

## Chapter

# Advanced Endobariatric Therapies for the Management of Bariatric Surgery Complications

*Michail Koutentakis, Aman Goyal, Manoel Galvão Neto, Benjamin L. Clapp, Athanasios G. Pantelis, Chetan Parmar, Juan Santiago Azagra, Beniamino Pascotto, Edmundo Inga-Zapata, Abhirami Babu, Safwan Taha, Adel Abou-mrad, Mehmet Mahir Ozmen, Adolfo Pérez-Bonet and Rodolfo J. Oviedo*

## Abstract

Metabolic and bariatric surgery (MBS) remains the most effective treatment for severe obesity and metabolic comorbidities, offering durable weight loss and superior outcomes compared with non-surgical approaches. However, despite operative refinements, enhanced recovery pathways, and perioperative optimization, complications can arise early or years postoperatively. These range from anastomotic leaks, intraluminal bleeding, strictures, marginal ulcers, perforations, and fistulas to functional disorders such as dumping syndrome and recurrent weight gain (RWG). Managing these challenges requires prompt diagnosis, multidisciplinary evaluation, and a stepwise, individualized treatment strategy. Endobariatric therapy has emerged as a vital component of bariatric care, serving both as a primary metabolic intervention and as an effective rescue platform. Modern therapeutic endoscopic techniques, including tissue apposition systems, pneumatic dilation, septotomy, stricture disruption, fully covered self-expanding metal stents (SEMS), over-the-scope clips (OTSC), endoscopic internal drainage (EID), transoral outlet reduction (TORe), endoscopic sleeve revision, and endoluminal remodeling, provide high precision, safety, and durability, often preserving altered anatomy while averting morbid revisional surgery. This chapter reviews current evidence, rescue maneuvers, and clinical protocols for managing post-MBS complications, emphasizing treatment sequencing, candidate selection, and decision-making in high-risk patients. Furthermore, it highlights the expanding role of artificial intelligence (AI), robotic-assisted endoscopy, standardized staging pathways, and predictive modeling in enhancing procedural planning, durability, and safety. As these innovations advance, endobariatrics is transitioning from an adjunct modality to a fundamental pillar of comprehensive bariatric practice, redefining modern standards of care.

**Keywords:** endobariatrics, surgery, management, therapeutic, complications

## **Strengths of this review**

This review has several notable strengths. First, it provides a comprehensive and contemporary overview of endobariatric therapies across the full spectrum of complications encountered after metabolic and bariatric surgery (MBS), encompassing acute, intermediate, and late presentations. Unlike reviews focused on individual complications or isolated endoscopic techniques, this chapter integrates structural, functional, and metabolic complications within a unified clinical framework.

Second, the review adopts a mechanism-based approach to complication classification and management. By organizing complications according to underlying pathophysiology rather than procedure-specific presentation alone, the chapter offers a practical framework that aligns diagnostic evaluation, endoscopic intervention, and surgical escalation with the biological processes driving disease progression.

Third, the chapter synthesizes evidence from systematic reviews, meta-analyses, large observational cohorts, expert consensus statements, and contemporary practice guidelines, providing a broad and clinically relevant assessment of current endobariatric practice. Particular emphasis is placed on evidence supporting drainage-based strategies, endoscopic vacuum therapy (EVT), luminal remodeling procedures, and anatomy-preserving interventions that increasingly influence modern bariatric care pathways.

Fourth, the chapter incorporates clinically applicable treatment algorithms and escalation pathways that translate heterogeneous evidence into structured decision-making tools. These algorithms emphasize patient stability, source control, mechanism-specific therapy, and predefined thresholds for surgical intervention, reflecting real-world multidisciplinary practice in high-volume bariatric centers.

Finally, the review extends beyond current practice by discussing emerging developments, including artificial intelligence, predictive analytics, robotic-assisted therapeutic endoscopy, and protocol-driven care models. This forward-looking perspective provides readers with insight into future directions likely to influence the evolution of endobariatric management and the integration of minimally invasive technologies into comprehensive bariatric care.

## **1. Introduction**

Metabolic and bariatric surgery (MBS) represents the most effective long-term treatment for severe obesity and obesity-related metabolic diseases, with sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), and one anastomosis gastric bypass (OAGB) accounting for the top three procedures performed worldwide. Despite ongoing refinements in surgical technique, perioperative care, and patient selection, postoperative complications remain an inherent part of bariatric practice and continue to contribute substantially to morbidity, prolonged hospitalization, and the need for revisional intervention. These complications are particularly challenging because they arise in altered gastrointestinal (GI) anatomy, often in patients with limited physiological reserve, where delayed recognition or suboptimal sequencing of therapy can rapidly escalate localized pathology into systemic illness

[1]. The clinical spectrum ranges from early staple-line or anastomotic leaks and postoperative bleeding to intermediate and late complications such as strictures, fistulae, marginal ulceration, and perforation, as well as functional sequelae including dumping syndrome and recurrent weight gain (RWG) [2].

There has been a shift toward endoscopic management of post-bariatric complications, driven by the ability to achieve earlier, less invasive source control in hemodynamically stable patients. The expansion of endobariatric therapies has been complementary to traditional surgical therapy, allowing for less invasive methods to treat complications. This paradigm was articulated by Eisendrath and Deviere, who positioned endoscopy as first-line therapy for major complications such as leaks and strictures in stable patients, with surgery reserved for hemodynamic instability, diffuse peritonitis, or failure of endoscopic therapy [3]. Subsequent reviews have reinforced this approach, emphasizing the ability of endoscopic intervention to prevent or delay revisional surgery while preserving bariatric anatomy [1, 4].

This transition has been driven in large part by advances in therapeutic endoscopy. Early endoscopic management of post-bariatric leaks relied on fully or partially covered self-expandable metal stents (SEMS), which demonstrated acceptable closure rates but were limited by migration, the need for repeated interventions, and incomplete control of associated collections. Meta-analyses confirm these trade-offs, with pooled leak closure rates approaching 88%–92% and migration rates of 17%–23%, underscoring the limitations of stent monotherapy [5, 6]. These limitations have forced a reevaluation of leak management, shifting practice away from isolated luminal closure toward strategies that simultaneously address closure and drainage.

