3P5-4

Proceedings of Symposium on Ultrasonic Electronics, Vol. 36 (2015)
5-7 November, 2015

Ultrasound Imaging Method Adaptable to Various Tissue Properties of Patients

患者の組織性状に依存しない超音波撮像法の検討

Tomoya Murakami[1†‡], Takashi Azuma[1], Kazunori Itani[2], and Shu Takagi[1]
([1] The Univ. of Tokyo; [2] Hitachi Aloka Medical)
村上智哉 [1†‡]，東隆 [1]，射谷和徳 [2]，高木周 [1] ([1] 東大, [2] 日立アロカメディカル)

1. Introduction

Rapid aging of Japan's population has a critical risk of lack of medical resource. Home hospital is one of promising solutions to overcome the lack of hospital. The ultrasound diagnostic equipment is convenient for carrying and the risk of the living body damage is small. Considering from above, the ultrasound diagnostic equipment is suitable for an at-home diagnosis. However, it is known that the precision of the ultrasound diagnosis image highly depends on the skill of a operator and tissue properties of patients. For the reason, it is one of the problems when we use it for an at-home diagnosis. Therefore, establishment of the imaging technique that is hard to depend on patient and operator is required.

The penetration length in the ultrasound propagation direction is one of the patient dependent indexes. It is known that penetration lengths are relatively short in a lot of fatty patient. Two following factors are considered as such a patient dependent factor. One is attenuation of medium tissue. The other is a heterogeneity of the speed of sound in the tissue which causes phase aberration after propagation. The solution is largely different by the cause of short penetration.

In this paper, we visualize an ultrasound beam *in vivo* by signal processing of ultrasound wave to investigate critical factor relating to patient dependency, and examine method of evaluation for it. Our beam imaging method is developed from our previous research of HIFU beam imaging (HBI) method [1].

2. Method

2.1. Beam imaging

Fig. 1 (a) shows the B-mode image of abdominal area by the beam imaging. This image was reconstructed by radio frequency (RF) data in each probe array. The configuration of beam imaging are shown in **Fig. 1 (b)**. The focused beam was transmit from all 128 elements, and echoes were received by all 128 elements. Since received beam was scanned while transmission beam was fixed, transmission beam profile can be imaged. Then, RF data of each probe array is summed on the basis of propagation path. This processing is conducted for all the pixels of the reconstruction area. As a result, we can get this image because the area where phases of RF data doesn't correspond can't get the enough high intensity.

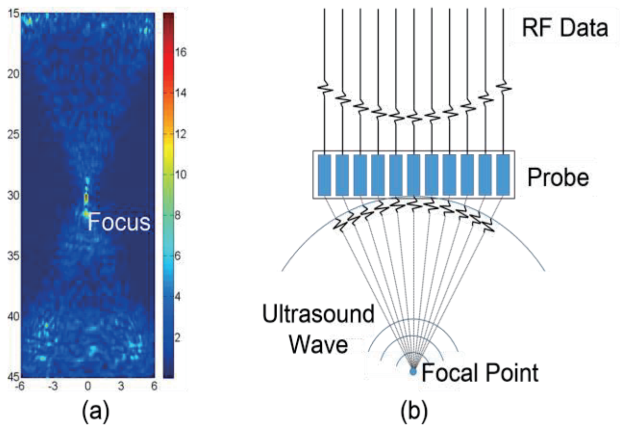

Fig. 1 (a) Beam imaging *in vivo*
(b) Configuration of beam imaging

2.2. Experiment

The experimental system is shown in **Fig. 2**. The RF data acquired by Verasonics through a linear probe is stored in host computer memory. Then, we could get the reconstruction image of ultrasound beam, as a result of running the reconstruction code by matlab for stored data. The diagnosis area was the abdominal region including the liver. In this experiment, we got images of four healthy volunteers that had a different somatotype. Center frequency was 5 MHz, the estimated acoustic velocity for beam-forming was 1540m/s and the focal point was 30 mm from body surface, respectively. The reconstruction area was 12 mm × 30 mm around the focal point, and the pixel size was 0.1 mm × 0.1 mm.

