Training in bariatric and metabolic endoscopy

Andrea Spota, Giovanni Guglielmo Laracca and Silvana Perretta

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. Obesity is strongly associated with several comorbidities, 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. However, surgical treatment is limited to 1% of the eligible population because of the risk of adverse events, reoperation, and costs, although it offers the best results in terms of weight loss.

The limited penetration of bariatric surgery and the scarce outcome of pharmacological options 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 experienced operators.

Correspondence to:
Silvana Perretta
Surgery, IRCAD, 1 place de l’hôpital, hopitaux universitaires, Strasbourg 67000, France
Silvana.perretta@ircad.fr
Andrea Spota
Scuola di Specializzazione in Chirurgia Generale, Università degli Studi di Milano, Milano, Italy
Giovanni Guglielmo Laracca
Surgery, IRCAD, Strasbourg, France
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. 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. 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. 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 esophagastroduodenoscopy (EGD) and colonoscopy. 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.

**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. 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.

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. 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. For those reasons, they are less commonly used for teaching basic upper gastrointestinal endoscopy (GR) procedures.

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. 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. 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 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. 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. 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, 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.

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. 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. 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. 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.
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, 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
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, 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 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 procedures for novices and after 7 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. As the correlation between RYGB anastomotic dilatation and weight regain 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, 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. In 2017, these guidelines were updated by the ASGE, 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.

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.

---

**Figure 2.** Bariatric endoscopy: primary procedures: (a) intragastric balloon, (b) AspireAssist, and (c) endoscopic sleeve gastroplasty.
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 minimvasive’, 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;\textsuperscript{122} VI: SAGES Flexible Endoscopy Surgery and Bariatric Endoscopy Course).\textsuperscript{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\textsuperscript{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.\textsuperscript{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 hepatobiliarypancreatic (ERCP, EUS), endoscopic imaging and resection (EMR, ESD, POEM, and tunneling techniques), and bariatric which includes primary techniques and adverse events management.\textsuperscript{127}

The university diploma and master’s degree are based on a model of flipped learning pedagogy\textsuperscript{6,128} 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.\textsuperscript{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),\textsuperscript{130} GI Bypass Sleeve (ValenTx, Endobarrier), space-occupying devices (FullSense, TransPyloric shuttle),\textsuperscript{131} and incisionless magnetic anastomosis systems.\textsuperscript{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.\textsuperscript{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.

ORCID iDs
Andrea Spota  https://orcid.org/0000-0002-7058-5089
Giovanni Guglielmo Laracca  https://orcid.org/0000-0002-4508-2180
Silvana Perretta  https://orcid.org/0000-0002-5354-535X

