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Technical Innovations and Clinical Translation in Raman Spectroscopy

Abstract

Raman spectroscopy offers label-free and non-invasive molecular information from biological samples and has shown vast potential for diagnostic applications. Nevertheless, the road for a clinical translation is full of technological and regulatory challenges. On the technical side, current fiber-based implementations of RS render imaging-acquisition impossible. Furthermore, single modalities provide a loop-sided picture of a disease, and the combination of multiple optical modalities is more promising. Regulatory challenges for in vivo applications in Europe include the new medical device regulation (MDR2017/745) for clinical investigations. Here, we present some recent developments in fiber-based imaging, multimodal instrumentation, and clinical translation of Raman spectroscopy. For example, we have developed a Raman-probe based imaging approach, using traditional fiber-optical probes in combination with real-time image and data-processing, which allows a real-time visualization of molecular information on a computer screen or directly on the sample surface, creating an augmented or mixed molecular reality image of the sample. Moreover, we have developed a combined RS, optical coherence tomography, and fluorescence life imaging microscopy for ex vivo tumor characterization. Because the signals are precisely co-registered with each other and with closely sampled H&E slides of entire biopsies, it is possible to intercorrelate the multimodal information at any location and assess the ground truth information. And at last, we present a RS-based system for in vivo endoscopy, which adheres to the high regulatory standard set-out by the MDR. The developed device is based on a 785 nm excitation and includes an in-house built fiber-optic Raman probe, which is developed in a single-unit and suitable for endoscopic in vivo investigations.

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