This evolution is reflected in the widespread adoption of endoscopic internal drainage (EID) and, more recently, endoscopic vacuum therapy (EVT). Large single-center series have demonstrated that EID, in selected cases, using double-pigtail stents with or without endoscopic ultrasound-guided drainage, achieves high clinical success in leaks, fistulae, and collections after SG, with low recurrence and acceptable adverse event rates, supporting its use as first-line therapy in stable patients [7]. Contemporary reviews emphasize that these modalities function as complementary components of a multimodal, mechanism-driven strategy rather than competing techniques [2, 8].

Late functional complications following RYGB, including dumping syndrome and RWG, further illustrate the expanding role of endobariatrics. Transoral outlet reduction (TORe) has been validated by systematic reviews and meta-analyses, demonstrating meaningful improvements in weight-related outcomes and dumping symptoms with acceptable safety, supporting its role as an alternative to surgical revision in appropriately selected patients [9, 10].

The aim of this chapter is to provide a structured, clinically applicable overview of advanced endobariatric therapies for the management of surgical complications following MBS. By classifying complications according to timing and mechanism, outlining a stepwise diagnostic approach, and integrating current evidence into complication-specific strategies, we seek to clarify how endoscopic and surgical interventions can be sequenced rather than opposed. Emphasis is placed on practical decision-making, preservation of bariatric anatomy, and realistic thresholds for escalation to operative management, reflecting contemporary endobariatric practice.

## 2. Methodology

### 2.1 Search strategy and literature identification

This chapter was developed as a comprehensive narrative review of contemporary endobariatric therapies for the management of complications following MBS. A structured literature search was performed to identify relevant evidence regarding the diagnosis, classification, endoscopic management, and surgical treatment of post-bariatric complications.

Electronic database searches were conducted in PubMed/MEDLINE, Embase, Scopus, and Google Scholar from database inception through January 2026. Search terms were developed using combinations of Medical Subject Headings (MeSH) and free-text keywords related to bariatric surgery, endoscopy, and postoperative complications. Representative search terms included:

*“bariatric surgery complications,” “sleeve gastrectomy leak,” “gastric bypass complications,” “endoscopic management,” “endobariatrics,” “endoscopic internal drainage,” “endoscopic vacuum therapy,” “covered stents,” “over-the-scope clip,” “endoscopic suturing,” “transoral outlet reduction,” “weight regain after bariatric surgery,” “dumping syndrome,” “revisional bariatric surgery,” and “therapeutic endoscopy.”*

### 2.2 Eligibility criteria

Studies were considered eligible if they addressed:

- (1) Diagnostic evaluation of complications following SG, RYGB, OAGB, or other established bariatric procedures.
- (2) Endoscopic management of postoperative complications, including:
  - Anastomotic and staple line leaks
  - GI fistulae
  - Strictures and stenoses
  - Postoperative bleeding
  - Marginal ulceration
  - Dumping syndrome
  - RWG
- (3) Comparative studies evaluating endoscopic and surgical management strategies.

- (4) Emerging technologies, including robotic-assisted therapeutic endoscopy, artificial intelligence applications, predictive analytics, and advanced endoluminal reconstruction techniques.

The review included randomized controlled trials, prospective and retrospective cohort studies, registry analyses, systematic reviews, meta-analyses, clinical practice guidelines, consensus statements, and landmark technical reports.

Case reports, small case series lacking generalizable conclusions, conference abstracts without full publication, non-English publications lacking adequate translation, and studies focused exclusively on primary bariatric procedures without relevance to complication management were excluded.

### **2.3 Evidence selection and prioritization**

Preference was given to:

- Systematic reviews and meta-analyses
- Multicenter studies
- Large prospective cohorts
- International consensus statements
- Society guidelines from organizations including the American Society for Gastrointestinal Endoscopy (ASGE), the American Society for Metabolic and Bariatric Surgery (ASMBS), the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), and the European Society of Gastrointestinal Endoscopy (ESGE).

When multiple studies addressed the same intervention, the most contemporary and methodologically robust evidence was prioritized. Landmark studies that influenced the evolution of endobariatric practice were included, irrespective of the publication date.

### **2.4 Data extraction and evidence synthesis**

Relevant studies were reviewed independently by the authors, and data were extracted regarding:

- Study design
- Patient population
- Type of bariatric procedure
- Nature of complication
- Endoscopic intervention performed

- Technical success
- Clinical success
- Adverse events
- Need for revisional surgery
- Long term outcomes

The extracted data were synthesized using a narrative approach because of significant heterogeneity among study designs, patient populations, intervention protocols, outcome definitions, and follow-up durations.

## **2.5 Development of management algorithms**

The diagnostic pathways, treatment algorithms, and escalation frameworks presented in this chapter were developed through the synthesis of the available evidence and the integration of contemporary expert practice patterns reported in high-volume bariatric and therapeutic endoscopy centers.

Algorithm construction emphasized:

- Patient stability
- Mechanism of failure
- Source control principles
- Preservation of bariatric anatomy
- Endoscopic salvage potential
- Objective thresholds for surgical escalation

Whenever evidence was limited or heterogeneous, recommendations were formulated according to recurring themes identified across systematic reviews, expert consensus documents, and large institutional experiences.

## **2.6 Limitations of the review methodology**

This chapter represents a narrative evidence synthesis rather than a formal systematic review or meta-analysis. Consequently, quantitative pooling of outcomes was not performed, and the conclusions are influenced by the quality and heterogeneity of the available literature. Nevertheless, emphasis was placed on high-level evidence and contemporary publications to provide a balanced and clinically relevant overview of current endobariatric practice.

### **3. Classification of complications**

Complications following MBS are heterogeneous in presentation, severity, and the underlying mechanism. Their management depends on both when they occur and what pathophysiologic process is responsible. A clinically useful classification needs to support real-time decision-making, the suitability for endoscopic intervention, and thresholds for surgical escalation. For this reason, complications are best classified using two complementary frameworks: timing of presentation and mechanism of failure, with the explicit inclusion of functional and metabolic sequelae that increasingly fall within the scope of endobariatric management [1, 2].

