3P2-12

The evaluation of human skin humidity using ultrasonic observation

超音波顕微鏡を用いたヒト皮膚の保水性評価

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1. Introduction

Skin is the largest organ of human organs. As it becomes hot, it plays a role of keeping the body temperature at an appropriate temperature by sweating, preventing invasion of bacteria, and protecting and protecting the body from the external environment. Noninvasively measuring the internal state of the skin, therefore, is extremely important both from the medical and industrial aspects.

Recently, it has been reported to visualize the state of cells in skin using ultrasound and skin[1]. The skin consists of the epidermis, dermis and subcutaneous tissue, and these measurements are necessary for health and beauty. We have observed that ultrasonic measurement of human cheek skin in B - Z mode is performed to detect internal structural signals corresponding to stratum corneum, papillary layer, and a reticular layer.

In this study, we aimed to measure the stratum corneum of actual human skin, to analyze the change of internal structure of the skin before and after skincare to improve humidity and to obtain guidelines for evaluation. Evaluation of humidity by the ultrasonic microscope is considered to be a tool for simple, noninvasive and quantitative monitoring of skin care.

2. Methods

Fig. 1 shows a schematic diagram of the Z-to-B analysis. In this method, a reflection signal that contains internal information of a target and a reflection signal from the substrate-reference boundary are needed for the conversion of an acoustic impedance image from a B-mode image.

For skin observation, human forearm skin (female, age: 23) was subjected to water absorption treatment using either a wet towel or steamed towel for up to 9 min. Steamed towel made by heating water Kim towel with microwave (700W) for 1 min and Wet towel made by Kim towel with Water or Toning water (Fig. 2). Ultrasound echo was acquired with an appropriate interval.

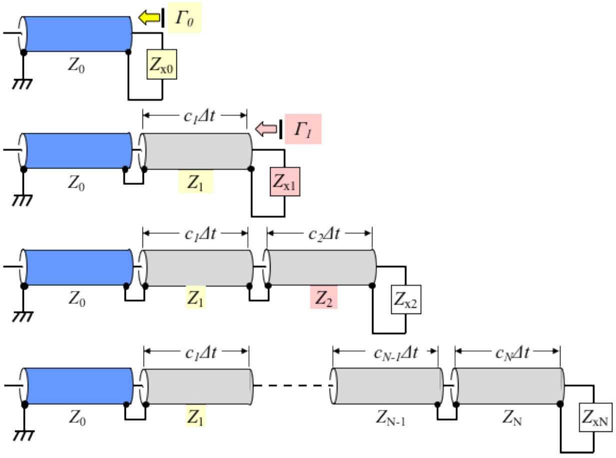

Fig. 1 Interpretation of Z-to-B algorithm.

Response waveform of conventional B-mode echo is interpreted into acoustic impedance along the depth of the ultrasound beam. Measurement conditions are the central frequency of oscillator: 80 MHz, measuring point: 200 pt × 200 pt, sampling interval: 1 ns and depth of 200 pt.

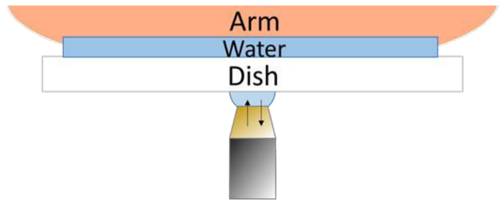

Fig. 2 Schematic diagram at human skin measurement

3. Results and Discussion

Fig. 3 shows the B-mode echo of the human forearm skin by ultrasonic observation. Conventional B-mode echo image cannot clearly highlight the stratum corneum.

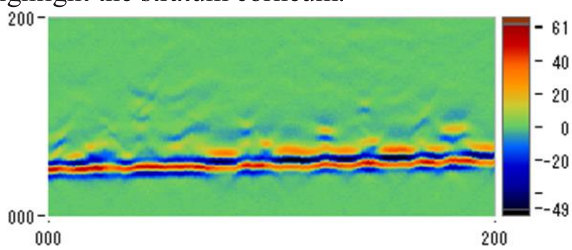

Fig. 3 B-mode skin-echo image

The acoustic impedance of the stratum corneum layer shows a tendency to increase in the process of water absorption and goes down in the process of drying out (Fig. 4). These tendencies are more significant in the case of using steamed towel treatment than a wet towel (Fig. 4).

