EDITORIAL

Double-balloon enteroscopy: ready for prime time?

Since its introduction in 2003, double-balloon enteroscopy (DBE) has enabled endoscopic therapy in an area of the small intestine previously accessible only with the aid of laparotomy. Widespread use of this technology, however, has been limited by several technical and logistical hurdles. In this issue of *Gastrointestinal Endoscopy*, Gross and Stark[1] report 200 consecutive DBEs performed in 137 patients by a single endoscopist. The largest single-center U.S. experience published to date, their study illustrates the promise of DBE as it grows beyond the academic setting and into everyday practice. It also addresses some of the fundamental questions that we must consider in evaluating the future of DBE in the United States:

- Can it be done? (technical feasibility)
- What are the benefits? (diagnostic yield and therapeutic impact)
- What are the drawbacks? (complication rate and resource utilization)
- What are the alternatives? (competing technologies)

TECHNICAL FEASIBILITY

Although the technical feasibility of DBE is well established, it remains a challenging procedure even for experienced endoscopists. The anal approach can be particularly difficult because of slippage of the scope during the first reduction maneuver inside the terminal ileum. In a previous study on the learning curve of DBE, procedure time for the oral approach decreased significantly after the first 10 DBEs, but the retrograde failure rate remained at 20%.[2] This rate does, however, appear to decrease after 20 procedures.[3] The current study by Gross and Stark reports excellent technical outcomes: the terminal ileum was intubated in all cases and mean insertion depths from the oral and anal approach were 220 and 124 cm, respectively. However, the procedure time did not decrease even after 150 procedures. These findings suggest that, although insertion depth and therapeutic yield can increase with experience, DBE remains an inherently time-consuming procedure.

In theory, DBE from both the oral and anal approach allows for a complete examination of the small intestine. However, this goal is not always achieved. Among the 45 patients in the current series in whom total enteroscopy was attempted, only 9 attempts (20%) were successful. The total enteroscopy rate of 86% initially reported by Yamamoto et al[4] has not been replicated in subsequent studies. A large multicenter international study found a total enteroscopy rate of 15%, with the highest of any individual center being 41%,[5] although it is unclear whether these numbers include patients for whom total enteroscopy was not attempted. May et al[6] reported a slightly higher rate of 45%. The generally lower total enteroscopy rates in Western countries compared with Japan may be partly due to a higher prevalence of obesity and adhesions from prior abdominal surgeries. These factors hinder pleating of the small bowel along the overtube, which is required for deep insertion of the enteroscope. However, experience and technical skill may also play important roles: the success rate of complete enteroscopy reported by Gross and Stark in the current series increased from 8% to 63% after the first 150 cases, as did the proportion of procedures deemed to be clinically helpful. It is also important to note that in most cases, complete enteroscopy is not required for diagnostic or therapeutic success. For example, Kaffes et al[7] limited insertion time to 60 minutes and had a 0% total enteroscopy rate, yet still reported 80% cessation of bleeding after a mean follow-up of 10 months.

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Given the challenging nature of DBE, the optimal training method is unknown. Perez-Cuadrado et al[8] have described a comprehensive training program that progresses from animal cases to supervised human procedures and culminates with a computerized simulator-based skills assessment. However, this type of hands-on mentorship is impractical for most physicians, and the current study demonstrates that DBE can be performed competently after training on an ex vivo porcine model and observation of

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human cases. This type of teaching could feasibly be carried out at training workshops, without the need for on-site mentorship. Future generations of gastroenterologists may be exposed to DBE as part of their training programs, but given the complexity of the procedure and the low volume of cases seen at any one institution, DBE may be best taught as part of an advanced endoscopy year.

In summary, DBE is a challenging but learnable procedure. Technical expertise, as measured by insertion depth, therapeutic yield, and success rate of total enteroscopy appears to increase with experience, but the procedure remains lengthy. On-site mentorship is probably not required for training, but given the relatively small number of patients needing the procedure, DBE should be performed by a limited number of endoscopists with an adequate patient volume.