References
1. Obesity and overweight, https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight.
2. https://www.cdc.gov/obesity/adult/causes.html.
3. Ponce J, DeMaria EJ, Nguyen NT, et al. American Society for Metabolic and Bariatric Surgery estimation of bariatric surgery procedures in 2015 and surgeon workforce in the United States. Surg Obes Relat Dis 2016; 12: 1637–1639.
4. Lee W-J and Almalki O. Recent advancements in bariatric/metabolic surgery. Ann Gastroenterol Surg 2017; 1: 171–179.
5. Chang S-H, Stoll CRT, Song J, et al. The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003–2012. JAMA Surg 2014; 149: 275–287.
6. Griffith PS, Birch DW, Sharma AM, et al. Managing complications associated with laparoscopic Roux-en-Y gastric bypass for morbid obesity. Can J Surg 2012; 55: 329–336.
7. Bray GA, Frühbeck G, Ryan DH, et al. Management of obesity. Lancet 2016; 387: 1947–1956.
8. Bray GA, Heisel WE, Afshin A, et al. The science of obesity management: an endocrine society scientific statement. Endocr Rev 2018; 39: 79–132.
9. Soetikno R, Kolb JM, Nguyen-Vu T, et al. Evolving endoscopy teaching in the era of the millennial trainee. Gastrointest Endosc 2019; 89: 1056–1062.
10. Bini E, Firoozi B, Choung RJ, et al. Systematic evaluation of complications related to endoscopy in a training setting: a prospective 30-day outcomes study. Gastrointest Endosc 2003; 57: 8–16.
11. Van Sickle KR, Buck L, Willis R, et al. A multicenter, simulation-based skills training collaborative using shared GI Mentor II systems: results from the Texas Association of Surgical Skills Laboratories (TASSL) flexible endoscopy curriculum. Surg Endosc 2011; 25: 2980–2986.
12. Buzink SN, Koch AD, Heemskerk J, et al. Acquiring basic endoscopy skills by training on the GI Mentor II. Surg Endosc 2007; 21: 1996–2003.
13. Cohen J, Cohen SA, Vora, et al. Multicenter, randomized, controlled trial of virtual-reality simulator training in acquisition of competency in colonoscopy. Gastrointest Endosc 2006; 64: 361–368.
14. Classen M and Ruppin H. Practical endoscopy training using a new gastrointestinal phantom. Endoscopy 1974; 6: 127–131.
15. Plooy AM, Hill A, Horswill MS, et al. Construct validation of a physical model colonoscopy simulator. Gastrointest Endosc 2012; 76: 144–150.
16. ASGE Technology Committee, Goodman AJ, Melson J, et al. Endoscopic simulators. Gastrointest Endosc 2019; 90: 1–12.
17. Hochberger J and Maiss J. Currently available simulators: ex vivo models. Gastrointest Endosc Clin N Am 2006; 16: 435–449.
18. Martinek J, Stefanova M, Suchanek S, et al. Training of different endoscopic skills on ex-vivo animal model. Simul Healthc 2014; 9: 112–119.
19. Martinek J, Suchanek S, Stefanova M, et al. Training on an ex vivo animal model improves endoscopic skills: a randomized, single-blind study. Gastrointest Endosc 2011; 74: 367–373.
20. Maiss J, Wiesnet J, Proeschel A, et al. Objective benefit of a 1-day training course in endoscopic hemostasis using the ‘compactEASIE’
endoscopy simulator. *Endoscopy* 2005; 37: 552–558.

21. Kim GH, Bang SJ and Hwang JH. Learning models for endoscopic ultrasonography in gastrointestinal endoscopy. *World J Gastroenterol* 2015; 21: 5176–5182.

22. Gerson LB and Van Dam J. Technology review: the use of simulators for training in GI endoscopy. *Gastroint Endosc* 2004; 60: 992–1001.

23. Khan R, Plahouras J, Johnston BC, et al. Virtual reality simulation training for health professions trainees in gastrointestinal endoscopy. *Cochrane Database Syst Rev* 2018; 8: CD008237.

24. Ekkelenkamp VE, Koch AD, de Man RA, et al. Training and competence assessment in GI endoscopy: a systematic review. *Gut* 2016; 65: 607–615.

25. Carter FJ, Schijven MP, Aggarwal R, et al. Consensus guidelines for validation of virtual reality surgical simulators. *Simul Healthc* 2006; 1: 171–179.

26. Mahmood T, Scaffidi MA, Khan R, et al. Virtual reality simulation in endoscopy training: current evidence and future directions. *World J Gastroenterol* 2018; 24: 5439–5445.

27. Bennett S, Gostimir M, Shorr R, et al. The role of routine intraoperative endoscopy in laparoscopic bariatric surgery. *Surg Endosc* 2002; 16: 1663–1665.

28. Parikh M, Liu J, Vieira D, et al. Preoperative endoscopy prior to bariatric surgery: a systematic review and meta-analysis. *Surg Obes Relat Dis* 2016; 12: 1116–1125.

29. Parikh M, Liu J, Vieira D, et al. Preoperative endoscopy prior to bariatric surgery: a systematic review and meta-analysis of the literature. *Obes Surg* 2016; 26: 2961–2966.

30. American Society for Gastrointestinal Endoscopy Standards of Practice Committee; Evans JA, Muthusamy VR, et al. The role of endoscopy in the bariatric surgery patient. *Gastroint Endosc* 2015; 29: 1007–1017.

31. Minhem MA, Safadi BY, Tamim H, et al. Does intraoperative endoscopy decrease complications after bariatric surgery? Analysis of American College of Surgeons National Surgical Quality Improvement Program database. *Surg. Endosc* 2019; 33: 3629–3634.

