Therapeutic Advances in Gastrointestinal Endoscopy Review

Training in bariatric and metabolic endoscopy

Ther Adv Gastrointest Endosc

2020, Vol. 13: 1–13

DOI: 10.1177/2631774520931978

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***Abstract*:** The limited penetration of bariatric surgery and the scarce outcome of pharmacological therapies created a favorable space for primary bariatric endoscopic techniques. Furthermore, bariatric endoscopy is largely used to diagnose and treat surgical complications and weight regain after bariatric surgery. The increasingly essential role of endoscopy in the management of obese patients results in the need for trained professionals. Training methods are evolving, and the apprenticeship method is giving way to the simulation-based method. Existing simulation platforms include mechanical simulators, ex vivo and in vivo models, and virtual reality simulators. This review analyzes current training methods for bariatric endoscopy and available training programs with dedicated bariatric core curricula, giving a glimpse of future perspectives.

Keywords: bariatric endoscopy, bariatric training, flexible endoscopy training, metabolic endoscopy

Received: 28 November 2019; revised manuscript accepted: 13 May 2020.

Introduction

Obesity is an emerging pandemic. According to the 2016 World Health Organization (WHO) report, 39% of adults are overweight and 13% are obese.[1] Obesity is strongly associated with several comorbidities,[2] resulting in an increased morbidity and mortality and a heavy burden to the health care system.

Current therapies consist of nonsurgical methods such as diet, exercise, pharmacologic agents, behavioral modifications, and surgery.

According to the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) survey, over the past 25 years bariatric surgery has grown more than 10-fold worldwide.[3,4] However, surgical treatment is limited to 1% of the eligible population because of the risk of adverse events, reoperation, and costs,[3,5,6] although it offers the best results in terms of weight loss.[7]

The limited penetration of bariatric surgery and the scarce outcome of pharmacological options[8] created a very favorable space for less morbid alternative treatments such as primary bariatric endoscopic techniques. The increased use of endoscopy as a minimally invasive therapeutic option coupled with its growing role in the management of bariatric surgery complications has created a great demand for bariatric endoscopic training for both surgeons and gastroenterologists involved in the treatment of obese patients.

This review aims to outline the available training possibilities for bariatric endoscopy (BR).

Endoscopic training

BR training calls for operators with an overall endoscopic background. The level of experience required to approach bariatric procedures is currently unclear. However, the operator must perform diagnostic and therapeutic endoscopy skillfully. The ability to perform advanced techniques such as endoscopic ultrasound (EUS) and endoscopic retrograde cholangiopancreatography (ERCP) is recommended but is not mandatory.

Traditionally, trainees learn to perform endoscopy in clinical settings under the supervision of

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an expert endoscopist, originating in the so-called master-apprentice model. This teaching method benefits from on-the-job training and from receiving immediate feedback from the supervisor. However, taking the first steps in flexible endoscopy while performing procedures in patients has certain drawbacks.[9] It is trial-and-error learning, which potentially increases patient discomfort and the risk of complications. It also adds extra time to each procedure, thereby impacting the capacity of services and economics.[10] In addition, it must be noted that novices often cannot adequately process feedback, given the stressful work conditions and the ever-increasing information overload.

Recently, many studies have described the benefit of simulation-based training in the early learning curve.[11–13]

Skills labs and simulators offer the possibility of training in a dedicated learning environment. These provide ideal conditions for trainees who can train in a 'stress-free' environment which can be personalized according to their learning curve and repeated until they reach proficiency before they can move on to patients. This preclinical training setting is also ideal to measure skills and competencies acquired by the trainees as various tasks can be repeated many times using rapid sequences of specific and diverse scenarios, until the technique and devices can be mastered appropriately.

Four types of simulation-based training models are mainly used: (1) mechanical simulators, (2) *ex vivo* models, (3) live animal models, and (4) virtual reality (VR) computer simulators.

Mechanical simulators

The first endoscopic simulators were mechanical models, especially designed for training of esophagogastroduodenoscopy (EGD)[14] and colonoscopy.[15] Mechanical models can simulate some aspects of endoscopic procedures but cannot really replicate the human tissue. These models are more useful to teach basic skills along with the first steps of endoscopic navigation.[16]

Ex vivo *models*

Ex vivo models represent a valuable alternative to live animals. These models consist of animal explanted organs mounted onto a plastic base or mannequin and are set up to allow an endoscope to pass through the mouth, simulating a real procedure.[17] Explanted organ models exist for nearly every endoscopic procedure, providing better haptic feedback than mechanical models and allowing the use of most endoscopic accessories commonly used during clinical work.

