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Full-field Optical Coherence Tomography: A New Imaging Modality for Rapid On-Site Evaluation of Resected Polyps During Colonoscopy

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A "characterize, resect, and discard" strategy has been proposed as a new approach, allowing more expeditious and efficient management of the patient with colonic polyps as well as histologic procedure cost savings. However, despite recent advances, the technologies embedded in currently available endoscopes have not proven to be sufficiently reliable to implement that strategy in the routine endoscopic practice.[1] Full-field optical coherence tomography (FFOCT) is an emerging optical technique for the rapid evaluation of tissue architecture.[2] FFOCT has been used to image fresh and fixed human tissues such as skin,[3] cornea,[4] brain,[5] and even pancreatic biopsy specimens.[6] FFOCT might prove useful during colonoscopy, when a rapid on-site assessment of tissue architecture can determine whether to discard polyps and immediately advise patients on subsequent surveillance or to warrant further histologic analysis. Here, we present the technical feasibility of ex vivo FFOCT imaging on colonic polyps and its ability to visualize cellular and architectural features of normal and neoplastic colonic tissue.

Description of Technology

The commercially available FFOCT apparatus (Light-CT Scanner, LLTech SAS, Paris, France; Figure 1), which is supplied with a reusable sample holder with no limit to the number of uses, produces images of ex vivo tissue with a transverse resolution of 1.5 μm and an axial resolution of 1.0 μm. This compact (310 × 310 × 800 mm, L × W × H, about the size of a standard optical microscope) FFOCT setup can be located in the endoscopy room. The system is unobtrusive and does not create any undesired heating, lighting, or sound. OCT[7] is a technique for imaging scattering media such as biological tissues by interferometric selection of ballistic photons. Unlike conventional OCT, FFOCT directly captures en face or cross-sectional images on megapixel cameras at high lateral resolution (down to 1 μm) by using medium to large aperture microscopy optics with high axial resolution (1 μm) and a white light source.[2] Capturing images in the desired orientation allows for easy comparison with histologic sections. A pathologist typically analyses tissue at several magnifications where the field of view varies from centimeters down to micrometers. The same effect is achieved with the present system by moving samples on a micrometric bench to create a mosaic of native field images that are stitched together to display a larger field of view. A previous study of the pathologist's training process dedicated to FFOCT imaging of prostatic tissue samples has shown a short learning curve and a good inter-reader agreement.[8]

Video Description

After endoscopic removal, a colonic polyp was placed in the FFOCT holder body with a drop of formalin solution under a glass slide closing the holder (Video 1). The surface on which the sample set within the holder could be raised on a piston to rest gently against the glass slide. The surface of the sample had to be flattened against the glass slide to capture an image of the entire sample area. Care was taken to raise the piston against the glass without excessive pressure to avoid tissue damage. The broad whole sample image could be zoomed down to the cellular scale to investigate different features, similar to the pathologist's use of different magnification lenses to navigate around a histologic slide. FFOCT image acquisition was set 15 μm

Abbreviation used in this paper: **FFOCT, Full-field optical coherence tomography.**

