EDITORIAL

Is double-balloon enteroscopy superior to spiral enteroscopy?

The small intestine had long been considered uncharted territory for endoscopy outside the operating room until capsule endoscopy (CE)[1] and double-balloon endoscopy (DBE)[2] were developed early in the 21st century. CE enabled endoscopic imaging of the entire small intestine without patient discomfort. Although it is a technical breakthrough in the diagnosis of small-intestinal diseases, CE still does not offer targeted inspection of suspect areas or interventional capabilities such as biopsy or therapeutic maneuvers. DBE is the first endoscopic technique that allows reliably controlled deep enteroscopy without laparotomy. It offers not only a stable and detailed examination of small intestinal lesions but also the use of a variety of endoscopic therapies in the small intestine. In DBE, the small intestine is pleated onto the overtube by pulling the overtube while the small intestine is gripped by the overtube balloon. The endoscope is advanced while the overtube balloon grips and stabilizes the intestine, and the overtube is advanced while the endoscope balloon grips the intestine. In this manner, much deeper insertion of the endoscope is achieved than by push enteroscopy. CE and DBE each have distinct features, and they are considered complementary rather than competitive.[3]

Recently, spiral enteroscopy (SE) was developed as another type of deep enteroscopy.[4] In SE, pleating of the small intestine is performed by the clockwise rotation of a specialized overtube with a raised helix at the distal end, which mimics the motion of a corkscrew. It has been shown that SE can reliably allow endoscopic visualization of a significant portion of the proximal small bowel. It is also reported that the procedure time in SE is considerably shorter than the time required for DBE. However, it is still questionable whether the depth of insertion achievable by SE is comparable to that of DBE. Although Akerman et al[4] reported reaching depths of up to 340 cm beyond the ligament of Treitz, with an average depth reached of 176 cm, comparable with those reported for DBE, interpretation of the depth of insertion in deep enteroscopy should be made with caution. In either DBE or SE, measurement of the depth of insertion is influenced by the endoscopic examiner's estimations, which are highly subjective and easily exaggerated. For a good comparison of insertion depth, the rate of complete enteroscopy is the sole objective and valid parameter. In this issue of *Gastrointestinal Endoscopy*, Messer et al[5] report the results of their prospective, randomized, comparative study comparing DBE and SE. The primary endpoint of this study was the rate of complete enteroscopies achieved. In attempting complete enteroscopy, they started the examination using the oral route. If a complete enteroscopy was not achieved by the oral route alone, the deepest point reached in the small bowel was marked with India ink. A complementary examination using the anal route took place on the day after the initial examination or even on the day after that, targeting to reach the marked point. As a result, the rate of complete enteroscopies with DBE was 12 times the rate achieved with SE (8% in the SE group and 92% in the DBE group; $P = .002$). As secondary endpoints, the estimated depth of insertion was also significantly greater in the DBE group than the SE group for both the oral and the anal routes, although the examination time was also longer in the DBE group. Therefore, these workers concluded that SE does not represent an alternative to DBE with regard to the depth of insertion or the rate of complete enteroscopies achieved.

Double-balloon enteroscopy resulted in 12 times the rate of complete enteroscopies achieved with spiral enteroscopy (8% in the spiral group and 92% in the double-balloon group).

To achieve better results in the insertion depth and complete enteroscopy rate for SE, some improvements in the system would be required. The overtube should be longer and more flexible. However, if the overtube in SE is longer and more flexible, rotation of the overtube could be more easily converted to the twist of a loop formed by the overtube rather than the rotation of the tip of the overtube. The twist of the loop would be not only ineffective for insertion but also harmful to the intestine, with a possible risk of injury.

Another important issue is the safety of the procedure. In this study, the authors reported 1 case of perforation during an examination when using the anal route as a relevant complication in SE. The perforation was located in the terminal ileum approximately 30 cm proximal to the ileocecal valve and was most likely caused by the overtube. To better assess the risk of intestinal injury, they evaluated mucosal lesions observed in the small bowel during withdrawal of the endoscope and categorized them

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into mild, moderate, or severe. They found that DBE led to fewer significant mucosal lesions ($P = .039$ based on the Mann-Whitney U test) than did SE. They considered that these results support the argument that DBE is the less harmful method.

When I developed DBE in cooperation with Fuji Photo Optical Incorporated Company (currently Fujifilm Corporation), I tried to minimize the risk of injury to the small intestine. Because the small intestinal wall is thin, it should be considered more fragile than the stomach or the colon. To minimize the risk, I decided to use the minimum gripping force to support endoscopic insertion. In DBE, a gripping force by the overtube balloon is used to support endoscopic insertion. In this system, when an endoscopist applies too much insertion force to the endoscope, the forceful insertion causes slippage of the overtube balloon rather than perforation of the intestine in case of ineffective advancement of the endoscope tip. To make the system effective and safe regardless of the size of the lumen of the intestine, I decided to use a very soft flexible balloon with a low inflation pressure (45 mm Hg).[6] The balloon is inflated up to the size of the lumen and grips the intestine gently with either a small or a large luminal size of the intestine.

In SE, the rotating force applied to the overtube shaft is directly transmitted to the overtube tip with a raised helix. If the small intestine clings to the raised helix, resistance to the rotational motion will increase. However, if a forceful rotation is applied against the resistance, it will injure the intestine, the mesentery, or both. Soria et al[7] performed experimental laparoscopic evaluation of DBE versus SE in an animal model. They observed a more altered vascular supply to the bowel in the SE group with twisting of the bowel and mesenteric vessels caused by clockwise rotation of the overtube. To make the procedure safer, an overtube with a smaller outer diameter would be desired. However, there is a limitation in decreasing the size of the overtube used in SE, because SE requires proper engagement of the raised helix of the overtube to the small intestine.

For the reasons given here, SE would have limitations in being applied to a fragile diseased intestine, dilated intestine, or stenotic intestine. In such situations, the risk would increase with DBE as well. However, DBE has been used widely in such situations, and sufficient safety has been confirmed.[8]

Although spiral enteroscopy is a new and promising enteroscopy technique that reduces the examination time, it should be used for a more selected group of patients with caution. I agree with the authors of the article in the current issue that SE does not represent an alternative to DBE. DBE still remains the most reliable deep enteroscopy technique, with a high success rate for complete enteroscopy.

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Abbreviations:: CE, capsule endoscopy; DBE, double-balloon endoscopy; SE, spiral enteroscopy.

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