#### **3.1 Classification by timing**

Temporal classification is clinically relevant because tissue characteristics, risk of contamination, and the effectiveness of endoscopic versus surgical strategies change over time. Early complications, typically occurring within the first 30 postoperative days, include staple-line or anastomotic leaks, postoperative bleeding, and acute obstruction, which often present with tachycardia, sepsis, abdominal pain, or intolerance of oral intake [11]. During this period, tissues are inflamed and friable, fluid collections may be immature, and patients may deteriorate rapidly. As a result, management decisions are heavily influenced by hemodynamic stability and the presence or absence of generalized peritonitis. In stable patients, early endoscopic intervention is increasingly favored to achieve rapid source control while avoiding high-risk reoperation, whereas surgery remains mandatory in the setting of instability or diffuse contamination [12, 13].

Intermediate complications, presenting between one and three months after surgery, include contained leaks, evolving fistulae, developing strictures, and marginal ulceration. At this stage, fluid collections are often organized, and fistulous tracts are more clearly defined and frequently identified on imaging. This improves the feasibility and effectiveness of advanced endobariatric interventions. The risk-benefit balance during this period often favors endoscopic strategies, such as internal drainage or vacuum therapy, particularly in patients with persistent symptoms despite initial conservative measures [7, 14].

Late complications occur from months to years after the index procedure and include refractory strictures, chronic fistulae, gastrogastic fistulas (GGF), dumping syndrome, and RWG. These presentations are rarely emergent but can significantly impair quality of life (QoL) and long-term outcomes, including persistent GI symptoms (e.g., dysphagia, reflux), nutritional deficiencies, and the need for repeated interventions or hospital readmission, and are therefore typically managed through structured outpatient evaluation rather than acute admission. Importantly, late complications increasingly fall within the scope of endobariatrics as an initial management strategy when functional failure predominates over structural disruption, allowing symptom control and physiologic recalibration while preserving existing anatomy. Nevertheless, surgical revision remains the definitive treatment when endoscopic therapy fails, when anatomy is no longer amenable to endoluminal correction, or when symptoms persist despite mechanism-targeted intervention, underscoring the complementary rather than substitutive role of endoscopic therapy in late complication management [9, 10, 15].

### **3.2 Classification by mechanism**

Mechanism-based classification determines the choice of therapeutic modality, as endoscopic tools are inherently mechanism-specific. Structural disruptions, including leaks, perforations, and fistulae, represent failures of tissue integrity and require strategies that combine defect control with effective drainage, particularly when associated with extraluminal collections. Accumulating evidence supports approaches that prioritize internal drainage and cavity management rather than isolated luminal closure, especially after SG, where large clinical series demonstrate high success rates with EID as first-line therapy in stable patients [16].

Luminal narrowing and obstruction constitute a distinct mechanistic category and most commonly present as strictures or functional sleeve stenosis, typically manifesting as progressive dysphagia, vomiting, or food intolerance. Endoscopic balloon dilation (EBD) is supported by robust evidence as a first-line therapy, with meta-analytic data demonstrating high clinical success and low rates of severe adverse events when performed in a graded and repeatable manner [17]. Differentiating fixed fibrotic strictures from functional narrowing is essential, as functional stenosis often responds to repeated dilation, whereas fibrotic disease may require alternative endoscopic strategies or surgical revision, informing decisions regarding escalation beyond dilation [18].

Hemorrhagic complications, marginal ulceration, and refractory ulcers represent mucosal or vascular pathology rather than primary mechanical failure and often present with overt or occult GI bleeding, pain, or anemia. In this setting, endoscopy serves a dual diagnostic and therapeutic role, enabling hemostasis, ulcer-directed therapy, assessment of ischemia, and exclusion of associated fistulization. Endoscopic and endobariatric therapies, including injection therapy, thermal coagulation, clipping, oversewing, and adjunctive luminal remodeling when indicated, may achieve symptom control and ulcer healing in selected patients, with surgical intervention reserved for refractory disease, perforation, or uncontrolled bleeding [19].

### **3.3 Functional and metabolic complications**

Functional and metabolic complications, including dumping syndrome and RWG after RYGB, represent disturbances in postoperative physiology rather than failures of tissue integrity and are typically identified during structured long-term follow-up rather than acute postoperative assessment [20, 21]. These conditions often evolve gradually and may be influenced by factors such as adaptive anatomical changes, dietary patterns, and patient-specific metabolic responses, making their recognition dependent on longitudinal evaluation rather than emergent presentation.

As a result, functional complications occupy a distinct position within post-bariatric care pathways, requiring coordination between surgical teams, endoscopists, nutrition specialists, and metabolic clinicians. Their inclusion within endobariatric classification highlights a broader shift toward managing obesity as a chronic condition, where iterative, minimally invasive interventions may be necessary over time. Within this framework, endoscopic revision techniques have gained relevance as structured interventions aimed at restoring balance rather than correcting discrete

| Timing                    | Mechanism                  | Representative complications                                           | Typical clinical context                                        | Key reference(s) |
|---------------------------|----------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------|------------------|
| Early (< 30 days)         | Structural failure         | Staple-line leak (SG), anastomotic leak (RYGB), postoperative bleeding | Tachycardia, sepsis, abdominal pain, intolerance to oral intake | [1, 3]           |
| Early (< 30 days)         | Luminal compromise         | Acute obstruction, twist, or kinking of the sleeve                     | Persistent vomiting, inability to tolerate liquids              | [12, 24]         |
| Intermediate (1–3 months) | Contained disruption       | Contained leak, evolving fistula, perigastric collection               | Low-grade sepsis, abscess on CT, persistent symptoms            | [7, 25]          |
| Intermediate (1–3 months) | Luminal narrowing          | Anastomotic stricture, functional sleeve stenosis                      | Progressive dysphagia, food intolerance                         | [17, 18]         |
| Late (> 3 months)         | Chronic structural failure | Chronic fistula, GGF                                                   | Recurrent infection, reflux, RWG                                | [1, 6]           |
| Late (> 3 months)         | Functional failure         | Dumping syndrome, RWG                                                  | Hypoglycemia, diarrhea, loss of satiety                         | [2, 9]           |

