advanced old age in both females and males.

A further controversial problem is that although sebum secretion declines, according to both Plewig and Kligman (12) and Kumar, Barton and Marks (10), the sebaceous glands get larger. Plewig and Kligman (12) explain this by the hypothesis that although less sebum is produced by the aged glands, the glands are larger because the differentiating cells move more slowly through the gland. When glands were labelled by local injection of tritiated thymidine and biopsies were taken from the upper cheek, the labelling indices for the middle-aged and old were similar, but the labelled cells disappeared more quickly in the younger subjects. For example, in a specimen from an elderly subject obtained 7 days after thymidine injection the labelled cells had scarcely moved from the basal layer, whereas in a younger subject they would already be at the fundus (12). it may be commented that although these findings could explain why the aged glands become enlarged, they do not explain why less sebum is produced. A lowered output must involve either reduced cell production or lessened intracellular synthesis or both. In fact, Kumar et al (10) did find slightly lower labelling index in aged patients with hypertrophic glands than in younger normal subjects, but failed to establish a statistically significant difference. The claim by Ito et al (8) that in females over 50 the sebaceous glands of the forehead do not become larger, but smaller, does not resolve or advance the argument.

The application of sebum absorbent tape (Sebutape) to the forehead has revealed changes in the patterns of follicular sebum excretion (11). In infants, only small numbers of small spots are produced. At puberty, the number of active follicles increases, but the spots are large and irregular. In old age there are fewer spots.

In summary, the activity of the sebaceous glands goes through a number of phases, with consequent effects on the composition and amount of skin surface lipid. It is high immediately after birth, very low in childhood, rises in advance of puberty, becomes high in adolescence and early adult life, declines steadily with age, perhaps more steeply in females after the menopause, and becomes low in old age. These changes must be born in mind when considering the physiological properties and cosmetic attributes of skin throughout the ages of man.

Table I

Composition of Human Sebum and Epidermal Lipids Deduced from the Anatomical Variations in Skin Surface Lipid Composition.

Component Lipids	Sebum *wt (%)*	Surface Epidermal Lipids. *wt (%)*
Triglycerides, diglycerides and free fatty acids	57.5	65
Wax esters	26	—
Squalene	12	—
Cholesterol	1.5	20
Cholesterol esters	3	15

Source: Greene et al., 1970

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