Spiral enteroscopy: a new twist on overtube-assisted endoscopy

The spiral is a spiritualized circle. In the spiral form, the circle, uncoiled, unwound, has ceased to be vicious; it has been set free.

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Until recently, the small bowel remained beyond the reach of direct endoscopic inspection outside the operating room. No matter how hard the endoscopist pushed a floppy tube, the twists and contours of the gut eventually ganged up, loops formed, and forward motion ended. Novel endoscope designs, like the Sondé enteroscope that relied on gut motility to move the tip through the bowel, proved too limiting to ever attain widespread use. The use of semirigid overtubes was fraught with complications, often pinching or creating shearing forces at the overtube tip. Ultimately, the devices did not enable much deeper insertion than standard push enteroscopy. Variable stiffness enteroscopes offered marginally deeper insertion without an overtube, but did not clearly improve diagnostic yield, and they never made it into widespread commercial production. While other areas of GI endoscopy evolved and flourished, small-bowel imaging remained the province of the radiologist.

Deep small-bowel imaging emerged from the barium age with the advent of capsule endoscopy. Although it is a quantum leap beyond contrast studies, capsule endoscopy still does not offer the ability to insufflate the gut or repeatedly inspect suspicious areas, much less perform biopsies or apply therapy. Furthermore, the erratic nature of capsule passage may lead to incomplete visualization of portions of the small bowel. Enter double-balloon enteroscopy (DBE) (Fujinon, Wayne, NJ) in 2001 as the first endoscope system that could reliably pass deeply into the small bowel. The device allows significantly greater direct endoscopic visualization of the small bowel, with reported average depths of antegrade insertion more than 200 cm beyond the ligament of Treitz, and about 130 cm proximal to the ileocecal valve when inserted anally. Visualization of the entire small bowel has been rarely reported from the antegrade approach only, but more frequently by combining an antegrade and a retrograde procedure. Yamamoto et al reported achieving total enteroscopy by combined routes in 86% of patients in whom it was attempted. May et al reported 45% total enteroscopy success. Single-balloon enteroscopy (SBE) (Olympus America, Center Valley Pa), an iteration of DBE that simply forgoes the second balloon at the tip of the endoscope, arrived soon after DBE and also allows deep enteroscopy. Depth of insertion of SBE has been less well studied than with DBE, but at least 1 case of total enteroscopy with SBE has been reported.

Despite its success, balloon enteroscopy has been slow to catch on in the United States, even at major referral centers. The reasons for this are not immediately clear, especially when groups offering diagnostic capsule enteroscopy proliferate. DBE and SBE may lack traction because of the perceived long learning curve for the technique, or due to a reluctance to purchase the additional equipment that is necessary. However, it more likely relates to the long procedure times reported (well over an hour in most series), combined with relatively low reimbursement.

Certainly there appears to be a need for a simpler, faster method for performing deep enteroscopy; and the idea of an “active” overtube is not new. Devices originally designed to speed colonoscopy have been modified for enteroscopy. The ShapeLock device (USGI, Palo Alto, Calif), a multi-linked, flexible overtube that can be converted into a rigid conduit by tensing connecting cables with a lever, was originally designed to reduce looping during difficult colonoscopies. It was modified and used successfully in small trials for enteroscopy. However, its large outer diameter as well as production and marketing decisions relegated it to “wait and see” status. The Spirus Discovery threaded overtube (Spirus Medical Inc, Stoughton, Mass), which was also originally designed (and has been commercially available) as a colonoscopy aid, was recognized by a group of intrepid endoscopists as a tool that may have utility in the small bowel. The article by Ackerman et al in this month’s Gastrointestinal Endoscopy represents the results of their initial investigation.
In this proof of concept case series, the investigators used a 130-cm flexible plastic overtube with an outer diameter of 17.5 mm, and a 5-mm thread at the tip (total maximum diameter 18.5 mm), along with a 160-cm pediatric colonoscope to examine 27 patients with obscure GI bleeding. The overtube could not be passed in 2 patients because of concerns about a Schatzki’s ring in one and difficulty intubating the esophagus in another. They describe reaching an average depth of insertion of 176 cm beyond the ligament of Treitz (range 80-340 cm), with an average procedure time of 36.5 minutes (range 19-65 minutes). Bleeding sites were identified in 9 of 25 patients (36%) and treated in 8. There were no major complications, although sore throat and esophageal mucosal injuries were noted in 22% and 28%, respectively. No direct mention was made of the difficulty or ease of the procedure; however, the authors describe the device as enabling a slow, controlled withdrawal during which bipolar cautery was applied to bleeding sites.

The investigators intended first and foremost to show that spiral enteroscopy, as it is fittingly called, can reliably allow endoscopic visualization of a significant portion of the proximal small bowel. Furthermore, they hoped to show that this could be done safely and in a time-efficient manner.

Two of these endpoints appear to have been reached. The average procedure time in this series approximates times reported for standard push enteroscopy, with or without an overtube, and is about half the time we expect to spend doing DBE or SBE. Of course, the procedure duration is largely controlled by the operator. The study suggests that the maximum depth reachable with spiral enteroscopy is fairly obvious to the operator and further attempts at advancement gain no additional ground. This occurs either because enough small bowel has pleated onto the overtube that the threads slip with additional rotation or the overtube simply will not turn further. The point of maximal insertion with DBE is less clear. Even at depths of 200 cm or more, repeating cycles of advance and withdrawal may result in additional gain, especially when modifications such as insertion of a stiffening wire or application of abdominal pressure are added. Yamamoto describes completing total antegrade enteroscopy only after persisting more than 4 hours (personal communication). It remains unclear from the current literature what depths and yields would be achieved if DBE or SBE were limited to 30 minutes.