The models can simulate common gastrointestinal pathological conditions and complications such as gastrointestinal polyps, active bleedings, strictures, leaks, and fistulas. Plain *ex vivo* stomachs are used to perform endoscopic mucosal resections (EMR), endoscopic submucosal dissections (ESD), per-oral endoscopic myotomies (POEM), and a variety of primary endoluminal bariatric procedures. Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy models simulating strictures, fistulas, and twists are useful to teach endoscopic dilatation, stenting, septotomy, and pigtail placement techniques. *Ex vivo* models are also often used to reproduce clinical situations such as dilated RYGB gastrojejunal anastomosis or RYGB pouch dilatation in which suturing or thermal therapies such as transoral outlet reduction (TORe) and argon plasma coagulation (APC) can be performed.

The use of *ex vivo* models has been proved to enhance endoscopic competence after 1-day training in resection, stenting, hemostasis, and perforation closure.[18–20]

Explanted organ models are less expensive, overcoming some limitations of live animals. However, they still require a dedicated infrastructure for manipulation and storage.

Live animal models

Live animal models provide the most realistic experience in terms of haptic feedback and physiological reactions due to living tissues and organs. Swine are the most commonly used models. Despite some anatomical differences such as wall thickness and organs position, trainees feel as if they are dealing with a clinical case.[16] In fact, *in vivo* models allow a full immersion experience not only by providing more realistic clinical scenarios but also because of the potential advent of complications such as bleeding or perforation and the opportunity to learn how to manage them. Live animal use has several drawbacks, including costs, the need for highly equipped facilities, the limited number of repetitions for each procedure, and

ethical concerns.[21] For those reasons, they are less commonly used for teaching basic upper gastrointestinal endoscopy (GR) procedures.[22]

VR simulators

VR simulators are promising tools. Their use in the early training phase in different gastrointestinal procedures is gaining acceptance, and several simulators have been validated for this purpose.[23,24] They are plug-and-play, making it possible for trainees to practice depending on their availability and according to their personal learning curve. Along with the image of the procedure, VR systems incorporate haptic feedback. They can replicate different procedures and complications to be managed by the trainee, and they can also reproduce technical issues such as endoscope looping and patient discomfort. For operative procedures, a universal accessory is used through the working channel of a replica endoscope; the system converts it to the desired therapeutic instrument for the specific task. Procedures can be repeated as many times as necessary or desired.[12,25] VR simulators are more easily accessible than live animal models for daily training. However, the costs associated with acquiring and maintaining a VR simulator may be a barrier to its widespread use. In addition, VR simulation–based training has been proven to be more useful during the early phase of training and has worse results if performed without experts' feedback[26] and clinical exposure. This has created an ever-increasing demand for a low-cost, widely available endoscopy simulator to train residents in basic therapeutic endoscopy.

BR training

BE covers a wide range of procedures from basic diagnostic to advanced therapeutic interventions.

The use of BE helps in the perioperative management of the bariatric patient, management of acute and chronic postbariatric surgery adverse events, primary endoluminal bariatric and metabolic procedures, and endoluminal techniques to address weight regain after bariatric surgery.

The complexity and diversity of endoscopic procedures performed in the bariatric field call for a well-structured training curriculum. This curriculum should allow transfer of the theoretical and practical knowledge required to safely perform both diagnostic and interventional BE.

Diagnostic procedures

Depending on the timing in relation to bariatric surgery, BE has different diagnostic purposes. Preoperative EGD aims to rule out any existing disease and findings that might alter the surgical management, such as hiatal hernia, reflux oesophagitis, Barrett's esophagus, severe gastritis, and peptic ulcer disease. However, there is a lack of consensus on what condition should prompt a change in the planned bariatric procedure. This is particularly true for the management of hiatal hernia detected at preoperative endoscopy.[27] In fact, according to a large systematic review and meta-analysis, preoperative endoscopic findings delayed or influenced only 7.6% of the initial bariatric surgical strategy.[28] In addition, to date, there are no existing guidelines detailing a standardized bariatric surgery preoperative workflow. The European Association of Endoscopic Surgery (EAES) guidelines recommend routine preoperative endoscopy in all bariatric surgery patients and specifically for RYGB patients,[29] whereas the American Society for Gastrointestinal Endoscopy (ASGE) guidelines recommend individualized decisions, limited to symptomatic patients and considering the type of bariatric procedure to perform.[30]

The role of intraoperative endoscopy (IOE) during bariatric surgery is still a matter of debate.