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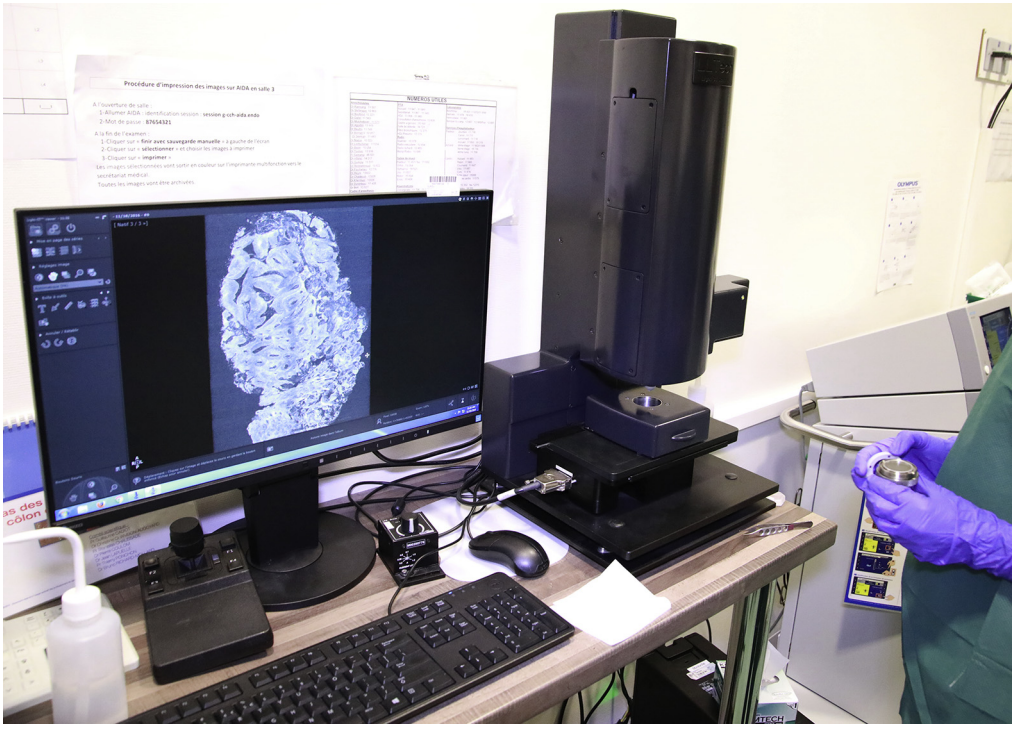

Figure 1. Full-field optical coherence tomography system. Photography of the system with light source, optical unit, and sample holder in the endoscopic room.

below the sample surface, at a depth where artifacts resulting from interference fringes on the glass cover slide are absent, image quality is optimal, and for which the entire surface of the sample remains visible. Once FFOCT imaging was complete, the data file was sent to the pathologist's office via the hospital's internal network. Real-time analysis of FFOCT data by the pathologist resulted in polyp diagnosis being provided within 4 minutes of polypectomy. The sample was removed from the holder by using tweezers and placed in a cassette for pathology. Thus, histologic analysis has been obtained within the time of colonoscopy with no need to have the pathologist on site or wait for standard pathology.

Some potential limitations of FFOCT imaging of colonic polyps must be acknowledged. As an ex vivo method, time must be dedicated to sample manipulation as well as image acquisition and transfer. A previous study of endoscopic ultrasound-guided fine needle aspiration pancreatic samples[6] raised an issue with the possibility of a degradation of material after FFOCT analysis, but such problems are unlikely with a coherent tissue such as polyps, and the integrity of samples at subsequent histology has always been confirmed in our experience.

Efficacy and the cost effectiveness of FFOCT imaging for colonic polyps need to be evaluated, and may partly depend on manageable technicalities such as specific sample handling tools or computing and data transfer power. The implementation of artificial intelligence algorithms could also make procedures less demanding for pathologists when a busy endoscopy schedule requires several simultaneous requests. On the cost-saving side, a single FFOCT station can serve several endoscopy rooms, with nearly no disposables.

The main strength of FFOCT imaging lies in its ability to obtain real-time histology, with 2 major advantages compared with virtual chromoendoscopy in the context of a characterize, resect, and discard strategy: (a) providing more information on dysplasia and polyp architecture through full-scale en face or cross-sectional images and (b) managing liability issues by resting polyp characterization on the pathologist (with or without artificial intelligence support), not on the gastroenterologist.[1]

Take Home Message

With further improvement in the manipulation and acquisition time, FFOCT has the potential to be used in the endoscopy suite for the rapid on-site evaluation of resected polyps with the aim to decide either to send polyps for histologic analysis in difficult and/or suspicious cases or to discard and determine surveillance interval at once in more straightforward cases.

Supplementary Material

Note: To access the supplementary material accompanying this article, visit the online version of *Gastroenterology* at www.gastrojournal.org, and at https://doi.org/10.1053/j.gastro.2018.07.054.

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Conflicts of interest
The authors disclose the following: E. Dalimier was employed by LLTech, manufacturer of the FFOCT device. No other conflict of interest (personal or financial relationship) relevant to this article has to be disclosed.