32. Champion JK, Hunt T and DeLisle N. Role of routine intraoperative endoscopy in laparoscopic bariatric surgery. *Surg Endosc* 2002; 16: 1663–1665.

33. Kim J, Azagury D, Eisenberg D, et al. ASMB position statement on prevention, detection, and treatment of gastrointestinal leak after gastric bypass and sleeve gastrectomy, including the roles of imaging, surgical exploration, and nonoperative management. *Surg Obes Relat Dis* 2015; 11: 739–748.

34. Kassir R, Kassir R, Deparaseval B, et al. Routine surveillance endoscopy before and after sleeve gastrectomy? *World J Gastroint Endosc* 2019; 11: 1–4.

35. Valli PV and Gubler C. Review article including treatment algorithm: endoscopic treatment of luminal complications after bariatric surgery. *Clin Obes* 2017; 7: 115–122.

36. Ferreira LEVV, Song LMK and Baron TH. Management of acute postoperative hemorrhage in the bariatric patient. *Gastroint Endosc Clin N Am* 2011; 21: 287–294.

37. Khoursheed M, Al-Bader I, Mouzannar A, et al. Postoperative bleeding and leakage after sleeve gastrectomy: a single-center experience. *Obes Surg* 2016; 26: 2944–2951.

38. Chang S-H, Freeman NLB, Lee JA, et al. Early major complications after bariatric surgery in the USA, 2003–2014: a systematic review and meta-analysis. *Obes Rev* 2018; 19: 529–537.

39. Souto-Rodríguez R and Alvarez-Sánchez M-V. Endoluminal solutions to bariatric surgery complications: a review with a focus on technical aspects and results. *World J Gastroint Endosc* 2017; 9: 105–126.

40. Donatelli G, Dumont JL, Cereatti F, et al. Treatment of leaks following sleeve gastrectomy by endoscopic internal drainage (EID). *Obes Surg* 2015; 25: 1293–1301.

41. Donatelli G and Cereatti F. ‘Double cut technique’ for endoscopic removal of eroded adjustable gastric band without previous surgical extraction of port and connection tube. *Surg Obes Relat Dis* 2019; 15: 342–344.

42. Feurer ME and Draganov PV. Training for advanced endoscopic procedures. *Best Pract Res Clin Gastroenterol* 2016; 30: 397–408.

43. Ponce J, Woodman G, Swain J, et al. The REDUCE pivotal trial: a prospective, randomized controlled pivotal trial of a dual intragastric balloon for the treatment of obesity. *Surg Obes Relat Dis* 2015; 11: 874–881.

44. Sullivan S, Swain JM, Woodman G, et al. 812d the Obalon Swallowable 6-month
balloon system is more effective than moderate intensity lifestyle therapy alone: results from a 6-month randomized sham controlled trial. Gastroenterology 2016; 150: S1267.

45. Dayyeh BKA, Eaton LL, Woodman G, et al. 444 a randomized, multi-center study to evaluate the safety and effectiveness of an intragastric balloon as an adjunct to a behavioral modification program, in comparison with a behavioral modification program alone in the weight management of obese subjects. Gastrointest Endosc 2015; 81: AB147.

46. Thompson CC, Abu Dayyeh BK, Kushner R, et al. Percutaneous gastrosomy device for the treatment of class II and class III obesity: results of a randomized controlled trial. Am J Gastroenterol 2017; 112: 447–457.

47. Sharaiha RZ, Kedia P, Kumta N, et al. Initial experience with endoscopic sleeve gastoplasty: technical success and reproducibility in the bariatric population. Endoscopy 2015; 47: 164–166.

48. Lopez-Nava G, Galvao M, Bautista-Castaño I, et al. Endoscopic sleeve gastropasty with 1-year follow-up: factors predictive of success. Endosc Int Open 2016; 4: E222–E227.

49. Lopez-Nava G, Sharaiha RZ, Vargas EJ, et al. Endoscopic sleeve gastropasty for obesity: a multicenter study of 248 patients with 24 months follow-up. Obesity Surgery 2017; 27: 2649–2655.

