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Hello double balloon enteroscopy, goodbye operating room: can the scope supplant the scalpel?

'...the technology of DBE is an extension of standard endoscopic techniques using manual advancement of a video scope through a natural GI orifice.'

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The field of gastroenterology has changed irrevocably in the last decade with the advent of wireless video capsule endoscopy. The ingestible camera has exposed the small bowel, the 'black box' of the GI tract, to visual scrutiny in an unprecedented manner. Until the mid-1990s, radiological studies were the only reliable way to obtain structural information about the small bowel, noninvasively, and the data were imprecise and often unhelpful. The capsule endoscope is now used widely worldwide and has received US FDA approval as the first-line therapy for the evaluation of the small bowel. It can give us over 50,000 digital images of jejunal and ileal mucosa with unprecedented clarity. With every exciting advance comes new ideas, and the gastrointestinal (GI) community found itself with a wealth of information from the small bowel, without the ability to use it meaningfully. Ulcers seen on capsule endoscopy could represent a myriad of conditions, such as inflammatory bowel disease, damage from NSAID drugs (e.g., ibuprofen) or even infectious conditions, such as tuberculosis. Polyps or masses could be viewed but not removed or even biopsied. Strictures and other surgical challenges could be documented but not treated. It was truly thanks to capsule endoscopy technology that a previously unrecognized need for noninvasive small bowel therapeutics was created [1] and into that therapeutic void walked double balloon enteroscopy (DBE). The question now is: how far beyond diagnostics and minor therapeutics can this scope take us? Will DBE technology move small bowel diseases out of the operating room (OR) and into the outpatient endoscopy suite?

'Will DBE technology move small bowel diseases out of the operating room and into the endoscopy suite?'

The DBE was developed in Japan in 2001 by Yamamoto as a new endoscopic insertion technique to facilitate observation of the entire small bowel [2]. A dedicated system was developed by 2003, and by 2004 the Fujinon system was approved by the FDA as a diagnostic and therapeutic resource for the endoscopist. The equipment consists of a 200-cm endoscope and 140-cm overtube with 45-mmHg disposable balloons attached to the ends of each. The technique allows the scope to advance through the entire length of the small bowel via the process of inflating and deflating the balloons, which grip the walls of the small intestine. With a series of 'reductions', the process pleats the small bowel over the overtube, like a curtain over a rod, and advances the scope. Endoscopic access to the entire small bowel can be obtained either with one extended procedure or with a combined antegrade (*per oral*) and retrograde (*per anal*) route [3].

Although new and long awaited, the technology of DBE is an extension of standard endoscopic techniques using manual advancement

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of a video scope through a natural GI orifice. What provides this scope with its revolutionary therapeutic potential is the use of a 2.8-mm channel designed to accept accessories for biopsy, balloon dilation, endoscopic mucosal resection, polypectomy and stent placement. It has become the nonsurgical alternative for therapy of small bowel lesions that would previously have been managed exclusively in the OR.

What kinds of clinical cases are most appropriate and how can we best use this technology [4]? DBE is most frequently used in the management of GI bleeding and has been extremely successful in locating and ablating vascular lesions that are responsible for transfusion-dependent anemias [5]. However, it is the obstructive and neoplastic lesions that traditionally require surgery, and it is here that DBE offers the most innovative approach to therapy [6].

One of the most debilitating diseases affecting the small bowel is Crohn's disease, an inflammatory condition of the GI tract that involves the small bowel in the majority of affected patients. In severe cases, complications, including inflammatory or fibrotic strictures, can cause small bowel obstruction. For patients with these complications, resective surgery has been the standard of care and remains the foundation of treatment. However, the risks of surgical intervention include the need for repeat resections, short gut syndrome and adhesions or pain related to the operation itself. Modifications of invasive therapy, such as strictureplasty or laparoscopic resection, have improved choices for patients. However, it is in this clinical setting that the most exciting and perhaps best approach comes from the nonsurgical DBE option for the treatment of strictures. A hydrostatic balloon dilator can be passed through the therapeutic channels in the DB scope, advanced through the stricture and inflated to designated pressures for endoscopic strictureplasty [7–9]. The DBE patient avoids an abdominal incision, as well as postoperative in-patient recuperation from anesthesia, and can go home shortly after awakening from sedation with little more morbidity than transient gas pains.