Spiral enteroscopy appears to be reasonably safe, at least in this small series. Although follow-up was not ideal, no major complications were reported. Sore throat and mucosal abrasions would be expected with manipulation—especially prolonged rotation—of a large overtube. No pinch or shearing injuries from the interface of the overtube and the endoscope were reported, possibly because the tip of the overtube had been fitted with a soft, snug seal. It is notable that small-bowel trauma from the rotating threads was not reported and that the device did not appear to cause torque injury to the stomach or intestine. Again, no formal imaging or other investigation beyond soliciting patient complaints was pursued. The investigators chose not to proceed in a patient with a Schatzki’s ring and another in whom initial intubation proved difficult. With the device in general use, such restraint may not be universal.

Newer versions of the overtube have a smaller outer diameter and a softer thread that comes in a standard version and a lower-profile version, so esophageal trauma may be less of a problem. The trade-off, however, is that the smaller overtubes can only be used with dedicated enteroscopes with an outer diameter no greater than 9.4 mm (such as the enteroscopes designed for single- and double-balloon procedures, which retail for $37,000 and $47,000, respectively) and will not be usable with the “off the shelf” pediatric colonoscope. In the initial series, one physician rotated the overtube and another guided the endoscope. The 2-physician model is not practical in most endoscopy suites, and it remains to be seen how easily one station—either overtube rotation or endoscope control—can be handled by a nurse or technician. Finally, all patients underwent propofol sedation for the procedure, and it is unclear whether many patients would tolerate spiral enteroscopy with midazolam and fentanyl sedation.

The less certain endpoint—and this is true with almost all reports of deep enteroscopy techniques—remains the actual depth of insertion. The authors describe reaching depths of up to 300 cm beyond the ligament of Treitz, with an average depth reached of 175 cm. These distances are similar to those reported, at least in the North American experience, to double-balloon enteroscopy. However, reports of depth of insertion in deep enteroscopy are like reports from fishermen concerning the size of the fish that got away: they are almost entirely subjective, have not been studied in any standardized manner, and are probably exaggerated. Measuring depth of insertion in DBE relies on adding the sum of multiple advancements minus estimates of slippage. Although 1 cycle may be fairly accurate, the accumulated errors, especially toward the end of the procedure, when slippage may exceed advancement, make these estimates highly suspect. At a recent international consensus meeting on DBE, the participants just barely achieved a 50% vote in favor of using the cumulative cycle technique for estimating depth of insertion, and then only because no better technique appears to exist. Radiographic estimates and measuring during withdrawal are equally unreliable. In practice, many centers in which DBE is performed have abandoned attempts at formal measurement and rely on estimates of the general segment of bowel reached (ie, midjejunum, proximal ileum, etc). In a recent article on SBE, no mention at all was made of
depth of insertion. During spiral enteroscopy, measurement of depth of insertion relies on visual estimates of the amount of small bowel that is seen passing the tip of the scope during both insertion and withdrawal. Comparing depth of insertion in vivo to the experience with a pig intestine model may help in making these estimations, but it does not guarantee accuracy. That said, in one abstract in which 2 patients with tumors were identified by spiral enteroscopy, the estimated depth of the lesion closely matched the location at surgery.

Although it was not a stated endpoint, the diagnostic yield of spiral endoscopy in this series (33%) appears low, at least when compared to data from DBE series, which report identifying bleeding sources in about 75% of cases. These yields seem low, even compared to older literature on push enteroscopy, which reports identifying obscure bleeding in 45% to 80% of cases. This may mean that actual depth of insertion was less than estimated, or, as the authors point out, this may be a factor of the patient population and patient selection. This Central and South American group of patients had not undergone the same rigorous work-up prior to deep enteroscopy as those patients in North American, Japanese, and European series (ie, no mention of transfusion requirement prior to the study, no capsule enteroscopy, CT scanning, etc). Clearly, formal studies in other populations are needed.

Nevertheless, spiral enteroscopy represents a dramatic shift not only in how we perform small-bowel endoscopy but in how we think of endoscopy in general. Instead of “pushing a noodle,” the spiral overtube pulls the small bowel over an essentially stationary endoscope. Its simplicity adds to its appeal. Combine this with relatively rapid achievement of maximum depth of insertion, which makes deep enteroscopy more financially appealing to busy endoscopy centers, and spiral enteroscopy begins to sound like it may earn a place on the endoscopists’ growing shelf.

However, as with all new technologies, impediments and unintended consequences can cast shadows on even the most promising devices. Can we be sure that the rotational forces of the overtube won’t traumatize the bowel or other structures in other circumstances, such as inflammatory bowel disease, extensive abdominal surgery, etc? Can the device be removed quickly in case of an emergency? What is the learning curve for the average endoscopist? What conditions will render spiral enteroscopy unsuccessful or even dangerous?

Ultimately, we will have to wait for additional studies in other patient populations, performed by investigators without a financial interest in the technology in order to better assess the diagnostic yield of spiral enteroscopy. This technology, along with any other new enteroscopy devices, will need to be measured against balloon enteroscopy, which represents today’s reference standard for nonsurgical enteroscopy, both in terms of an objective measure of depth of insertion as well as diagnostic and therapeutic outcomes.

Those of us who perform deep enteroscopy look forward to seeing additional studies of spiral enteroscopy. We will then be able to tell whether it represents a real advance or is another idea that held promise but fails to deliver. Ultimately, we await a device—whether it is a modification of the spiral system or something completely different—that will allow reliable, total nonsurgical enteroscopy in one session. Until that time, we will continue to use unsatisfying surrogate markers like depth of insertion and diagnostic yield to tell us how far we are along that path.

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