Photoacoustic/Ultrasonic Dual-Modality Endoscopy in Vivo

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Abstract

Early diagnosis and treatment of cancer are of vital importance. Novel imaging methods are in great need to achieve this. Photoacoustic endoscopy (PAE) is an emerging endoscopic technology capable of providing both functional and molecular information of intact biological tissue of internal organs in vivo. With endogenous or exogenous contrast agent, cancer formation and the corresponding vascular morphology and function changes can be detected and imaged by PAE. In addition, Utilizing multi-wavelength laser excitation, a number of important physiological parameters, such as the total hemoglobin concentration, oxygen saturation of hemoglobin, and micro-hemodynamic flux, can be obtained by PAE. Such information directly correlates with vascular angiogenesis and abnormal metabolisms and thus reflects the formation and progression of many neoplasms.

In our study, a miniaturized, simple and full field-of-view photoacoustic/ultrasonic endoscopy system was developed. A flexible coil was used to transmit the rotational torque from the rotary stage, which enables a 360° field-of-view imaging in vivo, for the first time to our knowledge. The developed imaging catheter was fully encapsulated by a single-use protective polyamide tube. A B-scan rate up to 5 Hz (200 A-lines/B-scan) was achieved. Three-dimensional photoacoustic and ultrasound images of the rectum from a SD rat were acquired in vivo. The significantly improved imaging field-of-view, together with the flexible, simple and encapsulated catheter design, suggests that this PAE system can be of great interest for clinical translation for a variety of endoscopic applications, such as the urogenital, colorectal and gastrointestinal tract imaging (Fig. 1).

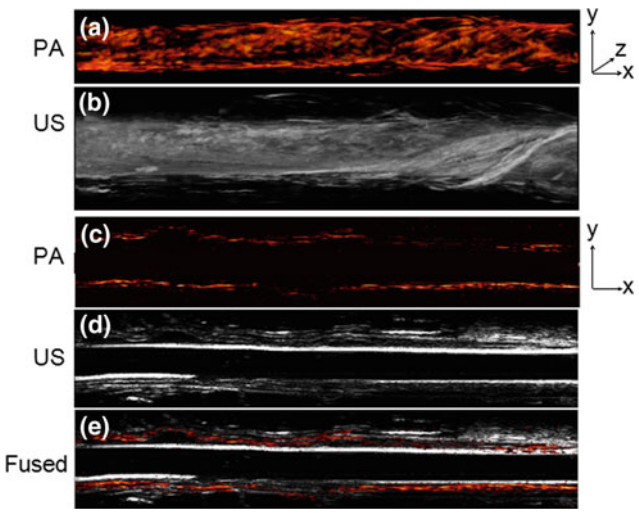

Fig. 1 Three-dimensional photoacoustic/ultrasound endoscopic imaging of a healthy rat rectum in vivo. **a** 3D PA and **b** US images of the rectum. **c** Unfolded images of (**a**), **d** unfolded images of (**b**), **e** fused images of (**c**) and (**d**)

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