IOE is currently performed in only 18–20% of bariatric procedures.[31] Routine IOE allows for the early identification of potential injury and correctable technical errors that can be successfully repaired at the time of surgery, thereby reducing postoperative morbidity.[32] In 2015, the American Society for Metabolic and Bariatric Surgery (ASMBS) did not report any sufficiently strong evidence to support the use of IOE to reduce leaks after SG and RYGB.[33]

In addition, although IOE may not always translate into an immediate benefit for the patient, it does benefit the surgeons' technical skills and education. From a resident and teaching standpoint, IOE stands for a great opportunity to gain expertise in endoscopy and to become familiar with the appearance of normal and abnormal bariatric constructions.

Postoperative endoscopy (POE) is commonly used to evaluate patients presenting with upper gastrointestinal (GI) tract complaints and to detect potential underlying mechanisms.

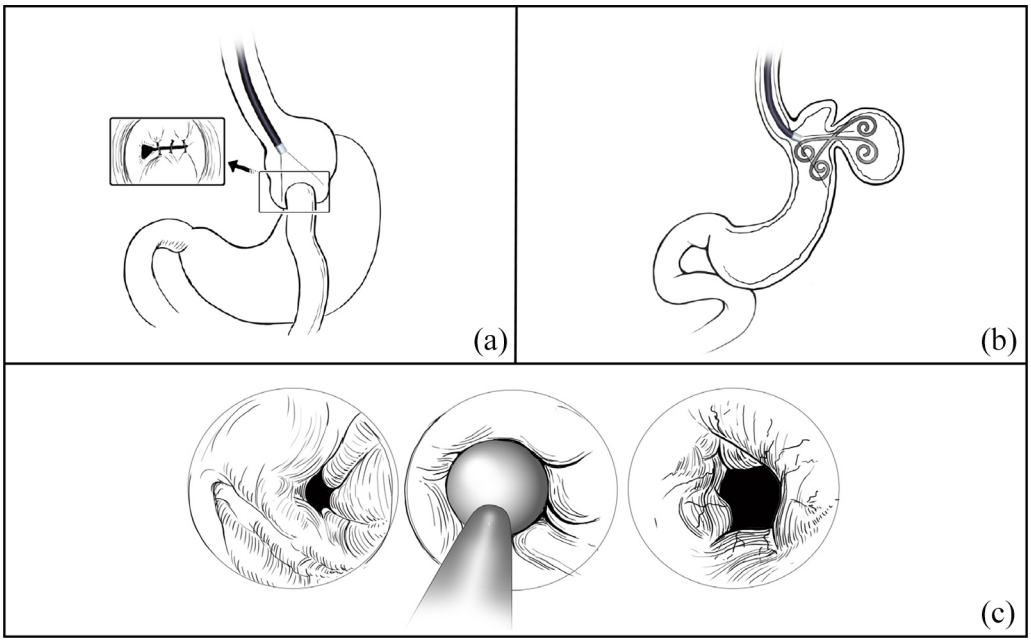

Figure 1. Bariatric endoscopy: adverse events management: (a) transoral outlet reduction (ToRE), (b) endoscopic internal drainage with double pigtail stents, and (c) stricture dilation with liquid-filled balloon.

It is essential for the endoscopist to understand the postsurgical anatomy of the upper GI tract to recognize normal and abnormal findings and to identify patients who may be treated endoscopically. Postoperative EGD is usually performed in symptomatic patients (typically those complaining of dysphagia, vomiting, epigastric pain, fatigue, gastroesophageal reflux, and weight regain) to complement radiological studies.

In addition, IFSO guidelines recommend a routine surveillance endoscopy after SG as the presence of esophagitis and *de novo* Barrett's esophagus after SG reaches 15–17%, and symptoms of gastroesophageal reflux disease (GERD) alone are not reliable.[34]

POE is also essential before revisional bariatric surgery to evaluate causes of failure of the initial procedure and to dictate the operative strategy.