**Table 1.**  
*Classification of post-bariatric surgical complications according to timing and dominant pathophysiological mechanism, with representative clinical presentations relevant to endobariatric decision-making.*

anatomic defects. Notably, not all cases of post-RYGB dumping syndrome can be effectively addressed by endoscopic revision, and therapeutic response to TORe is closely linked to the presence of a dilated gastrojejunal (GJ) anastomosis. Systematic reviews and meta-analyses demonstrate that TORe is most effective in carefully selected patients with functional failure associated with an enlarged anastomotic diameter, leading to significant improvement in dumping symptoms and meaningful weight stabilization with acceptable safety profiles [22, 23].

**Table 1** summarizes this classification by integrating timing, mechanism, representative complications, and typical clinical context relevant to endobariatric management.

#### 4. Diagnostic evaluation

Accurate and timely diagnostic evaluation is a prerequisite for the safe application of endobariatric techniques following MBS. In contrast to primary bariatric procedures, postoperative complications arise in altered GI anatomy, where clinical signs may be attenuated, radiologic findings can be equivocal, and delays in diagnosis may rapidly limit minimally invasive options. Importantly, variability in diagnostic pathways across institutions remains substantial, with some centers reserving endoscopy for late or salvage scenarios. This heterogeneity contributes directly to differences in outcomes and highlights the need for a standardized, stepwise diagnostic workflow that aligns clinical assessment, imaging, and endoscopic evaluation into a coordinated process [26].

In this chapter, diagnostic evaluation is structured as a progressive sequence consisting of clinical suspicion, contrast-enhanced computed tomography (CT), and endoscopic assessment. Endoscopy may serve a diagnostic role and/or

a therapeutic role. This embodies the practical reality of post-bariatric care, where timely endoscopic involvement often determines whether a complication can be managed endoluminally or progresses to require operative intervention. Endoscopy is, therefore, considered an active component of early evaluation in selected patients rather than a confirmatory test used after the failure of other modalities.

#### **4.1 Clinical suspicion and initial assessment**

The diagnostic process begins with the recognition of clinical features suggestive of post-bariatric complications, which may differ significantly from presentations in patients with unaltered anatomy. Early warning signs include tachycardia, fever, abdominal pain, intolerance of oral intake, GI bleeding, or unexplained sepsis, particularly in the early postoperative period. However, symptoms may be subtle or nonspecific. This is especially true after SG, where leaks can remain partially contained and systemic manifestations delayed. Persistent deviation from an expected postoperative course should, therefore, prompt early investigation, even in the absence of overt peritoneal signs [27].

Initial assessment must prioritize physiologic stability and identification of patients who require immediate operative intervention. Hemodynamic instability, diffuse peritonitis, or rapid clinical deterioration mandate urgent surgical exploration and preclude endobariatric management. In contrast, patients who are clinically stable without signs of generalized contamination are candidates for structured diagnostic evaluation and potential endoscopic intervention. Early distinction between these groups is critical, as it directly influences both diagnostic sequencing and the feasibility of minimally invasive rescue strategies [28].

#### **4.2 Role of cross-sectional imaging**

Once clinical suspicion is established, cross-sectional imaging represents the cornerstone of diagnostic evaluation. Contrast-enhanced CT with oral and intravenous (IV) contrast is the preferred modality, as it allows comprehensive assessment of staple-line or anastomotic integrity, extraluminal collections, abscess formation, bleeding, obstruction, and ischemic changes [29].

Upper GI contrast studies may be used selectively but have limited sensitivity for contained leaks and extraluminal pathology and should not delay cross-sectional imaging when clinical suspicion is high. From a surgical perspective, imaging findings should be interpreted not only diagnostically but also strategically, helping to determine whether a patient is best served by endoscopic evaluation, percutaneous intervention, or operative management. In this sense, imaging functions as a triage tool that informs downstream diagnostic and therapeutic decisions rather than a definitive endpoint in itself [12].

#### **4.3 Diagnostic and therapeutic endoscopy**

Endoscopy plays a central and often decisive role in the evaluation of post-MBS complications and may function as a diagnostic modality, a therapeutic intervention,

or both within the same procedure. In stable patients, early endoscopic assessment provides direct visualization of staple lines, anastomoses, luminal narrowing, ulceration, and bleeding sources – information that complements and often clarifies radiologic findings. Importantly, endoscopy allows immediate escalation to therapy when appropriate, reducing delays to definitive intervention [30].

In suspected leaks or fistulae, endoscopy enables precise characterization of defect size, location, tissue viability, and communication with extraluminal cavities – parameters that cannot be reliably inferred from imaging alone. In cases of hemorrhage or marginal ulceration, endoscopy permits targeted hemostasis and assessment of mucosal ischemia, frequently obviating the need for operative exploration [19].

Critically, delaying endoscopy until after the failure of conservative or radiologic measures may unnecessarily prolong morbidity and reduce the effectiveness of endobariatric strategies. Evidence synthesized in multiple reviews supports early endoscopic involvement once instability and diffuse peritonitis have been excluded, emphasizing its role in diagnostic clarification and treatment sequencing rather than as a last-resort intervention [31, 32].

#### **4.4 Integrating diagnostics into a stepwise pathway**

Cross-sectional imaging defines the presence, extent, and organization of extraluminal pathology, while early endoscopy in clinically stable patients without diffuse peritonitis assesses luminal anatomy, tissue viability, and the feasibility of endoluminal intervention. This combined assessment allows early differentiation between complications suitable for endoscopic management and those requiring surgical escalation, supports prompt source control, and preserves future surgical options when revision becomes necessary [33].

### **5. Endoscopic treatment modalities**

From a surgical perspective, endoscopic therapies should be viewed neither as substitutes for operative management nor as rescue options after the failure of surgery, but rather as complementary instruments capable of addressing specific failure modes while preserving altered anatomy [34, 35].

