

Balloon by balloon, inch by inch

The pursuit of a dream to endoscopically visualize the entire small bowel is as old as modern endoscopy. The initial attempts included sonde-type endoscopes that went through several design changes in order to improve maneuverability and the ability to obtain specimens. However, these instruments continued to be cumbersome to use and allowed only for passive examination during endoscope withdrawal after peristalsis aided by motility agents advanced the instrument into the distal small bowel. Pediatric experience was extremely limited, with its use described in only 3 patients, with a maximum small-bowel intubation depth of 140 cm.¹ Push enteroscopy replaced sonde-type instruments, but, again, published pediatric experience was restricted to only a single report.² In that series, 44 children underwent push enteroscopy over a 5-year period, with a mean insertion length beyond the pylorus of 132 cm. The reported diagnostic yield was 77%, and no complications were seen. With these techniques, a significant segment of small bowel remained unexamined, necessitating further research and design of devices capable of complete small-bowel examination. Subsequently, wireless capsule endoscopy (WCE) and balloon-assisted enteroscopy were introduced during the last decade.

Wireless capsule small-bowel endoscopy, developed in 2000,³ was approved by the U.S. Food and Drug Administration (FDA) for use in children 10 years and older in 2004, and approval was most recently expanded to include children 2 years and older. This technique can examine the entire small bowel in 75% to 90% of patients, and there is a growing body of literature on its use in children⁴ as young as 18 months of age.⁵ The obvious disadvantage of this device is that it does not allow the endoscopist to obtain specimens or perform therapy. Finally, the latest technologies developed for small-bowel examination are spiral enteroscopy and single-balloon and double-balloon enteroscopy (DBE). There are no pediatric reports on spiral enteroscopy or single-balloon enteroscopy, which became available in 2007. In this issue of *Gastrointestinal Endoscopy*, Nishimura et al⁶ report on the largest-to-date experience with DBE in a pediatric population. A total of 92 DBE procedures was performed in 48 pediatric patients with an age range of 4 to 18 years. The most common indication for examination

was treatment of a biliary anastomotic stricture after liver transplantation with Roux-en-Y hepaticojejunostomy. Other common indications included obscure GI bleeding and surveillance of polyposis syndromes. The overall diagnostic yield was 65%, and the therapeutic yield was 40%. In 5 out of 9 patients (56%), a combination of antegrade and retrograde approaches resulted in complete examination of the small bowel. No serious complications were reported except for 1 patient who developed bleeding after polypectomy, which was treated endoscopically and did not require transfusion. This is a very welcomed and important study that single-handedly more than triples the number of reported cases of small-bowel endoscopy in the pediatric lit-

Several important aspects of double-balloon endoscopy that are unique to the pediatric population—training; type of sedation used; comparison to experience in adults in terms of safety, technical difficulties, and procedure time and success; and the lack of instruments designed specifically for children, a factor that is very often the case in pediatric endoscopy—deserve further analysis.

erature. The study comes from a group that helped develop this technique and is probably the most experienced in use of the technique in the world. Considering the unique primary indication and extensive experience, the results may not be completely applicable to the general pediatric population or in less-experienced centers around the world. Yet, several important aspects of this technique unique to the pediatric population were addressed and deserve further analysis. These include training; type of sedation used; comparison to experience in adults in terms of safety, technical difficulties, and procedure time and success; and the lack of instruments designed specifically for children, a factor that is very often the case in pediatric endoscopy.

Previous experience with DBE in pediatrics consists of 2 abstracts with a total of 14 procedures,^{7,8} several adult series including an unclear number of young patients,⁹⁻¹² 2 case reports,^{13,14} and 2 pediatric series with 14 and 15 pediatric patients, respectively.^{15,16} One of the 2 case reports described jejunal perforation subsequent to polyp