---

tmahh@fel.t.u-tokyo.ac.jp

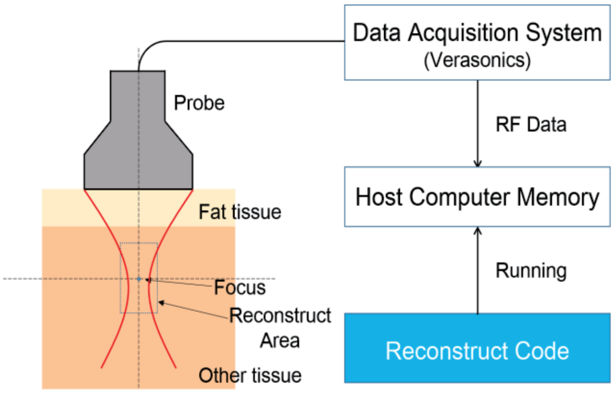

Fig. 2 Experimental system

3. Results and Discussions

Reconstruction images of ultrasound beam are shown in **Fig. 3**. These figures show that volunteers are positioned to be gradually thin from left to right. The highest point of intensity in each figure is located around set focal point, 30 mm. Especially, the focal point exists at an only point in patient 4's image. However, each intensity of focal point is greatly different. The patient 2's image contains the point of high intensity nearby 15 mm, and the patient 3's image has low intensity overall because of the poor contact between a body and a probe. These factors were major operator dependency. The operator dependency should be investigated independently to estimate the factor relating to patient dependency. We should collect more data from each patient to compare data in equal conditions.

Fig. 4 shows the lateral distribution of intensity of actual focal point. Fig. 4 (a) shows patient 1, and Fig. 4 (b) shows patient 4. This point is defined as the highest point of intensity located around set focal point, respectively. We could observe not only beam image but also the amounts of sidelobe which have a potential to be estimated as a factor highly relating to phase aberration after propagation.

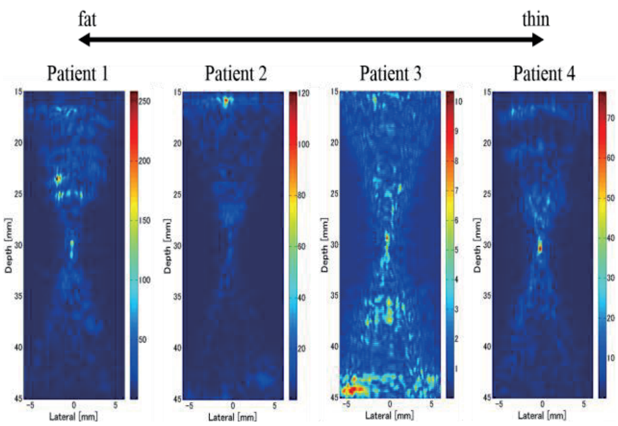

Fig. 3 Reconstruction images of each patient

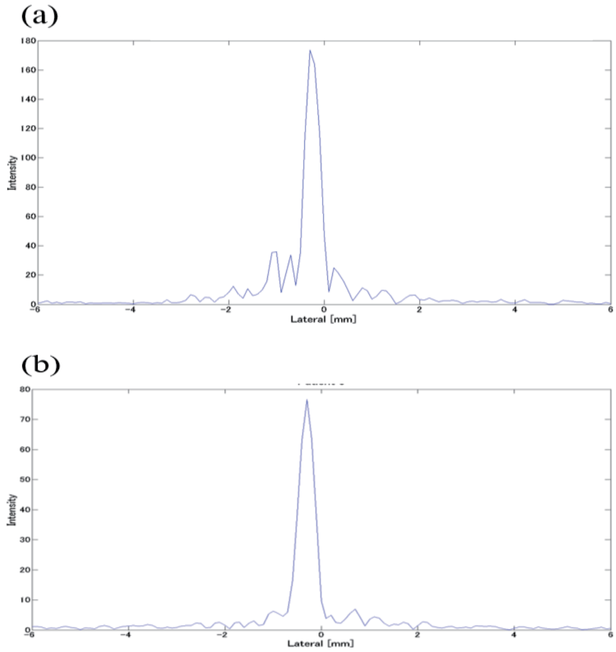

Fig. 4 Intensity of actual focal point
(a) Patient 1 (b) Patient 4

4. Conclusion

We visualized an ultrasound beam *in vivo* by signal processing of ultrasound wave, and got images of four healthy volunteers that had a different somatotype to investigate critical factor relating to patient dependency. The diagnosis area was the abdominal region including the liver, and we evaluated the lateral distribution of intensity of actual focal point. As a result, we could observe not only beam image but also the amounts of sidelobe which have a potential to be estimated as a factor highly relating to phase aberration after propagation. However, each intensity of focal point is greatly different because of the operator dependency. We should collect more data from each patient and need to get data of many patients.

Acknowledgment

This work was partially supported by Center of Innovation, Self-Managing Healthy Society, The University of Tokyo.

Reference

1. Fujiwara K.: Proceedings of Symposium on Ultrasonic Electronics, 32(2011), 583-584.