#### **5.1 Tissue apposition and closure techniques**

Tissue apposition techniques are designed to achieve direct approximation of luminal defects and are most effective when applied to small, well-circumscribed disruptions in the setting of preserved tissue viability. Over-the-scope clips (OTSC) represent the most established modality in this category, providing full-thickness mechanical compression capable of sealing acute leaks or perforations when surrounding tissue remains healthy. Their relative ease of deployment and immediate visual confirmation of closure make them particularly attractive in early postoperative presentations and iatrogenic perforations identified promptly [36].

From a surgical perspective, however, the limitations of closure-based strategies must be clearly acknowledged. OTSC and similar devices do not address extraluminal contamination, cavity formation, or ongoing inflammatory processes and are therefore prone to failure when used in isolation in the presence of associated collections. Multiple clinical series have demonstrated reduced effectiveness of OTSC in chronic leaks, fistulae, or inflamed tissue beds, where premature closure may seal infected spaces and lead to persistent sepsis, delayed breakdown, or fistula chronicity [6, 37]. In addition, retained or misplaced closure devices may complicate subsequent revisional surgery by obscuring tissue planes, distorting local anatomy, or interfering with safe dissection and stapling. This modality needs to be complemented by radiological drainage of sepsis for better outcomes.

Consequently, the role of tissue apposition has evolved from primary definitive therapy toward strategic reinforcement within multimodal endoscopic management. In current practice, closure devices are most often applied after adequate source control has been achieved through drainage-based strategies or vacuum therapy, serving to reinforce healing rather than force it. When used judiciously and within the appropriate biological context, tissue apposition remains a valuable component of the endobariatric toolbox; when applied indiscriminately, it exemplifies the limitations of technique-driven intervention divorced from underlying pathophysiology [38, 39].

## **5.2 Endoscopic suturing systems**

Endoscopic suturing systems extend the principles of tissue apposition by enabling controlled, customizable tissue approximation, reinforcement, and luminal remodeling. Unlike clip-based devices, suturing allows adjustment of tension, orientation, and depth, which facilitates the closure of larger defects and functional modifications, such as anastomotic reduction. These capabilities have positioned suturing platforms as central tools in both defect management and endoscopic revision procedures, particularly in post-bariatric anatomy, where flexibility and precision are required [40, 41].

From a surgical reasoning standpoint, endoscopic suturing should be approached with the same discipline applied to laparoscopic suturing. Technical success depends on adequate exposure, favorable tissue quality, and operator experience, with outcomes closely linked to case volume and technical proficiency. Multiple series have demonstrated that suturing in inflamed, ischemic, or heavily fibrotic tissue is associated with early failure and limited durability, emphasizing that suturing should not be used to compensate for inadequate source control or unfavorable biological conditions [42].

In experienced hands, suturing systems function as precision instruments that allow nuanced intervention beyond the capabilities of clips or stents. Their greatest value lies not in replacing other modalities, but in enabling targeted refinement once biological conditions are favorable, such as reinforcing healed defects or restoring restrictive physiology during revision procedures. This reinforces the principle that, in endobariatric therapy, timing and context are as critical as technical capability – a concept consistently emphasized in bariatric revision literature [43, 44].

### 5.3 Stent-based therapies

Covered SEMS are designed to exclude luminal defects and divert enteric flow, thereby reducing intraluminal pressure and facilitating mucosal healing. Stents have been widely used in the management of leaks following SG and anastomotic complications after RYGB, particularly in settings where rapid luminal diversion is required. Their ability to provide immediate coverage has historically positioned them as first-line endoscopic tools in acute postoperative presentations [5].

An example of endoscopic stent placement for luminal diversion in the setting of an acute gastric pouch leak is shown in **Video 1**, demonstrating principles of defect exclusion, pressure reduction, and temporary stabilization as part of a multimodal management treatment construct.

Despite these advantages, stent therapy is associated with well-recognized limitations, including migration, patient intolerance, need for repeated interventions, and incomplete control of extraluminal contamination. Meta-analyses and large clinical series have consistently demonstrated that while stents achieve acceptable rates of defect coverage, migration remains common, and resolution is often incomplete when associated collections are not addressed. Importantly, stents do not actively treat extraluminal cavities, and reliance on luminal exclusion alone may result in delayed healing or progression to chronic fistulization [45, 46].

As a result, the role of stents within endobariatric practice has undergone significant reassessment. In current practice, SEMS are increasingly employed as temporary adjuncts rather than definitive solutions, frequently combined with drainage-based strategies to achieve effective source control. Their primary value lies in controlled diversion during early stabilization rather than long-term defect management, underscoring the importance of careful patient selection and predefined plans for stent removal or escalation when healing fails to progress as expected [47].

#### Endoscopic Treatment of Gastric Pouch Chronic Leak from RYGB with Partially Covered Stent after Redo HHR

Student Dr. Pedro Vega; Juan E. Zubillaga G., MD; Abhishek Thapa, MBBS; Student Dr. Monzer Alatrach; Michail Koutentakis, MD; Student Dr. Tara Sheets; Student Dr. Jason Park; Aman Goyal, MBBS, MS; Rodolfo J. Oviedo, MD, FACS, FRCS, FICS, FASMB, DABS-FPDMBS



#### Video 1.

*Endoscopic treatment of a gastric pouch leak from RYGB with a partially covered SEMS after redo hiatal hernia repair (HHR).*

## **5.4 Drainage-based strategies**

Drainage-based endoscopic therapies represent a fundamental shift in the management of post-bariatric leaks and fistulae by prioritizing effective source control over immediate luminal closure. EID, most commonly achieved using double-pigtail plastic stents, facilitates continuous drainage of extraluminal collections into the GI lumen, promoting gradual cavity collapse and resolution of sepsis. Multiple series have demonstrated that this approach is particularly effective in clinically stable patients with localized collections following SG, where controlled internal drainage allows healing to proceed without the risks associated with premature closure [7, 48].