removal in a 3-year-old boy with Peutz-Jeghers syndrome,¹⁴ whereas there were no complications documented in the other studies. In the Chinese series, the main indication for DBE was obscure GI bleeding, and the length of small bowel examined was reported as the middle or lower portion of the ileum in 70% and the terminal ileum in 14% of patients.¹⁶ The diagnostic yield was 86%. In the Korean study, several adults were included, so the pediatric diagnostic yield is unclear.¹⁵ The depth of small-bowel intubation was reported as difficult to assess, but the author thought that the mid-small bowel was reached in most patients. The technical difficulties in advancing the enteroscope were encountered secondary to the sharp angulation of the instrument, and the reported procedure and anesthesia time ranged from 90 to 120 minutes. Similarly, Nishimura et al⁶ report procedure times longer than in adults, and lower diagnostic and full examination rates presumably because of the sharp angulation of the instrument in the smaller abdominal cavity in pediatric patients. It is interesting that similar numbers of procedures necessary to attain competency were recommended in these 2 series (15 and 20, respectively). The extensive prior experience in adults, however, needs to be taken into consideration. The authors should be congratulated on their cautious approach of gaining experience in adults for several years prior to attempting pediatric procedures. This most likely helped to keep the complication rate in children lower than that reported in adults, which is one of the most important concerns for all pediatric practitioners. In a multicenter study in which the investigators examined DBE complications in 2362 adult patients, bleeding was seen in 0.8%, and pancreatitis and perforation in 0.3% of patients each.¹⁷ The majority (5 of 6) of perforations occurred with therapeutic procedures. In the presented series by Nishimura et al, no such complications were seen, except for bleeding in 1 patient who underwent removal of a very large number of polyps. In their thorough work, the authors looked for evidence of pancreatitis by routinely obtaining serum amylase levels after the procedures, but they did not find any evidence of pancreatitis. The lack of postprocedure pancreatitis may be related to their extensive experience with DBE and careful inflation of the balloon in the duodenum, but it also could be related to altered anatomy in patients who underwent liver transplantation as well as a relatively small overall number of performed procedures. Importantly, current design of the instruments with their diameters and balloon sizes does not seem to be a concern in older children and adolescents, but clearly, more studies will be necessary to assess safety in very young patients. In regard to sedation for the procedure, the authors used variable approaches, depending on the preference of the endoscopist and the pediatrician. In older children, they used moderate intravenous sedation, whereas in younger children they used general anesthesia. Considering the procedure length reported

in this series and the current trend in the United States, that is, an increased proportion of pediatric endoscopic procedures being performed with propofol administration, one would expect most endoscopists to choose this option, better assuring patient comfort and successful procedure completion. As is the case with other advanced endoscopic procedures, the question that remains to be answered is who will be best equipped to perform DBE in children. The best approach might be to carry out these procedures at large pediatric practices or centers of excellence, especially those with established polyposis centers and liver transplantation programs. In these settings and after initial training at adult treatment centers, pediatric interventional endoscopists will be able to provide state-of-the-art care but also will perform sufficient numbers of enteroscopies yearly to maintain proficiency. Alternatively, as currently is practiced at many pediatric centers, these procedures will be left in the hands of our capable adult-treatment colleagues.

So, what should a pediatric practitioner do with the presented information? First, proceed with caution. The device is not yet FDA approved for use in children, and the published pediatric experience is very limited, especially in younger patients. Second, a large pediatric comparison study of video capsule endoscopy and DBE could help answer the question regarding the best diagnostic/treatment algorithm. However, it is not likely that such a study, especially one powered to examine the differences between these two techniques, will be undertaken any time soon. Trying to extrapolate from the adult experience, a meta-analysis showed comparable diagnostic yields of WCE and DBE.¹⁸ Considering their inherent differences, the two perhaps need to be viewed not as competing but as complementary techniques. In pediatric patients with obscure GI bleeding or suspected Crohn's disease and negative initial work-up results, it would make sense to start with a less-invasive test and perform WCE. In doing so, one needs to take into consideration the possibility of capsule retention. In the largest adult experience with more than 900 patients, retention of the capsule occurred at a rate of 0.65%.¹⁹ In pediatrics, there are no such large series but only pooled data from various reports. These data add up to a total of 272 patients and reveal 3 (1.1%) retained capsules that were removed endoscopically and an additional 4 (1.4%) that required surgical removal. However, the most recent report on 85 procedures in patients 8 years and younger, which was included in this total number, reported no retained capsules.²⁰ Careful selection of patients and consideration of patency capsule examination prior to WCE seems prudent. As the next step, and in order to firmly establish the diagnosis and potentially avoid surgery, or in pediatric patients who are not suitable candidates for WCE or surgery, DBE could provide more definitive answers. This might be true especially for a select group of pediatric patients with established small-bowel pathology amenable to endoscopic therapy, like biliary obstruction after liver transplantation,

bleeding lesions, strictures, and small-bowel polyps, as presented in this excellent study by Nishimura et al.

In conclusion, we finally seem to have a technique that, although it requires significant expertise, is capable of examining most, if not all, of the small bowel in children and adolescents as well as providing therapeutic options. We need to be smart about how best to use it in the pediatric population in order to maximize its benefits and minimize complications, at least until the time when the next generation of wireless robotic devices that are maneuverable and are capable of collecting specimens and providing therapies becomes available and helps us to complete the small-bowel journey.

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Abbreviations: DBE, double-balloon enteroscopy; FDA, U.S. Food and Drug Administration; WCE, wireless capsule endoscopy.

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