50. López-Nava G, Bautista-Castaño I, Jimenez A, et al. The primary obesity surgery endolumenal (POSE) procedure: one-year patient weight loss and safety outcomes. Surg Obes Relat Dis 2015; 11: 861–865.

51. Gys B, Plaek P, Lamme B, et al. Endoscopic gastric plication for morbid obesity: a systematic review and meta-analysis of published data over time. Obes Surg 2019; 29: 3021–3029.

52. Saumoy M, Schneider Y, Zhou XK, et al. A single-operator learning curve analysis for the endoscopic sleeve gastropasty. Gastrointest Endosc 2018; 87: 442–447.

53. Sharaiha RZ, Kumta NA, Saumoy M, et al. Endoscopic sleeve gastropasty significantly reduces body mass index and metabolic complications in obese patients. Clin Gastroenterol Hepatol 2017; 15: 504–510.

54. Hill C, Zein ME, Agnihotri A, et al. Endoscopic sleeve gastropasty: the learning curve. Endosc Int Open 2017; 5: E900–E904.

55. Mahawar KK, Himpens JM, Shikora SA, et al. The first consensus statement on revisional bariatric surgery using a modified Delphi approach. Gastrointest Endosc 2020; 34: 1648–1657.

56. Abu Dayyeh BK, Lautz DB and Thompson CC. Gastrojejunal stoma diameter predicts weight regain after Roux-en-Y gastric bypass. Clin Gastroenterol Hepatol 2011; 9: 228–233.

57. Brunaldi VO, Jirapinyo P, de Moura DTH, et al. Endoscopic treatment of weight regain following Roux-en-Y gastric bypass: a systematic review and meta-analysis. Obes Surg 2018; 28: 266–276.

58. Wexner SD, Eisen GM, Simmang C, et al. Principles of privileging and credentialing for endoscopy and colonoscopy. Gastrointest Endosc 2002; 55: 145–148.

59. ASGE Standards of Practice Committee, Faulx AL, Lightdale JR, et al. Guidelines for privileging, credentialing, and proctoring to perform GI endoscopy. Gastrointest Endosc 2017; 85: 273–281.

60. Acosta A, Streett S, Kroh MD, et al. White paper AGA: POWER – practice guide on obesity and weight management education, and resources. Clin Gastroenterol Hepatol 2017; 15: 631–649.e10.

61. Shahnazarian V, Ramai D and Sarkar A. Endoscopic bariatric therapies for treating obesity: a learning curve for gastroenterologists. Transl Gastroenterol Hepatol 2019; 4: 16.

62. Kumar N, Dayyeh BA, Dunkin BJ, et al. ABE/ASGE position statement on training and privileges for primary endoscopic bariatric therapies. Gastrointest Endosc 2020; 91: 1230–1233.

63. Jirapinyo P and Thompson CC. How to incorporate bariatric training into your fellowship program. Gastroenterology 2019; 157: 9–13.

64. GI Fellowship Program Information – American College of Gastroenterology, https://gi.org/trainees/gi-fellowship-program-information/

65. Banerjee S. Fellowship Programs, http://med.stanford.edu/gastrohepfellows/curriculum/Advanced-Endoscopy.html

66. Millette N. UAB – GI Fellowship – School of Medicine – Gastroenterology & Hepatology, https://www.uab.edu/medicine/gastroenterology/education/fellowship

67. Mayo Clinic College of Medicine & Science. Advanced Endoscopy Fellowship (Arizona), https://college.mayo.edu/academics/residencies-and-fellowships/advanced-endoscopy-fellowship-arizona/
68. Advanced Endoscopy Fellowship. Cedars-Sinai, https://www.cedars-sinai.org/education/graduate-medical/fellowship/endoscopy.html

69. Faculty Career Development in Advanced Endoscopy – Los Angeles – UCLA Digestive Diseases Interventional Endoscopy – CA, https://www.uclahealth.org/gastro/ies/advanced-endoscopy-fellowship

