A Dual-mode Linear Array for Imaging Guided Stent Thrombosis Treatment

Min Su[1], Fei Li[1], Rong Liu[1], Zhiqiang Zhang[1], Ning Lyu[1], Ruilin Cai[1], Hairong Zheng[1], and Weibao Qiu[1]
[1]*Paul C. Lauterbur Research Center for Biomedical Imaging, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China*

Background, Motivation and Objective

Stent thrombosis (ST) may lead to myocardial infarction and sudden death in some severe cases. Drugs of dual antiplatelet therapy and thrombolytic have been applied to prevent the thrombosis. However, prevention of thrombotic event using these drugs comes with disadvantage of an increased bleeding risk. Ultrasound controlled drug delivery is a new method for allocating the drugs to the targeted area. The present study proposes a dual mode linear array transducer for visualizing the vascular stent, and such an array can also control drug loaded microbubbles to adhere on the surface of the stent, i.e. drug delivery on the stent. The drug can be delivered to the stent precisely by the guidance of ultrasound imaging, and hence the formation of stent thrombosis can be potentially inhibited.

Statement of Contribution/Methods

PZT-4/epoxy composite material was used for the piezoelectric elements due to its high electromechanical coupling coefficient and low acoustic impedance. The frequency of the array is 1.5 MHz and there are 32 elements in it. A vascular stent prototype that was fabricated by 3D printing was placed in a vascular phantom. Microbubbles were pushed through the vascular phantom using a pump. The array can find the accurate position of the stent by offering the images of the area of interest. In the meantime, the drug loaded microbubbles can be trapped to adhere on the surface of the vascular stent using acoustic radiation force. The procedure was also monitored by a commercial ultrasound scanner (Visualsonics Vevo 2100) for comparison.

Results/Discussion

The structure and prototype of the proposed dual mode array transducer is shown in Fig. (a). An impedance analyzer (Wayne Kerr) was used to measure the impedance of the array elements and the impedance of a typical element is shown in Fig. (b). The echoes were acquired using a pulser/receiver (Utex UT340) and a digital oscilloscope (Tektronix DPO 4104), and a typical echoic waveform is shown in Fig. (c). The ultrasonic stent image acquired by the proposed transducer is shown in Fig. (d). The drug loaded microbubbles were trapped to the surface of the stent under control by the proposed dual mode array. The whole procedure can be observed by Vevo2100 (shown in Fig. (e)). It indicated that drugs can be delivered to the stent precisely by the proposed array transducer.