Molecular Imaging for GI Endoscopy; Where Are We Now?

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Introduction

In March issue of Nature journal, Atreya R et al created a fluorescent antibody for molecular membrane bound TNF (mTNF) imaging rather than therapeutic biologics. In detail, topical antibody administration in 25 patients with Crohn’s disease (CD) led to detection of intestinal mTNF(+) immune cells during confocal laser endomicroscopy. Beyond imaging, patients with high numbers of mTNF(+) cells showed significantly higher short-term response rates compared to patients with low amounts of mTNF(+) cells (92% vs 15%), indicating that molecular imaging with fluorescent antibodies has the potential to predict therapeutic responses to biological treatment and can be used for personalized medicine in CD. Our group also published data that mass spectroscopy analysis can provide either optimal biomarkers or imaging mass spectrometry (IMS) in inflammatory bowel disease or Barrett’s esophagus. In this symposium, we will show recent advances in molecular imaging for future GI endoscopy.

Recent advances in molecular imaging

**Imaging Mass Spectrometry (IMS)**

As the only imaging method available, Imaging Mass Spectrometry (IMS) can determine both the identity and the distribution of hundreds of molecules on tissue sections, all in one single run. IMS is becoming an established research technology, and due to recent technical and methodological improvements the interest in this technology is increasing steadily and within a wide range of scientific fields. Of the different IMS methods available, matrix-assisted laser desorption/ionization (MALDI) IMS is the most commonly employed. Our recent study showed that the integrated pipeline can efficiently identify increased number of proteins compared to the conventional method which can be a breakthrough in identification of a potential biomarker candidate.

**Surface enhanced Raman scattering (SERS) and Raman spectrometry-assisted endoscopy**

Raman spectroscopy, amplified by SERS nanoparticles, is a molecular imaging modality with ultra-high sensitivity and the unique ability to multiplex readouts from different molecular targets using a single wavelength of excitation, which holds exciting prospects for a range of applications in medicine, including identification.
and characterization of malignancy during endoscopy and intraoperative image guidance of surgical resection. Though the development of Raman molecular imaging with SERS nanoparticles is presently limited by long acquisition times, poor spatial resolution, small field of view, and difficulty in animal handling with existing Raman spectroscopy instruments, soon it will be applied for GI endoscopy because of larger information that can be deduced compared to NBI or AFI. Now figure printing is very popularly used for door lock, mobile phone starting, immigration checking, etc, similarly soon Raman spectroscopy probe is frequently used during endoscopy in order to identify mass like figure printing check.

**Development of cell specific dye for molecular imaging as well as therapeutics**

The hardware for confocal microscopy is available in some endoscopy unit and soon it can be more popular as the most laboratory had equipped with confocal microscopy to publish research in high impact journal. The critical one might be the right fluorescent dye or more to be added with the confocal microendoscopy for higher clinical application. Our group has successfully developed new photoacoustic endoscopy (PAE), one of four major implementations of photoacoustic tomography that have been developed recently. The prototype PAE was based on scanning mirror system that deflected both the light and the ultrasound. During this development, we could have add quite discriminating fluorescence based nanoparticles for confocal microscopy. In near future, we can navigate endoscopic surgery under this dye and achieve pathology even before the changes of premalignant lesions in colitis-associated cancer or Barrett’s esophagus.

**Conclusions; where are we now?**

Although narrow band imaging (NBI), autofluorescence imaging (AFI), and chromoendoscopy are currently applied for fortified imaging in the clinic, further adoptions of probe-based confocal laser endomicroscopy, high-resolution microendoscopy, optical coherence tomography, and metabolomic imaging, as well as IMS, will lead to detection at the earliest and will guide predictions of the clinical course in the near future in a manner that is beyond current advancements in optical imaging. The continued technologic advancements in colonoscopy and endoscopic imaging may result in improvements in the quality of colonoscopy and should lead to a decrease in the incidence and mortality from GI cancer.

**References**