70. Advanced Endoscopy Fellowship – Gastroenterology, https://gastroenterology.ucsf.edu/advanced-endoscopy-fellowship

71. Gastroenterology Fellowship – Carilion Clinic, https://www.carilionclinic.org/gastroenterology-fellowship#about

72. Advanced Endoscopy Fellowship – Virginia Mason Seattle, http://www.virginiamason.org/advanced-endoscopy-fellowship

73. Website, http://www.medicine.wisc.edu/gastroenterology/advancedendoscopyfellowship

74. https://www.uvaphysicianresource.com/wp-content/uploads/2018/01/17-67806-Admin.-Intervent.-Endoscopy-Fact-Sheet-FINAL.pdf

75. Advanced Endoscopy Fellowship – Division of Gastroenterology, https://lsom.uthscsa.edu/gastroenterology/fellowship/advanced-endoscopy-fellowship/

76. Advanced Therapeutic Endoscopy Fellowship. MD Anderson Cancer Center, https://www.mdanderson.org/education-training/clinical-research-training/graduate-medical-education/residencies-fellowships/advanced-therapeutic-endoscopy.html

77. McGovern Medical School. Advanced Endoscopy Fellowship – McGovern Medical School, https://med.uth.edu/internalmedicine/gastroenterology-hepatology-and-nutrition/education/advanced-endoscopy-fellowship/

78. Advanced Endoscopy Fellowship. Baylor College of Medicine, https://www.bcm.edu/departments/medicine/sections-divisions-centers/gastroenterology-and-hepatology/education/advanced-endoscopy/

79. Advanced Endoscopy Fellowship, https://www.utsouthwestern.edu/education/medical-school/departments/internal-medicine/divisions/digestive-liver-diseases/fellowships/endoscopy-training.html

80. Advanced Endoscopy Fellowship – Department of Medicine, https://medicine.vumc.org/advanced-endoscopy-fellowship

81. Advanced Endoscopy Fellowship – Penn Medicine, https://www.pennmedicine.org/departments-and-centers/department-of-medicine/divisions/gastroenterology/education-and-training/fellowship-programs/advanced-endoscopy-fellowship

82. Fellowships – Philadelphia University + Thomas Jefferson University, https://www.jefferson.edu/university/skmc/departments/medicine/divisions/gastroenterology-hepatology-fellowships.html

83. Advanced Endoscopy Training Program, 2018, https://www.foxchase.org/research-training/education/advanced-endoscopy-training-program

84. Minimally Invasive and Bariatric Surgery Fellowship – Penn State College of Medicine Residencies and Fellowships, https://residency.med.psu.edu/programs/minimally-invasive-bariatric-surgery-fellowship/

85. Gastroenterology and Hepatology Fellowship – Penn State College of Medicine Residencies and Fellowships, https://residency.med.psu.edu/programs/gastroenterology-fellowship/#conferences

86. Advanced Endoscopy Fellowship – Graduate Medical Education – University Hospitals – Cleveland, OH – University Hospitals, https://www.uhospitals.org/medical-education/medicine-medical-education/gastroenterology-fellowship/advanced-endoscopy-fellowship

87. Advanced Endoscopy Fellowship – Cleveland Clinic, https://my.clevelandclinic.org/departments/digestive/medical-professionals/education/advanced-endoscopy-fellowship

88. Advanced Endoscopy Fellowship Program – Renaissance School of Medicine at Stony Brook University, https://renaissance.stonybrookmedicine.edu/medicine/gastroenterology/fellowship/interventional-endoscopy

89. Advanced Endoscopy Fellowship – NYU Langone Health, https://med.nyu.edu/departments-institutes/medicine/divisions/gastroenterology-hepatology/education/fellowships/advanced-fellowships/advanced-endoscopy-fellowship

90. Advanced Gastrointestinal Endoscopy Fellowship Training Program. Memorial Sloan Kettering Cancer Center, https://www.mskcc.org/hcp-education-training/fellowships/advanced-gastrointestinal-endoscopy-fellowship-training

