ADVANCES IN ENDOSCOPY

Current Developments in Diagnostic and Therapeutic Endoscopy

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Innovations in Gastrointestinal Endoscopy: Challenges in Advancing the Frontier

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G&H What limitations are inherent in conventional endoscopy in terms of the quality of the imaging and detection of abnormalities?

DS It is first worth mentioning that conventional endoscopic imaging is very high quality. Over the past 20 years, endoscopic imaging has evolved from fiber-optic large pixels of very poor quality to video images of better quality to, currently, very high-resolution video images with incredible magnification and clarity that capture extensive detail within the gastrointestinal (GI) tract. Nevertheless, manufacturers are striving for even crisper, better images in new generations of endoscopes.

Although the current imaging quality is excellent, problems still arise in difficult anatomy in which tight corners and folds may obscure some targets. New more-flexible scope designs, wider-angle lenses, and even different arrangements of multiple cameras have been developed to address some of these limitations. Newer caps and cuffs can help manipulate tissue to visualize behind folds and can be very effective in improving polyp detection. However, most of the problems in polyp detection result from poor-quality bowel preparation or inattention or inexperience on the part of the endoscopist.

G&H Have innovations such as chromoendoscopy and confocal laser endomicroscopy improved the ability to detect polyps and diagnose conditions such as GI cancer?

DS Chromoendoscopy is a technique that involves instilling various chemical dyes through the endoscope to coat or be absorbed by the GI mucosa to accentuate textural differences or to highlight abnormal tissue based on the tissue's ability to take up dye. Chromoendoscopy is an older technology that has a mixed record of applicability. It is messy and time-consuming, and not many clinicians know how to do it well. Some of the features of chromoendoscopy are offered on newer endoscopes through light filtration or select new-generation full-spectrum technologies.

Some clinicians still prefer chromoendoscopy, especially for use in difficult situations such as diagnosing dysplasia in the setting of inflammatory bowel disease or to detect early cancer within squamous mucosa of the esophagus. Most of the gastroenterology community has moved away from chromoendoscopy except in very select circumstances.

Confocal laser endomicroscopy is an interesting technology that allows the clinician to see individual cells in real time during endoscopy, but it is cumbersome and time-consuming to use. It requires giving a dye intravenously, avoiding motion, and looking at very small areas of tissue that, in turn, require more time to scan. It is often easier and faster to simply obtain multiple pinch biopsies and wait for the pathologist's report. Confocal laser endomicroscopy has shown some promise in difficult-to-biopsy sites, such as the bile duct and within pancreatic cysts.

G&H What role does narrow-band imaging play compared with conventional white-light endoscopy in the detection and characterization of mucosal abnormalities?

DS Narrow-band imaging and other limited-spectrum light systems are similar to chromoendoscopy in that they enhance surface textures and characteristics. The limited spectrum of light restricts the red and violet frequencies that tend to penetrate tissue more deeply, narrowing the band of light to browns and greens that reflect off the surface. This enhances surface texture and highlights superficial blood vessels, as increased vascularity can be a sign of neoplastic change.

Narrow-band imaging has some benefit compared with white-light endoscopy when looking for small or flat polyps and other abnormalities because of enhanced contrast of surface characteristic. Narrow-band imaging does take some getting used to, and the screen may appear darker than some users are used to. However, in many of the studies that compared narrow-band imaging with conventional white-light endoscopy, no major differences were found in polyp detection when these techniques were performed by experienced gastroenterologists.

Narrow-band imaging has shown some benefit for gastroenterologists in training because the modality can make some abnormalities more obvious and can help differentiate hyperplastic polyps as well as classify pit patterns of adenomatous polyps. Conventional white-light endoscopy, as used with currently available high-resolution scopes, remains an excellent modality for mucosal inspection. Chromoendoscopy and narrow-band imaging are often not needed in routine endoscopy but can add information in certain situations.

G&H What other innovations in endoscopic diagnostic imaging should be noted?

DS One such innovation is volumetric laser endomicroscopy (VLE). VLE uses light that bounces off different tissue layers to provide a near-microscopic analysis of tissue. It has the advantage over confocal laser endomicroscopy in that large areas of tissue can be surveyed simultaneously. This can be particularly useful for surveying Barrett mucosa, especially after ablation where subsquamous glandular tissue may persist. It also has limitations, however. VLE can be time-consuming to perform and master. The number of centers that perform it is limited, and studies that validate the images and standardize the findings have been slow to appear.

Most of the new innovations in imaging focus less on capturing detailed images and more on using artificial intelligence (AI) to interpret the images and decrease miss rates. This is a large area of growth, with the bulk of research and publishing now focusing on computer-based analysis of the images that are collected.

