ADVANCES IN GERD

Current Developments in the Management of Acid-Related GI Disorders

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Optical Coherence Tomography for Barrett Esophagus

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G&H Can you provide a brief overview of optical coherence tomography?

VK Optical coherence tomography (OCT) is an advanced imaging technology that was developed in the 1990s. Its application in the endoscopic realm began in the late 1990s. Approximately 5 years ago, a second-generation, advanced OCT technology known as volumetric laser endomicroscopy (VLE; NvisionVLE Imaging System, NinePoint Medical) became available in the US market. Since then, VLE has been the main commercially available OCT-platform product approved by the US Food and Drug Administration for the purpose of advanced endoscopic imaging.

The mechanism by which OCT technology works is by measuring the signal intensity of infrared light as it is reflected from the target tissue. In the current version, the VLE balloon catheter is inserted through the endoscope biopsy channel and positioned at the level of the Barrett segment, and imaging is then initiated. The device measures the signal intensity of reflected infrared light from the targeted tissue in 6-cm segments axially. VLE is able to provide images at a very high resolution (7 μm) up to 3 mm beneath the esophageal mucosa. The latest-generation VLE system allows for laser marking of the mucosa to denote areas of abnormal imaging for biopsy or endoscopic resection guidance.

G&H What are the clinical uses of OCT?

VK OCT enables a real-time diagnosis of both epithelial and subepithelial abnormalities. The original application was in the field of ophthalmology to provide high-resolution images of the retina. The technology has also been applied in interventional cardiology to diagnose coronary artery disease, and in dermatology to provide high-resolution images of the dermal layers. Within the field of gastroenterology, the major application of OCT has been in Barrett esophagus (BE) for the evaluation of dysplasia and neoplasia in a variety of settings.

G&H What are the gastroenterologic applications of OCT? In particular, what role does OCT play in patients with BE?

VK Within the field of gastroenterology, and especially in patients with BE, OCT can be used to diagnose dysplasia and early esophageal neoplasia, including squamous dysplasia and squamous neoplasia. OCT technology (currently in the form of VLE) provides clinicians with cross-sectional and longitudinal images of the surface of the esophagus as well as the subsurface structures, both in real time and in high resolution, in a very efficient manner (each scan lasts approximately 90 seconds). Patients with BE undergo routine endoscopic surveillance on a periodic basis as per current guidelines, using forceps and/or wide-area transepithelial brush biopsies. OCT may help in detecting occult areas of dysplasia or early neoplasia that may not be picked up with traditional surveillance tools, thereby allowing clinicians to then target the biopsies to the area(s) highlighted or marked by OCT imaging.

More importantly, patients who have undergone endoscopic ablation treatment (eg, radiofrequency ablation or cryoablation) for their dysplastic BE can then be followed up with OCT imaging to assess for subsquamous dysplasia or neoplasia (buried glands) or buried subepithelial dysplastic tissue, which may not be visible with standard high-definition endoscopy. The ability to diagnose buried Barrett glands, whether dysplastic or nondysplastic, is a very specific application of OCT technology in the setting of postablation surveillance.

G&H What is the accuracy of OCT in detecting or diagnosing buried Barrett glands or dysplasia?

VK Several reports and studies have demonstrated promising results for the OCT platform in the realm of esophageal imaging. A study that was recently accepted for publication in *Gastrointestinal Endoscopy* compared various surveillance modalities for dysplasia detection in patients with BE, including random biopsies, Seattle protocol biopsies, VLE imaging (an OCT product), and VLE with laser marking. In terms of dysplasia detection, the highest yield (34%) was found with VLE with laser marking as compared to random biopsies (5.7%), which are the current standard for surveillance. The laser-marking VLE device was also found to be significantly better when compared to random 4-quadrant forceps biopsy for the detection of neoplasia and high-grade dysplasia.

Dr Michael S. Smith and colleagues presented findings from the national OCT registry in poster form at the 2016 Digestive Disease Week. The registry demonstrated that 73% of patients (595/819) who had no suspicious findings on a standard endoscopy had concerning findings on VLE. Eighteen percent of patients (81/450) had additional dysplasia identified on VLE that was not seen on white-light endoscopy. An additional 20 patients with concerning findings on VLE had dysplastic disease found later on. In a 2016 study, Dr Cadman Leggett and colleagues devised a scoring system for dysplasia detection using VLE. By taking endoscopic mucosal resection (EMR) specimens (using ex vivo imaging analysis), applying VLE technology to that specimen, and evaluating the final pathology, the researchers found a sensitivity and specificity for VLE of 86% and 88%, respectively. Of note, the resected specimens were evaluated ex vivo, and future studies should demonstrate in-vivo accuracy with real-time imaging compared to biopsy and/or EMR pathology. A 2017 study led by Dr Anne-Fré Swager evaluated the use of VLE to detect buried glands in patients with BE who underwent radiofrequency ablation. The researchers determined that VLE was able to identify subsquamous esophageal structures in 76% of patients (13/17). Additionally, in a multicenter study involving high-volume users, Dr Arvind J. Trindade and colleagues showed a very high overall interobserver agreement for VLE diagnosis of neoplastic vs nonneoplastic esophageal and gastric cardia lesions (k=0.81). Thus, overall, there are encouraging data to support the notion that OCT technology adds a complementary platform for endoscopic imaging and is likely to become more established and mainstream as more robust data emerge.