EVT further expands drainage-based management by applying controlled negative pressure to infected cavities, thereby promoting granulation tissue formation, cavity contraction, and progressive defect resolution. It has shown particular value in larger cavities, chronic fistulae, and stent-refractory cases, where other endoscopic strategies have failed or are unlikely to succeed. Systematic reviews and large clinical series consistently report high clinical success rates, albeit with the requirement for repeated endoscopic exchanges and close clinical monitoring, underscoring the need for institutional expertise and patient adherence [49].

From a surgical perspective, drainage-based strategies align closely with established principles of managing infected spaces. Rather than forcing premature closure in hostile biological environments, these techniques, including endoscopic and interventional radiology (IR)-guided drainage, allow inflammation to subside and tissue planes to mature, transforming uncontrolled pathology into a staged and manageable clinical course. Their widespread adoption across high-volume centers marks one of the most significant conceptual advances in endobariatric care and has fundamentally reshaped treatment algorithms for post-bariatric leaks and fistulae [6, 50].

## **5.5 Pneumatic dilation for luminal narrowing**

Pneumatic and balloon dilation remain the cornerstone of endoscopic management for luminal narrowing, including strictures and functional sleeve stenosis. The goal of dilation is the restoration of luminal patency through controlled radial expansion, relieving obstructive symptoms while minimizing the risk of perforation. When performed in a graded and repeatable manner, dilation achieves high rates of symptom resolution in appropriately selected patients [17, 24].

A critical surgical distinction must be made between fixed fibrotic strictures and functional narrowing. While both may present with similar symptoms, their responses to dilation differ substantially. Functional narrowing often responds favorably to serial dilation, whereas fibrotic disease may recur or fail to respond, signaling the need for alternative strategies or surgical revision [51].

The effectiveness of dilation depends not on maximal force but on strategic restraint. Escalation of balloon size without reassessment of the underlying mechanism increases complication risk without improving durability, reinforcing the importance of mechanism-based decision-making, even in seemingly straightforward interventions [18].

## **5.6 Luminal remodeling and revision techniques**

Luminal remodeling techniques address functional failure rather than structural disruption, particularly in late complications after bariatric surgery. TORe is the most established modality in this category and targets dilated GJ anastomoses in patients with dumping syndrome or RWG following RYGB or OAGB [52]. By restoring restrictive physiology, TORe offers symptom control and metabolic benefits without altering overall anatomy [10, 53].

Endoscopic sleeve revision techniques apply similar principles to patients with sleeve dilation or loss of restriction after SG. These procedures aim to restore functional anatomy through volume reduction rather than anatomic conversion, making them attractive options for selected patients who are poor surgical candidates or who wish to avoid revisional surgery [2, 54].

From a surgical standpoint, these interventions require careful patient selection and realistic goal-setting. Endoscopic revision is not a substitute for primary surgery but rather a targeted recalibration of altered physiology, reinforcing the role of endobariatrics within chronic metabolic disease management [1, 2].

## **5.7 Integration of modalities and surgical perspective**

For surgeons, the critical skill lies in recognizing which problem is being treated at a given moment – whether infection, obstruction, or functional failure – and selecting the modality that directly addresses that problem while preserving future therapeutic options. Endobariatric therapy is, therefore, best practiced as a collaborative and iterative process integrated into established bariatric care pathways, rather than as a standalone intervention divorced from surgical decision-making [7].

This structured understanding of endoscopic treatment modalities provides the conceptual foundation for the complication-specific management strategies discussed in the following section, where these tools are applied in defined clinical scenarios informed by timing, mechanism, and patient-specific context. The principal endoscopic modalities, their mechanism-based indications, expected performance, and key limitations are summarized in **Table 2**, providing a comparative reference that highlights the complication-specific strategies discussed in the following section.

## **6. Complication-specific management strategies**

Complication-specific management after MBS requires tailoring therapeutic strategies to the distinct pathophysiology, anatomical context, and clinical trajectory of each presentation. Although overarching principles guide initial assessment and escalation, effective management depends on recognizing how failure mechanisms differ across leaks, strictures, bleeding, fistulae, and functional disorders. Accordingly, this section presents a structured, complication-focused approach that integrates endoscopic, radiologic, and surgical options to reflect real-world practice, highlighting points of divergence in diagnostic workup, therapeutic sequencing, and thresholds for operative intervention.

| Endoscopic modality         | Primary mechanism addressed                                                                        | Best-fit clinical indications                                                                                                                            | Effectiveness and outcome data                                                                                                                                                                                                       | Key limitations and failure modes                                                                                                                                         |
|-----------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tissue apposition, OTSC     | Full-thickness approximation of small defects with viable tissue.                                  | Small acute leaks or iatrogenic perforations without significant cavity involvement, as well as selected small fistula orifices after adequate drainage. | Effective for small, well-circumscribed defects, success decreases in chronic leaks or inflamed tissue beds; outcomes are highly dependent on tissue viability and timing [33, 51].                                                  | Does not address extraluminal cavities, has a high failure rate in chronic fistulae, and poses a risk of sealing uncontrolled sepsis if used without prior drainage [33]. |
| Endoscopic suturing systems | Adjustable tissue approximation and luminal remodeling, reinforced after biological stabilization. | Reinforcement or closure after source control, anastomotic reduction, and endoscopic revisional procedures when tissue quality is preserved.             | Effective as part of staged therapy, outcomes depend on tissue quality and operator expertise, and it is best positioned after inflammation subsides rather than as primary therapy in active leaks [3, 51].                         | Technical complexity, failure in ischemic or fibrotic tissue, and not being a substitute for drainage or source control in septic patients [3].                           |
| Covered SEMS                | Luminal diversion and pressure reduction across defects.                                           | Acute leaks requiring diversion, as an adjunct to drainage strategies, selected perforations, or anastomotic disruptions.                                | Meta-analyses report clinical success rates of approximately 70%–90%, with migration rates of up to 17%–30%; efficacy is reduced when used as monotherapy in the presence of collections [5, 6].                                     | Migration, intolerance, need for repeat procedures, incomplete resolution when cavities persist, and lack of active treatment for extraluminal infection [6, 55].         |
| EID                         | Internalization of sepsis, continuous drainage promoting cavity collapse.                          | Stable patients with localized collections, SG leaks, and early evolving fistulae.                                                                       | Large series report overall clinical success at 84.7%, leak resolution at 89.5%, fistula resolution at 78.5%, recurrence at 1.8%, and adverse events at 4.5%, supporting EID as a first-line therapy in appropriate anatomy [7, 51]. | Requires cavity access and close follow-up, does not immediately seal defects, and may require a combination with diversion or closure in selected cases [7].             |
| EVT                         | Negative-pressure cavity management, granulation, and progressive defect contraction.              | Large infected cavities, chronic fistulae, stent-refractory leaks.                                                                                       | Systematic reviews and meta-analyses show pooled clinical success exceeding 85%–90%, proving effective in complex and chronic diseases when applied in structured protocols [14, 56].                                                | Resource-intensive, requires multiple exchanges; patient tolerance and institutional expertise are critical [14].                                                         |