AI is an exciting new frontier. It involves having a computer process the data points of all the pixels of all the images provided using algorithms that change based on experience. This rapidly evolving area of computer science uses machine learning and convoluted neural network algorithms to differentiate normal from abnormal images.

A variety of AI programs have been tested in the GI tract with impressive results. For the colon, AI programs have been used to help identify polyps that the endoscopist may have missed by comparing the pixel composition of small areas of mucosa and comparing it to others and "boxing" abnormal areas on the screen. The endoscopist can then further inspect or even biopsy these areas to determine if they are truly abnormal. Early studies have found a polyp detection rate of up to 93% compared with expert endoscopist examination. These programs may be particularly helpful for trainees and even established endoscopists who may have low polyp detection rates.

Other programs have highlighted areas of poor preparation or obscured mucosa for closer inspection or washing. AI has been used to help identify areas of early cancer or dysplasia within Barrett esophagus and in gastric and esophageal tissue in high-risk areas of the world such as South and East Asia. AI also has been looked at as a promising tool to reduce read times for capsule endoscopy by highlighting the rare abnormal images among the huge number of normal images.

These technologies and algorithms remain in early stages and have not been widely tested, much less commercialized. However, if route-finding applications and Spotify algorithms are any indication, more and more AI aides in GI endoscopy will likely be seen.

G&H How can gastroenterologists in practice best gain familiarity and expertise with the many emerging innovations in endoscopy?

DS There are 2 main areas of focus that clinicians need to consider. One is AI and computer-based technology. Industry is making a push for this and will be providing the technology in the platforms that clinicians are buying. Familiarity of use will involve staying updated on current imaging equipment and discriminating between what has real value and what is in a beta-testing stage and might seem "cool" but may not demonstrate a true benefit in terms of health improvement, safety, or time-saving.

The other area of focus is endoscopy tools. Lumen-apposing stents, tools for endoscopic submucosal dissection to stave off early cancers, more effective polypectomy devices, closure devices, and new technologies for

treating bleeds all have exploded over the past decade, yet only a subset of gastroenterologists have become familiar with their use. Learning how to use such tools can be very challenging and perhaps even off-putting for clinicians who have been out of training for several years. Resources and mechanisms for learning how to use these tools are not always easily accessible. Device representatives can be of some help, but these representatives generally explain how a device works; they cannot show a clinician how to use the device in a patient.

Courses and training are available through some of the GI societies, such as the American Society for Gastrointestinal Endoscopy, which offers hands-on courses and has multiday courses at its training center in Chicago and sometimes at national meetings. Certain centers around the country sponsor multiday learning events as well.

One example involves peroral endoscopic myotomy (POEM), which is an endoscopic surgery for treating achalasia. Performing POEM and other third-space endoscopies (those that involve accessing and tunneling in the submucosal plane) requires not just training but also a shift in mindset for classically trained gastroenterologists who have been always cautioned to stay within the GI lumen and not disrupt the tissue layers. Courses involving animal models and observation are offered, but it is a large leap going from viewing a multiday course to performing one's first case in a hospital.

In third-space endoscopy, industry representatives can often facilitate mentorship with national experts. They also may help facilitate bringing a mentor to the trainee's institution to observe and advise during the first few cases. Obviously, this is a large investment in time, training, and energy and is clearly not something most endoscopists will or should learn, but it is an example of how some new technologies and techniques can enter clinical practice outside of traditional training programs.

G&H What needs and caveats exist in regard to use, safety, and standardization of current innovations in endoscopy?

DS Just because a device or technique is approved by the US Food and Drug Administration does not mean that it is safe in everyone's hands. Many new technologies do not have long track records, and clinicians are learning as they are performing their first cases. It is wise to allow experts in major academic medical centers to get early experience with new techniques and technologies first because they are accustomed to pioneering new techniques. These experts often have an integrated system in place that includes multiple clinicians with experience in new technologies. Patients also know that clinicians at these teaching hospitals are on the cutting edge. Further, clinicians from these centers are usually quick to publish or lecture on their experiences and results so that other clinicians can learn from their initial experiences.

Any physicians and centers that are planning to use new technologies should have adequate familiarity and experience with these tools and should inform patients that newer or novel technologies are being used. Clinicians also should have backup plans in place in case the technologies used are not doing everything that they are supposed to. Clinicians should also provide useful feedback to the creators and manufacturers of a new technology so they can optimize it as quickly as possible as well as identify a poor performing tool quickly and either improve it or remove it from the market.

Disclosures

Dr Schembre receives royalties and speaking honoraria from Cook Medical.

Suggested Reading

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