G&H What are the benefits and limitations of OCT?

VK The main benefit of OCT is that it provides real-time, high-resolution, cross-sectional and axial imaging in 6-cm segment lengths of the esophagus very quickly (approximately 90 seconds), and imaging of the entire esophagus can be completed in 3 to 4 minutes. Additionally, OCT or VLE has the ability to view subepithelial and subsquamous structures that are not seen with high-definition white-light endoscopy or even with electronic chromoendoscopy. Another significant benefit that has become available more recently is the real-time laser-marking capability while performing OCT imaging using the VLE device; endoscopists now have the ability to scan the area of abnormality with OCT/VLE, laser-mark it, and then either biopsy the marked area or perform EMR if the area is larger or concerning for neoplasia. In essence, OCT/VLE enables imaging, marking, and potential tissue diagnosis or therapy in a single session. This capability is a major paradigm shift.

The main limitation of OCT is the cost to acquire the platform. The institution and the practice have to invest in the technology, along with the cost of the consumables (eg, catheters), which are single-use and disposable. The time added to the procedure can also be seen as a potential limitation, especially given the time and schedule pressures under which most endoscopy units and clinicians practice nowadays. Another limiting factor may be the general slow rate of acceptance of a new technology by the community at large; however, as positive, validated, and more rigorous data emerge, the technology is likely to find wider acceptance.

G&H What risks are associated with OCT?

VK In and of itself, OCT or VLE does not present any specific or direct risk over and above the endoscopy procedure of which it is a part. No radiation is involved, and the laser that is used is of a very low power that should not cause any damage to patients or providers. Any risk that is associated with an OCT- or VLE-type procedure is the same as the inherent risks of endoscopy (ie, risks associated with sedation, anesthesia, and the endoscopy or intervention performed).

G&H Who is the ideal candidate for OCT? In whom should it be avoided?

VK Ideal candidates for OCT are patients with BE who are undergoing surveillance who may have dysplastic tissue, and patients with esophageal squamous dysplasia. OCT is especially ideal in patients who have previously received ablation therapy and are undergoing postablation surveillance. This patient population may have buried glands (ie, subepithelial low- or high-grade dysplasia, or neoplasia) that may not be seen on other imaging devices (eg, standard endoscopy, high-definition white-light endoscopy, electronic chromoendoscopy, endoscopic ultrasound).

Patients who are not good candidates for OCT/VLE are those with significant esophageal luminal pathology, including esophageal varices, esophageal masses or large tumors, esophageal strictures, or eosinophilic esophagitis. In general, patients with narrow esophageal lumen may not be good candidates for this procedure.

G&H Is OCT likely to replace any imaging modality in the clinical setting?

VK It is not clear if OCT will necessarily replace any imaging modality. High-definition white-light endoscopy and electronic chromoendoscopy will likely remain the basic minimum evaluation standards. OCT definitely adds value as a unique complementary imaging modality, which is likely to become more mainstream in the future with wider acceptance and dissemination through the gastrointestinal community. OCT may compete with other high-resolution endoscopic imaging technologies that are commercially available, such as confocal laser endomicroscopy, which also offers high-resolution images but is a different concept and technology altogether.

G&H What training is needed to perform OCT? How significant is the learning curve?

VK Any new technology or procedure requires some form of training and learning. An essential aspect of training is observing procedures in a high-volume (ie, expert) center. Video-based learning is another tool that many endoscopists employ. Once the technology has been acquired, clinicians may choose to perform their initial procedures under the watchful eye of an onsite expert who can guide them through cases or perform cases alongside them (after appropriate credentialing and privileging at the host institution). Clinicians can also familiarize themselves with the technology by performing procedures on explants or other types of models or demonstration platforms.

A 2017 study assessed the learning curve and competency for VLE among 31 novice clinicians across 3 different centers. After a brief training session, the clinicians viewed 96 VLE images electronically. Twenty-two clinicians (71%) were able to achieve VLE image interpretation competency during the slide review, with half achieving competency at 65 slides.

G&H What are the priorities of research in this field?

VK Randomized, prospective studies evaluating the accuracy of VLE and OCT technologies in real-time endoscopy in a large number of patients will be helpful to determine whether this approach has an incremental yield for additional dysplasia or neoplasia detection compared to traditional methods. The cost-effectiveness of using OCT-based diagnostic or treatment algorithms will also be important in this era of cost-conscious medicine. With value-based medicine, it is important to ensure that any new technology or platform is providing enough value to justify the cost. A next-generation OCT device is being developed that uses computer-automated detection of VLE abnormalities. Within the next 1 to 2 years, a computer algorithm may be able to help with image interpretation and remove any subjectivity from the process. Future research around this technology will likely further consolidate the role of OCT in BE screening, imaging, and diagnosis.

Dr Kaul has no relevant conflicts of interest to disclose.

Suggested Reading

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