ADVANTEST® Photoacoustic Microscope Hadatomo™ Z

Measure Differences in Dermis Structure, Blood Vessels, and Melanin Distribution in Different Regions of the Body

Measurement of face and upper arm of a healthy subject:

We measured a healthy subject using the Hadatomo™ Z photoacoustic microscope. The measurement area is 9 mm square and scan step is 30 μm. Lasers of two wavelengths, 575 nm and 650 nm, were used for measurement. We measured the face and upper arm and compared the measured images.

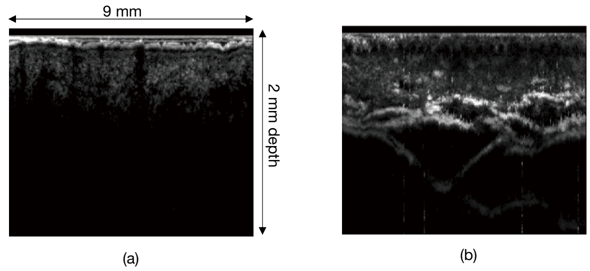

Fig. 1 Tomographic Image by ultrasonic signal
(a) Tomographic image of face
(b) Tomographic image of upper arm

1 Comparison of ultrasound images

Fig. 1 shows tomographic images acquired by ultrasonic waves. In the tomographic image of the face shown in picture (a), pores are observable, and the boundary between the dermis and the subcutaneous tissue is ambiguous. In contrast, in the tomographic image of the upper arm shown in picture (b), the boundary between the dermis and the subcutaneous tissue can be seen clearly.

Fig. 2 shows 3D ultrasound images of four different depths. Pictures a1 and b1 show the depth of 0 to 100 μm, which is the same depth as in Fig. 1. Pictures a2 and b2 show a depth of 100 to 200 μm, a3 and b3 a depth of 400 to 500 μm, a4 and b4 a depth of 700 to 800 μm. On the face images, many pores are observed on the dermis (a2, a3). In the deep area, almost no signal is observed, and the boundary of the subcutaneous tissues is ambiguous (a4). In the upper arm images, pores are fewer compared to the face: only a few pores are observed. Also, linear structures, assumed to be derived from fibers in the dermis, are observed (b2, b3). In the boundary between the dermis and the subcutaneous tissues, strong signals are observed (b4). This shows that the upper arm structure is largely different from the face structure (b4). As shown above, we could confirm differences between different body regions using ultrasound images.

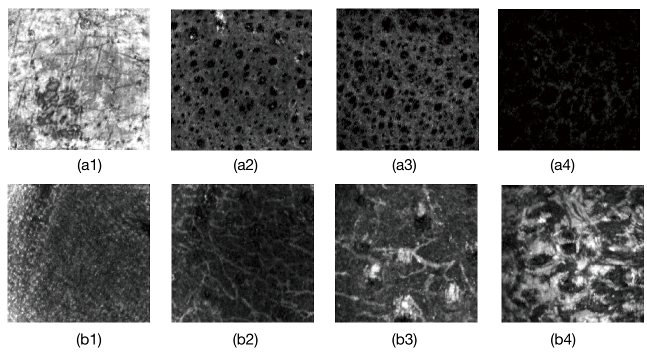

Fig. 2 Top view of 3D ultrasound image
(a) 3D image of face (b) 3D image of upper arm
(a1)(b1) Depth 0 to 100 μm, (a2)(b2) Depth 100 to 200μm, (a3)(b3) Depth 400 to 500 μm, (a4)(b4) Depth 700 to 800 μm

2 Comparison on photoacoustic images

Fig. 3 shows photoacoustic images using a wavelength of 575 nm. Each image visualizes blood vessels clearly. In the face image, curved blood vessels are dominant (a), while linear vessels are dominant in the upper arm image (b).

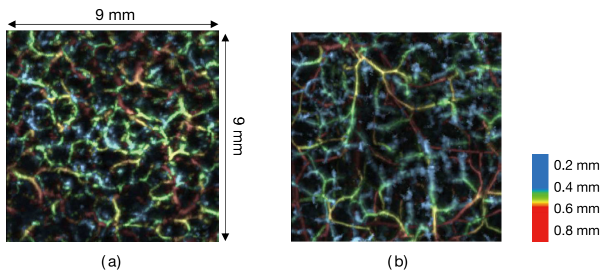

Fig. 3 Top view of photoacoustic 3D image (575 nm)
(a) 3D image of face (b) 3D image of upper arm
Color bar indicates depth.