Adverse events management

The endoscopic treatment of bariatric surgery complications has initially complemented and then largely replaced surgical revisions, alone or in combination with interventional radiology, avoiding multiple surgical interventions,[35] especially in patients with high operative risks.[36–39] This was also possible, thanks to the large armamentarium of endoscopic devices and techniques allowing to treat a wide spectrum of complications (Figure 1(b) and (c)).[39–41]

Management of bariatric surgery complications is highly demanding as it requires an extensive knowledge of both bariatric surgical anatomy and the mechanism accountable for surgical complications to apply the best endoscopic treatment for each clinical scenario. Ideally, in order to receive appropriate training, the trainee should join a high-volume bariatric center with facilities and experts dealing with these complex, often multidisciplinary cases.[42]

In addition, image guidance such as EUS and fluoroscopy is often required during these procedures, and the trainees should become familiar with these modalities.

Primary procedures

Internationally approved bariatric endoscopic primary procedures include space-occupying techniques, aspiration therapies, and endoluminal suturing (Figure 2).[43–50]

The learning curve of primary bariatric procedures depends on the complexity of the device and dictates the type of training required. For

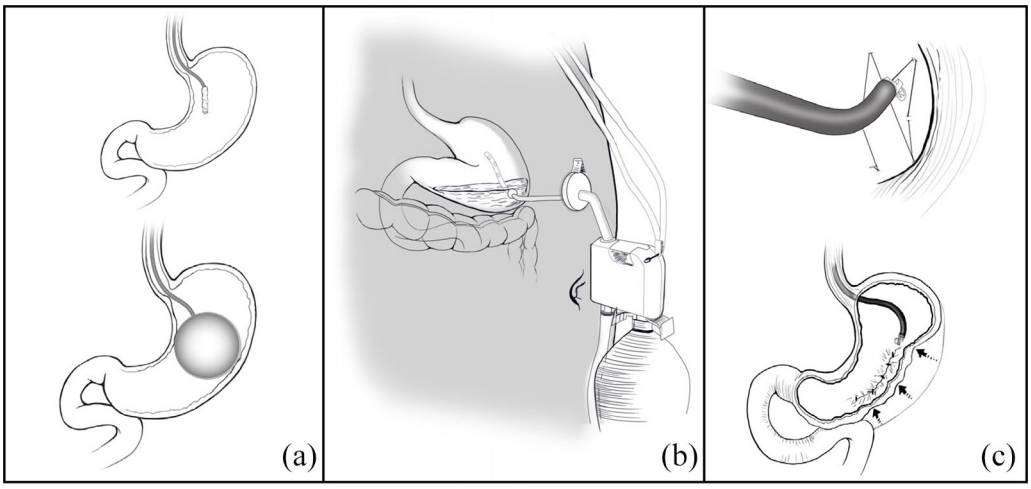

Figure 2. Bariatric endoscopy: primary procedures: (a) intragastric balloon, (b) AspireAssist, and (c) endoscopic sleeve gastroplasty.

simpler devices such as intragastric balloons (IGBs), mechanical models are usually sufficient to understand the different steps of balloon placement and removal. The learning curve for IGB placement has not been analyzed in any study, but training is reported as easy and fast for experienced endoscopists.

Existing endoscopic suturing systems, such as the Apollo OverStitch device, the Endomina system, and the primary obesity surgery endoluminal (POSE) technique,[51] are more complex to use, and it is therefore recommended to undergo an extensive training, including both *ex vivo* and live models, as well as expert supervision during the first cases to master the entire procedure from the introduction of the device to its final retrieval.

A few studies assessed the learning curve of experienced endoscopists for endoscopic sleeve gastroplasty (ESG). Saumoy and colleagues[52] defined a 29–38 procedure range to achieve efficiency and a 55 cut-off number of procedures to reach mastery. Efficiency was addressed by two other studies, showing that efficiency was achieved after 35[53] procedures for novices and after 7[54] cases for endoscopists already familiar with the device who had undergone specific ESG lab training. Therefore, we can infer that training on models before starting clinical cases could dramatically reduce the number of procedures required to guarantee technical efficiency and safety.

