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Characterization of an Ultrasonic Probe for Medical Puncturing
医療穿刺用超音波探触子の特性評価

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1. Introduction

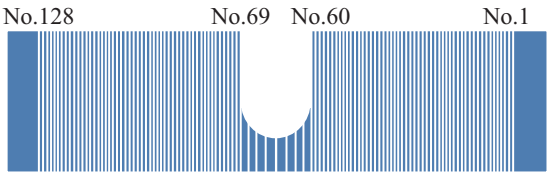
Ultrasound-guided puncturing has been used in practice in the field of medicine. For example, there are convex ultrasonic probes with puncture guides and ultrasonic probes for endoscopic ultrasound-guided fine needle aspiration (EUS-FNA). Making accurate punctures with them requires a great deal of skill because when they are used as methods they are oblique to the lesion areas to punctures. We fabricated ultrasonic probes with a through hole to puncture forward lesions while observing the lesions and the needle tip, and a B-mode image was obtained by observing the signals from the frontal object and the needle tip[1][2]. In this study, we fabricated and characterized a 128 channel linear array ultrasonic probe with a through hole to obtain more image information.

2. Structure of array probe

Figure 1 outlines (a) the transducer layout and has (b) a photograph of the 128 channel linear array ultrasonic probe with a through hole. The U-type slit was located so that the probe could be removed after a puncture was made. The transducer was composed of linear array transducers (1–60 channels and 69–128 channels) that were at a pitch of 0.15 mm on both sides of the slit and central array transducers (61–68 channels). The transducer material was PZT-epoxy 1-3 composite and the frequency was 7.5 MHz.

3. Experiments using array probe

The image resolution was measured with a B-mode image using aluminum blocks with widths of 0.7, 2.5, 4, and 10 mm. The probe was placed in water, and the aluminum block was imaged with the linear array transducer. The probe was driven by a pulser-receiver (Krautkramer Japan, PAL3). There is a B-mode image of the reflected signal from the 0.7 mm width block in Fig. 2. The width measured from the B-mode image was 0.72 mm. The three other blocks of various widths were also measured as shown in Table 1. They could be imaged with error of less than 0.03 mm, which confirmed the



(a)

(b)

Fig. 1 128ch linear array probe: (a)Transducer layout (b) Photograph.

Fig. 2 B-mode image of the reflected signal from the 0.7mm width block.

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Table 1 Block widths and measured widths by 128channel linear array probe.

Block width (mm)	Measured width (mm)
0.7	0.72
2.5	2.50
4.0	4.03
10.0	9.98

images were high resolution.

Detection of the needle tip was evaluated using the 61–68 channels of the eight central transducers. The signal intensity from the needle tip was 63[relative unit] as shown in Fig.3. Detection of the needle tip was also evaluated using transducers on both sides. The largest signal intensity was 26[relative unit] when 53–60 channels were transmitters and 69–87 channels were receivers as shown in Fig.4. Therefore, the eight central transducers are better than the transducers on both sides to detect the needle tip.

The needle tip was detected using a phantom of a blood vessel (Kyoto Kagaku, Real vessel). The outer and inner diameters of the blood vessel are 10 mm and 8 mm. The B-mode image of the blood vessel being punctured is shown in Fig.5. The signal reflected from the blood vessel wall and the signal from the needle tip were detected, which confirmed the puncturing needle could be detected and imaged with the 128 channels linear array probe.

4. Conclusion

We fabricated a 128-channel linear array ultrasonic probe, and examined image resolution and the needle detection performance. The resolution was less than 0.7 mm in the B-mode image. The needle tip was detected using eight central transducers. The needle tip puncturing the phantom of a blood vessel was also observed.

Acknowledgements

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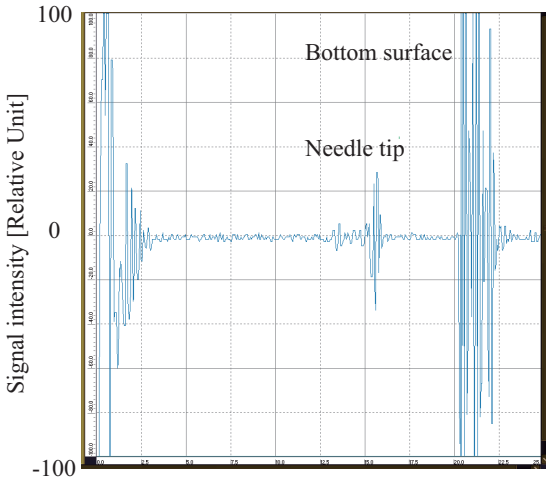

Fig. 3 A-mode image of needle tip detected using eight central elements.

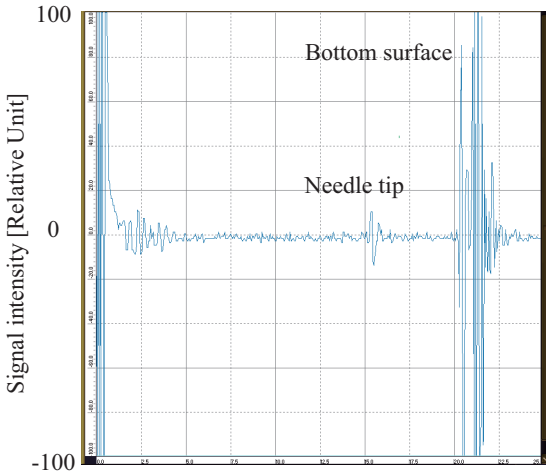

Fig. 4 A-mode image of needle tip detected using 53–60 channels and 69–87 channels.

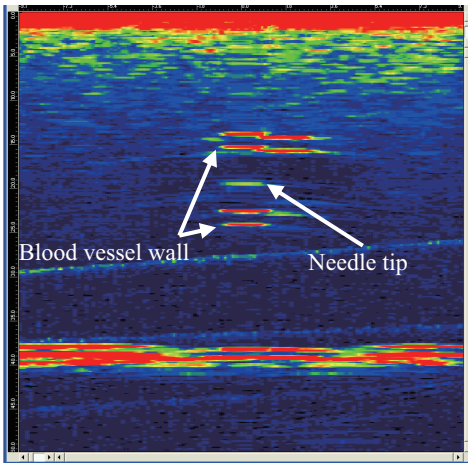

Fig. 5 B-mode image of phantom of blood vessel.