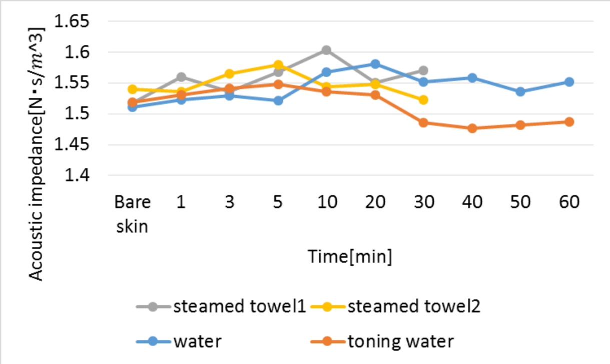

Fig. 4 Averaged acoustic impedance values of the changes over time

From the bottom, things like stratum corneum, epidermis, dermis were confirmed. The acoustic impedance of the stratum corneum is the highest, and Acoustic impedance is the lowest in the epidermis (Fig. 5).

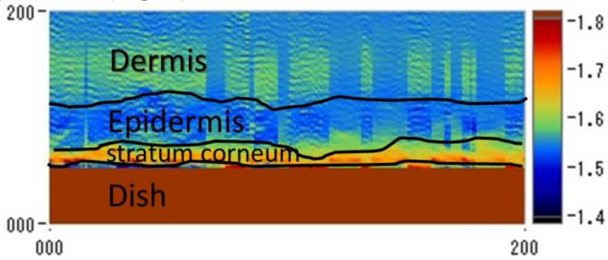

Fig. 5 3D acoustic impedance mapping of skin on the forearm

The stratum corneum layer get thicker as it is exposed to the water absorption treatment, and get thinner in the process of drying out (Fig. 6).

B-mode echo image is composed of reflections from interfaces between different layers; however, it cannot independently display a thin layer like stratum corneum, as the waveform has a finite width along the time direction. Acoustic impedance image, after being interpreted from the B-mode signal, is contrasted by physical property, which leads to the image compatible with anatomic understanding.

Lamella in stratum corneum is composed of cells after annihilation. Therefore the acoustic impedance of the lamella in dry condition would be higher than water. However, the result shows that the impedance of the stratum corneum gets higher with water absorption. It would be because the small cavity spaces between lamellae are filled with water. The acoustic impedance decreases after coming back to dry condition.

The result clearly shows the increase in stratum corneum after water absorption. It looks natural because lamellae themselves get hydrated.

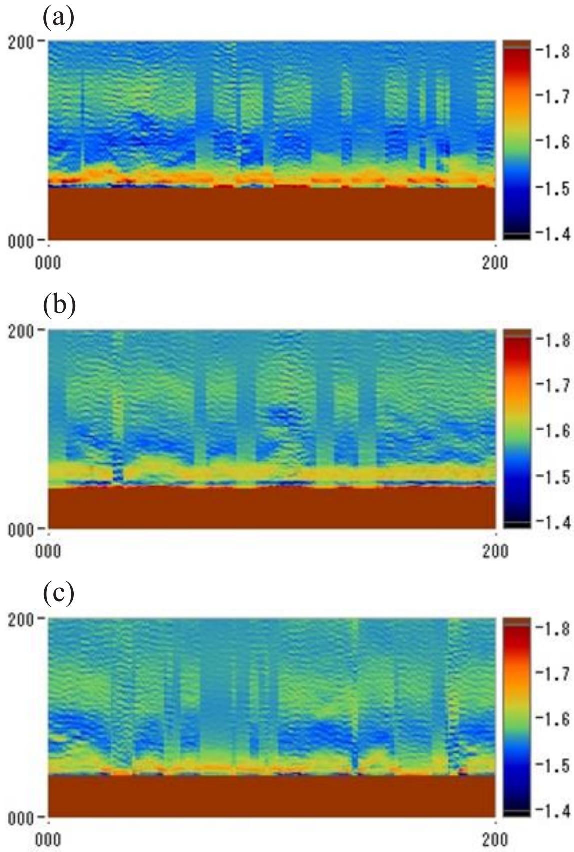

Fig. 6 3D acoustic impedance mapping
(a) Bare skin (b) steamed towel holding for 3min
(c) after 30min

4. Conclusion

By conducting a 3D analysis, it is possible to evaluate the acoustic impedance of only the stratum corneum portion. Changes in stratum corneum before and after water loading were continuously monitored. This method can be expected as a tool effective for evaluating water retentivity.

References

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