91. Advanced – Endoscopy Fellowship – Icahn School of Medicine. Icahn School of Medicine at Mount Sinai, https://icahn.mssm.edu/education/residencies-fellowships/list/msh-advanced-endoscopy-fellowship/curriculum
92. Advanced Endoscopy Fellowship Program – NewYork-Presbyterian Brooklyn Methodist Hospital, https://www.nyp.org/brooklyn/medical-education/fellowship-training-programs/gastroenterology/advanced-endoscopy-fellowship

93. Gastroenterology Division – Duke Department of Medicine, https://medicine.duke.edu/divisions/gastroenterology/education-and-training/advanced-training/advanced-endoscopy-training

94. Gastroenterology > Internal Medicine – Residency Programs. Atrium Health, https://atriumhealth.org/education/graduate-medical-education/physician-fellowships/internal-medicine/Gastroenterology

95. Advanced Endoscopy Fellowship – Department of Medicine, https://www.med.unc.edu/medicine/gi/education/advanced-endoscopy-fellowship/

96. Advanced Endoscopy Fellowship Program – John T. Milliken Department of Medicine Division of Gastroenterology, https://gastro.wustl.edu/education/endoscopy-fellowship/

97. Mayo Clinic College of Medicine & Science. Advanced Endoscopy Fellowship (Minnesota), https://college.mayo.edu/academics/residencies-and-fellowships/advanced-endoscopy-fellowship-minnesota/

98. nivens. Advanced ERCP/EUS Fellowship. Department of Medicine – University of Minnesota, https://www.dom.umn.edu/divisions/gastroenterology-hepatology-and-nutrition/fellowship-programs/advanced-ercp-eus-fellowship/

99. Advanced Endoscopy Fellowship – Internal Medicine – Michigan Medicine. Internal Medicine, 2016, https://medicine.umich.edu/dept/intmed/divisions/gastroenterology-hepatology/education-training/fellowship-training-programs/advanced-endoscopy-fellowship.

100. Day JA. Advanced Endoscopy Fellowship Program – Johns Hopkins Division of Gastroenterology and Hepatology, 2017, https://www.hopkinsmedicine.org/gastroenterology-hepatology/education-training/advanced-endoscopy-fellowship-program.html

101. Advanced Endoscopy Fellowship. University of Massachusetts Medical School, 2017, https://www.umassmed.edu/gastro/advanced-endoscopy-fellowship/

102. Advanced Endoscopy Fellowship – Brigham and Women’s Hospital, https://www.brighamandwomens.org/medicine/gastroenterology-hepatology-and-endoscopy/advanced-endoscopy-fellowship

103. Advanced Endoscopy Fellowship – BIDMC of Boston, https://www.bidmc.org/medical-education/medical-education-by-department/medicine/medicine-fellowships/gastroenterology-fellowship/advanced-endoscopy-fellowship

104. Advanced Endoscopy Fellowship – Internal Medicine, http://internalmedicine.med.uky.edu/im-advanced-endoscopy-fellowship

105. Gastroenterology Fellowship – Internal Medicine – IU – School of Medicine. Indiana University School of Medicine https://medicine.iu.edu/departments/internal-medicine/specialties/gastroenterology-hepatology/education/fellowship/

106. jtran. Fellowship Program. Chicago Medicine, https://chicago.medicine.uic.edu/departments/academic-departments/medicine/gastroenterology-and-hepatology/fellowship-program-2/

107. Mayo Clinic College of Medicine & Science. Advanced Endoscopy Fellowship (Florida), https://college.mayo.edu/academics/residencies-and-fellowships/advanced-endoscopy-fellowship-florida/

108. Advanced Endoscopic Fellowship, http://medicine.emory.edu/digestive-diseases/education/advanced-endoscopic-fellowship.html#Advanced%20Endoscopic%20Fellowship

109. Advanced Endoscopy Program. Moffitt Cancer Center, https://moffitt.org/education/medical-education/residency-and-fellowship-programs/moffitt-fellowship-programs/advanced-gastroenterology/

110. Mayo Clinic College of Medicine & Science. Advanced Endoscopy Fellowship (Florida), https://college.mayo.edu/academics/residencies-and-fellowships/advanced-endoscopy-fellowship-florida/

111. 4th Year Advanced Endoscopy Fellowship Program, https://gastroenterology.ufl.edu/education/4th-year-advanced-endoscopy-fellowship/