Fig. 4 shows similar photoacoustic images using a 650 nm wavelength. Because the absorption coefficient of melanin is dominant in the wavelength of 650 nm, we

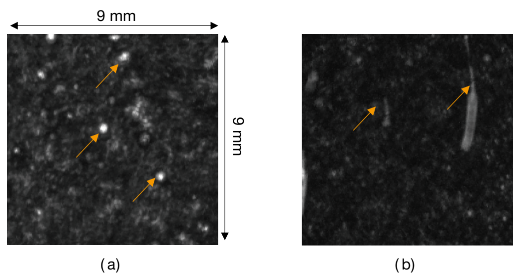

Fig. 4 Top view of 3D photoacoustic image (650 nm)
(a) 3D image of face (b) 3D image of upper arm

can assume that they are visualizing melanin distribution. Comparing to the exposed face, the unexposed upper arm is showing lower luminance of signals, so it seems that less melanin exists in the upper arm. Arrows indicate body hairs.

3 Comparison of photoacoustic images superimposed on ultrasound images

Fig. 5 shows photoacoustic images, acquired with a 575 nm waveform, superimposed on ultrasound images. In Fig. 5, (a1) and (b1) show top views of the face and the upper arm, respectively, at a depth of 400 to 600 μm. In the image of the face shown in Fig. 5 (a1), blood vessels running around pores are observed. In the image of the upper arm shown in Fig. 5 (b1), there are fewer pores than in the face image, so the running blood vessels appear different. In Fig. 5, images of (a2) and (b2) are tomographic images of (a1) and (b1), respectively. In the tomographic images, the blood vessels appear different on the face and the upper arm. It is assumed that the results are affected by the presence or absence of pores.

Fig. 6 shows photoacoustic images, acquired with a 650 nm waveform, superimposed on ultrasound images. Both are tomographic images; (a) is showing the face and (b) is showing the upper arm. In both body regions, body hairs inside the skin are visualized with the photoacoustic images (arrows in the picture). Through these pictures, we can tell that the depths of body hairs and structures around pores are different in the upper arm and the face.

Fig. 7 shows a 3D image made with a 575 nm photoacoustic image superimposed on a 650 nm photoacoustic image. Distribution of melanin brightness, depth of body hair, and blood vessels are observable.

As shown above, we could visualize and confirm the difference of dermis structures between the face and the upper arm using the Hadatomo™ Z photoacoustic microscope. There are possibilities of evaluating differences by body region, age, or sex, and evaluating aging over time.

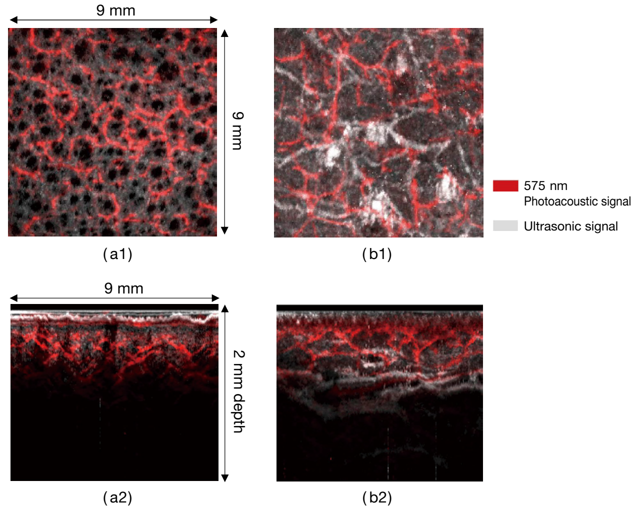

Fig. 5 Photoacoustic (575 nm) images of face (a) and upper arm (b) superimposed on ultrasound images. (a1, b1) are top view, (a2, b2) are tomographic images.

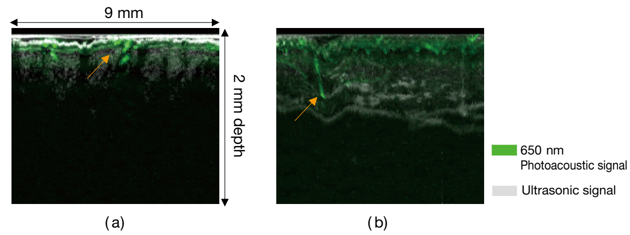

Fig. 6 Tomographic image of face (a) and upper arm (b), made by photoacoustic image (650 nm) superimposed on ultrasound image

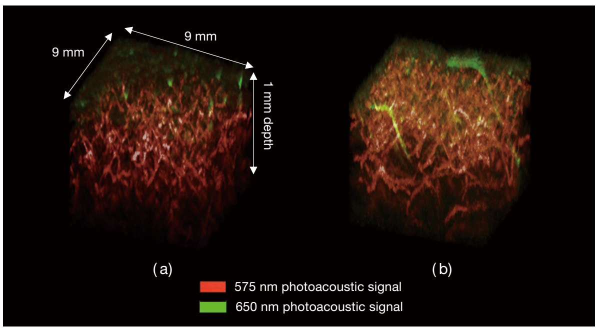

Fig. 7 Face (a) and upper arm (b) 3D images made by photoacoustic image (575 nm) superimposed on photoacoustic image (650 nm)

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