DIAGNOSTIC YIELD

Because of the lack of an easily reproducible gold standard for small bowel pathology, ''diagnostic yield'' is often used as a surrogate for the sensitivity of small bowel examination techniques. DBE is itself likely to become the new gold standard, especially when total enteroscopy can be achieved. Even intraoperative enteroscopy and autopsy are not necessarily superior to DBE because vascular lesions may disappear with diminished perfusion to the small bowel, and trauma during intraoperative enteroscopy may be mistaken for vascular lesions. Although capsule endoscopy examines the entire small bowel more often than DBE, lesions can be missed as a result of the uncontrollable speed and orientation of the capsule. In the current study, Gross and Stark found that 3 of 4 patients with a ''negative'' capsule endoscopy had significant lesions found on DBE, although this likely represents a biased sample because only patients with continuing symptoms underwent DBE.

The usefulness of DBE in patients with obscure GI bleeding (OGIB) is unquestionable. When DBE is performed predominantly for this indication, the diagnostic yield is 75%, with remarkable agreement among multiple studies from around the world.[7,9-12] However, the findings themselves vary considerably, with vascular lesions being more common in Western countries and tumors being reported more often in Asia. This may reflect an underlying difference in the prevalence of these lesions. Other well-accepted indications for DBE include removal of polyps in Peutz-Jegher's syndrome and biopsy of ulcerating lesions to distinguish lymphoma from Crohn's disease or refractory celiac disease. Chronic diarrhea and chronic abdominal pain are also sometimes addressed with DBE, but the diagnostic yield falls to 30% to 40% under these indications.[13] Although this yield is not insignificant, DBE must be used judiciously in such cases given the resources required.

In the current series, the diagnostic yield of DBE was 80%, reflecting appropriate patient selection (74% of patients had OGIB). Perhaps more important than ''diagnostic yield,'' however, is whether the findings at DBE are helpful in the care of a patient. For example, a negative examination in a patient with unexplained anemia might adequately rule out GI blood loss and allow the clinician to focus elsewhere. Conversely, finding and treating a single small arteriovenous malformation (AVM) in a patient with recurrent massive hemorrhage and small bowel obstructions is unlikely to fix the problem. In the current series, Gross and Stark report that 71.5% of procedures were felt to be helpful, with an additional 11.7% of procedures deemed possibly helpful. However, an accurate determination of whether a procedure is helpful requires long-term follow-up.

THERAPEUTIC IMPACT

Although no long-term studies on the clinical impact of DBE are available, the results of short-term follow-up studies are encouraging. Kaffes et al[7] found that 80% of patients with OGIB who underwent DBE had cessation of bleeding after a mean follow-up of 10 months. A larger study with a mean follow-up of 16 months showed an 89% nonrebreeding rate among 96 patients, but 56 patients who had no findings at DBE or were lost to follow-up were excluded from the analysis.[11] Because the natural history of AVMs is not well defined, it is unknown whether bleeding in these patients will recur after several years, and if so, at what interval repeat procedures will be required. Similarly, it is unknown at what interval patients with Peutz-Jegher's polyposis need DBE to prevent small bowel obstruction. The therapeutic impact of DBE in patients with strictures requiring dilation, ulcerating lesions requiring biopsy, or Roux-en-Y anatomy requiring examination of the biliary ducts is immediate, but such indications account for a minority of cases. The major impact of DBE on the practice of gastroenterology will undoubtedly be in the treatment of obscure GI bleeding.

COMPLICATION RATE

As shown in the current study, DBE is a safe procedure. The most common adverse effect from DBE is minor abdominal pain from gas in the small bowel. This can be ameliorated by insufflation with carbon dioxide rather than air because carbon dioxide is absorbed more rapidly through the intestinal wall. The reduced distention seen with carbon dioxide may also facilitate stricture dilation[14] and increase insertion depth by allowing for better pleating of the small bowel.

Bleeding and perforation are uncommon in DBE. The largest study of DBE-related complications to date, encompassing more than 2300 procedures at 10 high-volume centers, reported a major complication rate of 8 per 1000 procedures.[5] This is comparable to the complication rate seen with other endoscopic procedures. Risk factors for