Revision procedures

Endoscopy may represent a less invasive, less morbid first step in the management of weight regain compared with surgical revision.[55] As the correlation between RYGB anastomotic dilatation and weight regain[56] has been determined, endoscopic revision procedures have gained a pivotal role in managing weight regain after bariatric surgery. There are different techniques such as APC, TORe (Figure 1(a)), and restorative obesity surgery endolumenally (ROSE). These procedures have been shown to be safe and effective,[57] thereby encouraging their dissemination among bariatric surgeons.

Dedicated bariatric core curricula. In 2002, the ASGE along with the Society of American Gastrointestinal Endoscopic Surgeons (SAGES) and the American Society of Colon and Rectal Surgeons (ASCRS) established training guidelines stating that the acquisition of endoscopic skills should be achieved in the context of training programs in gastroenterology or surgery.[58] In 2017, these guidelines were updated by the ASGE,[59] and the White Paper from the American Gastroenterological Association (AGA) proposed the inclusion of methods for obesity care and weight management in existing gastroenterological practice.[60]

Indeed, the spread of bariatric and metabolic endoscopic therapies has led to the necessity of incorporating them within the more structured endoscopic pathway in order to educate trainees

in performing these specialized procedures according to a standardized program. We stress the necessity of not performing endoscopic bariatric therapy (EBT) in isolation but as part of a multidisciplinary approach, including the clinical management of obese patients.

As BR is not uniformly performed and is concentrated in highly specialized centers, training in bariatric and metabolic endoscopy should be limited to high-volume training institutions with comprehensive interdisciplinary care, which includes dedicated and educated multidisciplinary staff.

As a result, bariatric specialists working in smaller peripheral centers may not have access to this training. To address this issue, national organizations such as the American College of Gastroenterology (ACG), AGA, and ASGE are considering the introduction of advanced fellowships in EBT.[61]

In addition to education and training, a formal and uniformly approved certification of a theoretical and practical curriculum should be developed for endoscopists or surgeons who wish to perform endoscopic bariatric procedures. For this purpose, the Association for Bariatric Endoscopy (ABE), an ASGE division, has identified three principles to provide quality EBT as follows: (1) a deep knowledge of obese patients' management, (2) the mastery of GI endoscopic skills with procedure- and device-specific competency, and (3) the management of potentially adverse events.[62] The objective is to encourage the diffusion of high-quality, standardized training, hence avoiding indiscriminate EBT performance by inadequately trained endoscopists.

Available training programs. Currently, there are several obesity medicine fellowship programs, which range from 1 to 3 years and require completion of an ACGME (Accreditation Council for Graduate Medical Education)-accredited residency program. Their curricula include the 360° management of obese patients, starting from the obesity physiology and highlighting the importance of a multidisciplinary approach. At the end of these programs, trainees may choose to pursue an additional year of BR fellowship. As an alternative, BR training can be part of the existing 3-year gastroenterology fellowships or, if not accomplished during this period, can be included in one additional-year programs in advanced endoscopy. An increasing offer of this last option is currently available, even if these programs are not entirely focused on bariatrics and do not give sufficient time to impart a comprehensive interdisciplinary approach that is critical for the management of obesity.[63]

The ACG has drawn up a list of 76 advanced endoscopy programs.[64] We conducted an Internet search and identified 52 of 76 programs.[65–114] After analyzing all these programs focusing on the BR offer, we found that only 7 of 52 centers mention bariatric procedures as part of the endoscopy curriculum. Most fellowships focus more on ERCP, EUS, and endoscopic resections than on bariatric procedures. In addition, these procedures are not specified and can include primary therapy or treatments of complications, depending on the center.

Most of these advanced endoscopy fellowships are fourth-year positions and need the previous completion of a 3-year accredited gastroenterology fellowship, addressed to gastroenterologists only.

A similar search in the American Fellowship Council directory, filtering by 'bariatric', 'advanced GI mininvasive', or 'flexible endoscopy', resulted in 130 programs.[115] Of the 130 programs, 42 have no endoscopic training at all, 55 include a general flexible endoscopic training, and 33 provide for a specific BR curriculum. All these programs are intended for surgeons.

The heterogeneity of all these fellowship programs is favored by the lack of precise recommendations. The Fellowship Council does not specify any guidelines for BR training in the curriculum of both bariatric surgery and flexible endoscopy.[116,117]

To the best of our knowledge, no similar fellowship programs have been published outside of North America.

