Non-invasive analysis using three-dimensional ultrasound tomography demonstrates gender- and age-wise differences in facial sebaceous glands

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Abstract

Introduction: Facial skin is rich in large sebaceous glands (SGs), the activity of which varies with age and gender. It is well known that sebum levels are plentiful in young and scanty in elderly people, and that males have a higher sebum level than females. Although age and gender related differences in SG activity and sebum levels have been reported, changes in SG morphology remain inconclusive.

Three-dimensional ultrasound microscopy with a central frequency of 120 MHz is an in vivo imaging technique for examining the structure of human skin. Earlier techniques with ultrasonic frequencies of ~50 MHz could image the deepest parts of the skin, but their spatial resolution was limited to 80–160 μm. The high frequency of the new ultrasound microscopy allows visualizing the structure of skin appendages such as SGs and hair follicles non-invasively with a spatial resolution of 20 μm.

To explore the differences in SG morphology by age or gender, we measured facial skin using a high-frequency 3D ultrasound microscope.

Methodology: Young male subjects (n = 32, mean 32 ± 3 y), young female subjects (n = 34, mean 29 ± 2 y) and elderly female subjects (n = 20, mean 62 ± 3 y) were recruited for the study. All subjects were healthy and of Japanese ethnicity. SG images of the cheek were obtained by 3D ultrasound microscopy from an area of 4.8 mm x 4.8 mm and a depth of 1.5 mm. One hundred and fifty consecutive B-mode images were reconstructed to obtain volume data using image analysis software (Image J), and multi-planar reconstructed images parallel to the skin surface were processed at 700 or 900-μm beneath the skin surface to measure the SG area. The sebum levels were measured using Sebumeter (Courage + Khazaka Electronic) at 2 hours after the faces were washed.

Results and Conclusions: In accordance with previous studies, sebum levels were higher in young male subjects than in young female subjects, and faint amounts of sebum were detected in elderly female subjects. These results indicate that SG activity is different for the three groups.

Low-intensity circular regions were observed in en face images of 3D ultrasound tomography. The areas of those regions gradually increased from the skin surface to the deep dermis,
suggesting that low-intensity circular regions observed by high-frequency 3D ultrasound tomography represent SG morphology. In young male subjects, the areas of the circular regions at 900-μm beneath the skin surface were significantly larger than at 700 μm. B-mode images also showed an increase in the width of low-density regions in the deep dermis for young male subjects, indicating that their sebaceous lobules were well developed in the deep dermis. In contrast to the male subjects, the areas of low-density circular regions at 900 μm did not differ from those at 700 μm in young female subjects. These results suggest that males have cauliflower-shaped SGs with large lobules while the SG shape in females is somewhat more cylindrical. As for a comparison of the areas of circles between genders, low-density circles at 900 μm were significantly smaller in young female subjects than in males. Although there are few studies describing the differences in SG size between the two genders, male SG size has been considered to be larger than female because of the high levels of androgen, which stimulates SG activity, and sebum in males. Our study suggests that both SG morphology and size are different between males and females.

Studies on age related changes in SG morphology have reported an increase in SG size with age among Caucasian males but not in females. By contrast, the size of sebaceous lobules, which was determined by 3D figures re-constructed with serial sections, was reported to diminish with age in both males and females among the Japanese. In our present study, compared with young female subjects, the areas of low-density circles at 900 μm were diminished in elderly female subjects. Moreover, the region where areas of circles appeared to be maximum was shallower in elderly female subjects. Therefore, SGs are suggested to shrink with age in Japanese females. As the cross-sectional areas of SG vary with depth, previous studies using thin sections might not have been able to compare the maximum SG area, which may have affected their results. By contrast, 3D ultrasound tomography can process at any depth. Our study, using this technique, was able to show the age related differences in SG morphology.

In conclusion, we revealed the differences in facial SG morphology between the genders as well as by age group through non-invasive 3D ultrasound tomography.