112. Day JA. Advanced Endoscopy Fellowship Program – Sibley Memorial Hospital, 2017, https://www.hopkinsmedicine.org/gastroenterology_hepatology/education_
113. Advanced Endoscopy Fellowship. Digestive Diseases, https://medicine.yale.edu/intmed/digestivediseases/training/advanced-endoscopy-fellowship/

114. Therapeutic Endoscopy Fellowship Program – Department of Medicine – University of Colorado Denver, http://www.ucdenver.edu/academics/colleges/medicalschool/departments/medicine/Gastroenterology/Fellowship/Pages/TherapeuticEndoscopyFellowshipProgram.aspx

115. Fellowship Council – Directory of Fellowships, https://fellowshipcouncil.org/directory-of-fellowships/?match=1

116. https://fellowshipcouncil.org/wp-content/uploads/2012/02/Bariatric-Surgery1.pdf

117. https://fellowshipcouncil.org/wp-content/uploads/2012/02/Flexible-Endoscopy1.pdf

118. User S. IFSO 2019 – IFSO Advanced Training Center, 2019, https://www.ifso2019.com/index.php/program/bariatric-metabolic-simulation-center

119. Madrid International Bariatric Endoscopy Meeting. invivox.com, https://invivox.com/training/detail/950

120. https://www.asge.org/docs/default-source/education/courses/bariatric-course-brochure.pdf

121. 7th Annual Flexible Endoscopic Surgery and Bariatric Endoscopy Course, https://fesconference.com/

122. HITEC (Hopkins International Therapeutic Endoscopy Course). invivox.com, https://invivox.com/training/detail/1312

123. Flexible Endoscopic Surgery and Bariatric Endoscopy Course 2018 via the SAGES Surgical Calendar. SAGES, https://www.sages.org/meetings/calendar/event/flexible-endoscopic-surgery-and-bariatric-endoscopy-course-2018/

124. Vassiliou MC, Dunkin BJ, Fried GM, et al. Fundamentals of endoscopic surgery: creation and validation of the hands-on test. Surg Endosc 2014; 28: 704–711.

125. Specialties / Course calendar – IRCAD France, https://www.ircad.fr/training-center/course-calendar/

126. COURS – IHU Strasbourg, https://www.ihtu-strasbourg.eu/education/formation-continue/cours/

127. webmaster. Surgical Endoscopy – EVE, https://mse.eve-evolving-education.eu/courses

128. Soetikno R, Asokkumar R, Chin YK, et al. Rapid and safe crossing of the chasm: application of a flipped learning framework for the clipping over the scope technique. Gastrointest Endosc Clin N Am 2020; 30: 99–106.

129. Rubino F. From bariatric to metabolic surgery: definition of a new discipline and implications for clinical practice. Curr Atheroscler Rep 2013; 15: 369.

130. van Baar ACG, Holleman F, Crenier L, et al. Endoscopic duodenal mucosal resurfacing for the treatment of type 2 diabetes mellitus: one year results from the first international, open-label, prospective, multicentre study. Gut 2020; 69: 295–303.

131. Glass J, Chaudhry A, Zeeshan MS, et al. New era: endoscopic treatment options in obesity—a paradigm shift. World J Gastroenterol 2019; 25: 4567–4579.

132. Machytka E, Bužga M, Zonca P, et al. Partial jejunal diversion using an incisionless magnetic anastomosis system: 1-year interim results in patients with obesity and diabetes. Gastrointest Endosc 2017; 86: 904–912.

133. Watanabe R, Barberio M, Kanaji S, et al. Hybrid fluorescent magnetic gastrojejunostomy: an experimental feasibility study in the porcine model and human cadaver. Surg Endosc 2020; 34: 1393–1400.

134. Weiss CR, Abiola GO, Fischman AM, et al. Bariatric embolization of arteries for the treatment of obesity (BEAT obesity) trial: results at 1 year. Radiology 2019; 291: 792–800.

135. Midulla M, Pescatori L, Chevallier O, et al. Future of IR: emerging techniques, looking to the future . . . and learning from the past. J Belg Soc Radiol 2019; 103: 12.