| Endoscopic modality                            | Primary mechanism addressed                                         | Best-fit clinical indications                                                             | Effectiveness and outcome data                                                                                                                                                    | Key limitations and failure modes                                                                                                          |
|------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Pneumatic or balloon dilation                  | Controlled radial expansion, restoring luminal patency.             | Fixed stricture after SG or GJ anastomosis; selected functional stenosis.                 | Meta-analysis demonstrates pooled clinical success at approximately 90%, typically requiring one to three sessions, with a low perforation risk when dilation is graded [17, 18]. | Reduced durability in rigid fibrotic disease; recurrence suggests an incorrect mechanism or the need for escalation [47].                  |
| Luminal remodeling, TORe                       | Restoration of restrictive physiology via GJ anastomosis reduction. | Weight regain or dumping syndrome after RYGB with enlarged anastomosis.                   | Systematic reviews show meaningful weight loss and significant improvement in dumping symptoms with acceptable safety and durability [9, 10].                                     | Effective only when the mechanism is outlet dilation, limited role in complex anatomic failure and requires careful patient selection [2]. |
| Luminal remodeling, endoscopic sleeve revision | Reduction of sleeve volume and restoration of functional geometry.  | Sleeve dilation or loss of restriction in selected patients, avoiding revisional surgery. | Reviews support use as anatomy-preserving recalibration in selected patients; outcomes depend on baseline geometry and adherence [2, 51].                                         | Limited role in structural complications requires realistic expectations and multidisciplinary follow-up [2].                              |

**Table 2.**  
*Overview of contemporary endoscopic modalities used in the management of post-MBS surgical complications, organized by the dominant mechanism addressed, optimal clinical indications, reported effectiveness, and principal limitations based on current evidence.*

## **6.1 Leaks and fistulae**

Leak management must begin with accurate classification, specifically distinguishing acute structural leaks with ongoing luminal contamination from chronic fistula physiology characterized by organized cavities and mature tracts. Acute leaks are primarily driven by uncontrolled flow and intraluminal pressure, continued contamination, and sepsis, whereas chronic fistulae are governed by cavity biology, epithelialization, and failure of collapse. This distinction predicts responsiveness to endoscopic therapy and determines whether diversion, drainage, or delayed closure represents the appropriate course of management. Evidence supports a drainage-first paradigm in clinically stable patients, prioritizing control of the infected space, with definitive closure reserved for settings in which sepsis is controlled [7, 8, 14, 56].

In stable patients with SG leaks and perigastric collections, EID promotes cavity collapse. Several studies have supported the high clinical success of drainage-based strategies in this setting, with radiologic reassessment guiding escalation when cavity shrinkage plateaus [57, 58].

When the primary failure mode is a large cavity and persistently infected space, or a refractory leak despite internal drainage, EVT works better because it treats the cavity as a wound bed, promoting granulation and contraction under negative pressure. Meta-analytic evidence demonstrates high rates of clinical success with EVT for post-bariatric leaks and fistulae, acknowledging that repeated exchanges and resource intensity are tradeoffs that require institutional expertise and careful patient selection [14, 56–58].

Covered stents retain a role when diversion of luminal content is necessary to reduce ongoing contamination, but the literature consistently highlights the limitations of stent monotherapy, including migration, intolerance, and inadequate control of associated cavities [33, 55, 59]. The practical implication is that stent placement should be paired with a plan for cavity management – —either internal drainage, percutaneous drainage, EVT, or staged closure – —rather than used as definitive therapy in the presence of collections. Closure tools such as OTSC and suturing are best positioned when sepsis is controlled, tissue is viable, and the defect is small or well-demarcated, because chronic inflammatory beds and mature tracts predict the failure of primary closure [6, 7, 33].

Escalation to surgical therapy is indicated when immediate source control is needed, when endoscopic access is not feasible, or when the patient fails to demonstrate objective improvement under a staged endoscopic therapy plan [12, 13].

An illustrative example of endoscopic closure of a GGF following RYGB is shown in **Video 2**, highlighting the principles of tract assessment, timing of closure, and the appropriate use of tissue apposition techniques after biological control has been achieved.

## **6.2 Strictures and obstruction**

Post-bariatric obstruction must be approached by differentiating fixed fibrotic narrowing from functional stenosis driven by twist, angulation, kinking, or dynamic narrowing, because the dominant mechanism predicts endoscopic response and the appropriate endpoint of therapy. Meta-analytic evidence supports graded EBD as first-line therapy for SG stenosis, with high clinical success and acceptable safety

## Endoscopic Bariatric Procedure with Closure of Gastro-Gastric Fistula

Dr. Michail Koutentakis, Dr. Aman Goyal, Dr. Lina Alami, Student Dr. Isaac Ballard, Dr. Israel A. Gaytan Fuentes, Dr. Juan Zubillaga, Student Dr. Pedro Vega, Prof./Dr. Adolfo Pérez Bonet, Prof./Dr. Rodolfo J. Oviedo



### Video 2.

*Endoscopic closure of a GGF following RYGB.*

when dilation is performed iteratively rather than forcefully in a single session [17, 18].