Another exciting use of this technology is the removal of small bowel polyps in patients with conditions such as Peutz–Jeghers syndrome or familial polyposis syndromes associated with malignant neoplasms. Mandatory repeat laparotomy has been the standard of care for polyp surveillance in many of these patients, and DBE has the potential to replace this surgical inspection. Small bowel tumors can be characterized, biopsied and removed with an endoscopic DBE, rather than with intraoperative enteroscopy. A snare or forceps, passed through the DBE therapy channel, removes the polyp and, along with it, the risk of malignant transformation [10].

Growing numbers of surgeries for obesity, cancer and transplantation can cause significant alterations in patient anatomies and produce dilemmas regarding access to sites in the small bowel. Patients who have undergone surgeries that bypass the stomach and duodenum, creating, for example, the Roux-en-Y anatomy, no longer have feasible endoscopic access to the biliary system [11]. Their stomachs and bile ducts have been excluded from the direct route from the esophagus to the colon. Relief of a common bile duct obstruction from a gall stone, stricture or tumor has, therefore, been impossible without interventional radiology or surgery. However, for the endoscopist thinking outside the box, the DB can be used to anchor an endoscopic channel to the inaccessible organ, thus allowing introduction of the appropriate scope or accessory for therapy. DBE-assisted Endoscopic Retrograde Cholangiopancreatography (ERCP), small bowel stent placements or jejunal feeding tubes can now be considered in distorted anatomy [12–14].

Even in normal GI tracts, foreign body ingestion can lead to obstruction or other dangers. The DBE has retrieved swallowed objects, including wireless video capsules retained in the small bowel, thereby preventing a trip to the OR [15].

The experience of the patient undergoing a DBE is not significantly different from what he or she would expect from a colonoscopy. The patient ingests a minimal preparatory treatment the night before, checks into the outpatient endoscopy center and, most commonly, receives conscious sedation or propofol during the procedure. When first performed in Japan, the procedures were prohibitively long, but they now last between 60 and 120 min. The risks are identical to those of a colonoscopy or EGD, with the additional rare occurrence of postprocedure ileus or mild pancreatitis.

> 'A hydrostatic balloon dilator can be passed through the therapautic channels in the DB scope, advanced through the stricture and inflated to designated pressures for endoscopic strictureplasty.'

Perhaps this sounds too good to be true: can we really substitute a less expensive, less morbid outpatient endoscopy for a more complicated surgical intervention without compromising the outcome? The answer is – sometimes. The fact that this is now a possibility in some cases gives us extraordinary optimism regarding the future potential for noninvasive treatment of small bowel lesions.

There are currently limitations regarding the eligibility of patients, the yield of the procedures, and the ease and success of the therapeutics. For example, in patients who have had previous abdominal surgeries that restrict plasticity of the bowel, the flexible 'pleating', which is the success feature of the technology, may be impossible. In a series of 19 patients with small bowel Crohn's strictures, nine were not amenable to endoscopic therapy due to severe inflammation or other anatomical reasons [16]. While the therapeutic potential of the DBE is its most compelling feature, the available therapeutic accessories are not designed specifically for the DBE scope and often fit poorly through the treatment channel. There is wide agreement that a hydrostatic dilating balloon can be extraordinarily difficult to pass through a long, narrow, flexible channel in a coiled scope [17]! Complications are low but real, with a general complication rate of 1% and an overall therapeutic complication rate of 3%, which is highest with polypectomies (>3 cm) and dilation of inflammatory strictures [5]. Long-term studies are not yet available to determine the duration of benefit or the rate of subsequent surgical referral.

DB technology and surgery are, of course, not mutually exclusive. DBE has been used in the OR for complicated polypectomies. Prior tattooing of the position of tumors through the endoscope allows the surgeon to localize lesions easily during open resection. Natural orifice surgery may utilize DBE to propel the robotics into an optimal location for state-of-the-art surgery.

While surgical intervention for certain small bowel pathologies is clearly the standard of care, we are now shaping an era in which noninvasive therapies, made possible by technologies such as the DBE, are not only feasible, but imminently do-able, with minimal risk to the patient and increasingly successful outcomes. DBE will not usurp the role of surgical expertise in the management of small bowel disease, but this innovative approach provides a noninvasive therapeutic alternative, and pushes us out of the OR, out of the endoscopy suite and into the future.

'...we are now shaping an era in which noninvasive therapies, made possible by technologies such as the DBE, are not only feasible, but imminently do-able...'

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