Latest News on the Development of a Stimulated Holographic Endoscopic Raman Imaging Technique for Early Detection of Colorectal Cancer

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Colorectal cancer (CRC) is a common cancer that occurs in both genders. Diagnostic tools available for screening CRC, i.e. fecal occult blood tests and colonoscopy, are well known to have rather limited sensitivity and specificity. This has motivated us to develop a clinical imaging technique based on stimulated holographic endoscopic Raman spectroscopy (SHER) for early, direct and safe detection of CRC in vivo. Raman spectroscopy has shown excellent results for detection of cancer [1], but, due to long integration times and the necessity to measure in the dark the method has not entered clinical settings yet. In stimulated Raman spectroscopy (SRS) photons are transferred from the pump beam (shorter wavelength) to the Stokes beam (longer wavelength) through stimulated emission with a frequency difference between the two beams that equals to a molecular vibration of interest. SRS has many appealing features compared to competing techniques: the light efficiency is several orders of magnitude larger than for spontaneous Raman, the spectral response is narrow band, Raman spectra are identical to spontaneous Raman spectra and are free from background noise as compared to coherent anti-Stokes Raman scattering (CARS), and SRS has excellent 3D sectioning capability and can operate at video speed rate [2]. It should, however, be noted that the SRS signal to noise ratio is very small and the signal can be buried in the laser noise. One way to solve the problem is to modulate the SRS signal temporally and detect the modulation using lock-in technique [3]. In our technique, we take advantage of the coherence of the SRS signal with the incident laser beam and couple it to digital holography for imaging. This has, to our knowledge, not been demonstrated previously. Promising results have been achieved on a Plexiglas (Poly(methyl methacrylate)) slab [4], and recently even single laser shot SHER images could be generated.

In order to find the optimum settings for the SHER imaging of colorectal tissue, conventional Raman spectra of normal and cancerous tissue have been taken. The Raman shifts with the largest differences between the two tissue types were phenylalanine at 1003 cm^{-1}, DNA/RNA at 1305 cm^{-1}, C-H-bending at 1448 cm^{-1}, Amide I at 1660 cm^{-1}, as well as the high wavenumber bands at 2854 cm^{-1}, 2874 cm^{-1} and 2934 cm^{-1}. First experiments with SHER images of viscous cod liver are now performed in the transmission mode. In a next step fresh tissue slices will be registered in the reflected mode. In this presentation, the latest progress will be discussed.

References

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