In addition to formal fellowship programs, several workshops in BR are available worldwide. These are 1- to 4-day courses with hands-on sessions generally provided during international congresses or organized separately (e.g. I: IFSO Hands-on Bariatric Endoscopy Course;[118] II: Madrid International Bariatric Endoscopy Meeting;[119] III: ASGE Bariatric Endoscopy Course;[120] IV: Miami FES conference;[121] V: John Hopkins International

Therapeutic Endoscopy Course;[122] VI: SAGES Flexible Endoscopy Surgery and Bariatric Endoscopy Course).[123]

Our experience. Considering the increasing need for BR training, we built a BR education portfolio, which included continuing medical education (CME)-accredited courses and two dedicated academic curricula in the form of a university diploma and a master degree at IRCAD-IHU in Strasbourg, France.

All the courses are inspired by the principles of the Flexible Endoscopy Curriculum (FEC) created by the SAGES[124] and broadened to guarantee a concrete implementation in the clinical activity of all the participants.

Short fully immersive 2- to 4-day courses are available both as purely bariatric flexible endoscopy programs or hybrid bariatric surgery and as endoscopy courses where surgical training is complemented with diagnostic and therapeutic flexible endoscopy procedures.[125,126] These courses include oral presentations from an international faculty, interactive clinical case presentation, live procedures, and daily one-to-one hands-on sessions on dry, ex vivo models and live animals.

In 2014, we introduced a 300-hour year-long university diploma open to both surgeons and gastroenterologists with 50 hours of hands-on training delivered over three hands-on sessions.

Since 2019, we opened a 2-year master's degree. The first year the participants acquire a general fund of knowledge about disorders amenable to diagnosis and/or treatment by flexible endoscopy. They learn the indications, techniques, and results of the most common procedures in flexible endoscopy and acquire basic endoscopic skills required to manage common surgical complications such as bleeding, perforations, stenosis, leaks, and fistulas.

The second year the students have the possibility to choose one specific endoscopic field among hepatobiliopancreatic (ERCP, EUS), endoscopic imaging and resection (EMR, ESD, POEM, and tunneling techniques), and bariatric which includes primary techniques and adverse events management.[127]

The university diploma and master's degree are based on a model of flipped learning pedagogy[9,128] where trainees have a 1-year online program with multiple lectures and procedural videos split into different modules which are interposed to three on-site meetings including theoretical lessons, live cases, and hands-on sessions. Furthermore, the participants have to complete a 150-hour clinical rotation to spend in one accredited endoscopy center under the mentorship of recognized world expert in the field.

Future perspectives

We are witnessing a constant migration from open surgery to minimally invasive techniques. Obesity treatment is a burning issue, involving different specialties. In addition, after the demonstration that bariatric surgery improves metabolic conditions such as type 2 diabetes, hypertension, dyslipidemia, and obstructive sleep apnea syndrome (OSAS), weight loss is not the only issue and we are progressively extending the concept of bariatric surgery to metabolic surgery.[129]

Currently, bariatric surgery provides the best results in obese patients. However, emerging alternatives are promising. Cutting-edge endoscopic procedures include duodenal mucosal resurfacing (Revita DMR),[130] GI Bypass Sleeve (ValenTx, Endobarrier), space-occupying devices (FullSense, TransPyloric shuttle),[131] and incisionless magnetic anastomosis systems.[131–133]

In addition, interventional radiology is focusing on bariatric and metabolic procedures through 'bariatric embolization', a new technique using the transarterial embolization of the gastric fundus to target its endocrine function and induce appetite reduction.[134,135]

Cooperation of different specialists brings about the best management of obese patients. The different techniques are not necessarily alternative but complementary.

Conclusion

Obesity treatment demands a comprehensive interdisciplinary approach and the specialists in charge should have a broad background allowing them to evaluate each patient on an individual basis and to offer the best relevant therapy.

BR is a valuable solution in the management of obesity. Currently, few endoscopists focus on obese patients, and they are often not fully trained for it. The need for standardized skills and

competencies requires adequate proficiency-based training in reference centers with expert trainers. The future should envisage hybrid bariatric specialists who are able to manage obese patients through pharmacotherapy, endoscopy, interventional radiology, and surgery. This would ensure that each patient receives the best treatment available, consequently securing the best outcomes.

Conflict of interest statement

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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