Temporary stent strategies may be considered in selected refractory cases as a bridge to remodeling, but the endoscopic literature emphasizes the predictable limitations, such as migration and intolerance, and therefore supports a planned endpoint and reassessment rather than indefinite luminal exclusion [39]. Surgical escalation is appropriate when obstruction is refractory to structured endoscopic therapy, when anatomy is not correctable endoluminally, or when cumulative interventions risk malnutrition or prolonged hospitalization [12, 51].

In this context, structured sequencing of endoscopic therapy with predefined reassessment points is essential to avoid futile interventions and to ensure timely escalation when durable luminal patency cannot be achieved endoluminally.

### 6.3 Bleeding and marginal ulcers

Hemorrhagic complications require an initial stability-based decision because unstable bleeding may necessitate urgent operative or angiographic control, whereas stable patients benefit from early endoscopic diagnosis and therapy [13, 24]. Endoscopic management is central in stable patients because it enables targeted hemostasis and simultaneous assessment of mucosal pathology, staple-line integrity, and anatomic contributors in altered post-bariatric anatomy [24].

Marginal ulceration after RYGB encompasses heterogeneous entities with distinct pathophysiologic drivers depending on the timing from the index operation. Early marginal ulcers are more commonly related to ischemia, staple-line tension, technical factors, or acute inflammatory injury and may present with bleeding or perforation, requiring prompt intervention. In contrast, late marginal ulcers are typically driven by persistent exposure mechanisms, such as acid secretion, bile reflux, foreign material, or an enlarged GJ anastomosis, and often manifest as recurrent bleeding rather than a single discrete bleeding point, necessitating durability-oriented management rather than one-time hemostasis. Refractory bleeding, perforation, or failure of endoscopic control in either setting justifies escalation to operative management, consistent with emergency-oriented bariatric complication frameworks [60].

## **6.4 Functional complications, dumping syndrome, weight regain**

Functional complications represent the failure of postoperative physiology rather than tissue integrity, and therefore, endoscopic revision is best framed as physiologic recalibration in appropriately selected patients. Late dumping syndrome and RWG after RYGB are frequently associated with dilation of the GJ anastomosis and loss of restrictive physiology, making outlet reduction a mechanism-targeted intervention rather than a purely cosmetic revision [10, 21].

Systematic reviews and meta-analyses support TORe for RWG and for dumping symptom improvement, with clinically meaningful outcomes and an acceptable safety profile in selected patients [9, 10]. Endoscopic outlet reduction is most applicable in patients where GJ anastomotic enlargement appears to play a central role in symptom persistence or weight recurrence in the context of preserved overall anatomy. Conversely, scenarios dominated by complex structural changes, eating behavior patterns, or systemic metabolic influences call for coordinated multidisciplinary assessment and consideration of therapeutic pathways other than isolated outlet modification [2, 51]. Optimal management of functional complications after RYGB depends on disciplined patient selection, confirmation of the dominant physiologic failure mode, and predefined thresholds for reassessment and escalation rather than indiscriminate revisional intervention.

Although a drainage-first, endoscopy-centered strategy is appropriate in clinically stable patients, escalation to operative management should be guided by clearly defined objective criteria rather than prolonged iterative endoscopic attempts. Surgical intervention remains mandatory, despite initial stability, in the presence of tissue ischemia or necrosis, generalized peritonitis, uncontrolled intra-abdominal contamination, or collections that are inaccessible or refractory to adequate internal or external drainage. In the absence of absolute surgical indications, failure of endoscopic therapy should be determined by the lack of objective clinical, biochemical, or radiologic improvement following a limited number of appropriately performed endoscopic interventions. Indicators of insufficient response include persistent tachycardia or sepsis, failure of inflammatory markers to decline, inability to tolerate oral intake, sustained high-output drainage, or absence of meaningful reduction in collection size on interval cross-sectional imaging. Under such circumstances, early surgical reassessment is essential to prevent delayed source control and progression to systemic deterioration.

**Table 3** discusses endoscopic failures.

## **7. Endoscopy versus revisional surgery**

Revisional surgery has traditionally been regarded as the definitive option for post-bariatric complications, particularly after the failure of initial management or when late adverse events develop. Data support the selective use of endoscopic management as an initial or intermediate step when clinical stability and the failure mechanism favor an endoluminal approach, with operative intervention reserved for scenarios in which endoscopic strategies are unsuitable or unsuccessful. The rationale for considering endoscopy early is grounded not in technical novelty but in fundamental differences between the two approaches with respect to morbidity,

| Mechanism of failure                                                                                                                                                                      | Endoscopic approach matched to the underlying pathophysiology                                                                          | Objective indicators of endoscopic exhaustion (escalation threshold)                                                                 | Surgical objective once the threshold is crossed                                                                                                                                          | Evidence base |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Acute leak with flow–pressure dominance (early SG or RYGB leak, viable tissue).                                                                                                           | Temporary luminal diversion using covered SEMS ± adjunctive drainage to reduce intraluminal pressure and permit early tissue recovery. | Persistent contrast extravasation, ongoing sepsis, or the inability to maintain effective diversion due to migration or intolerance. | Definitive operative source control with repair or revision ± washout.                                                                                                                    | [3, 5, 6]     |
| Contained leak with cavity-driven biology (organized perigastric collection; stable patient).                                                                                             | EID (double-pigtail stents ± EUS guidance) promotes controlled cavity collapse and internalization of sepsis.                          | No reduction in cavity size on serial imaging or endoscopic assessment, despite adequate internal drainage.                          | Surgical drainage or revisional resection should be considered once endoscopic cavity control shows no further cavity size reduction on two sequential imaging or endoscopic assessments. | [1, 7]        |
| Large infected cavity or stent-refractory leak (extensive cavity inflammation with necrotic tissue, ongoing purulent contamination, or failure of granulation despite adequate drainage). | EVT, treating the cavity as a wound bed, induces granulation and progressive defect contraction.                                       | Failure to demonstrate a granulation response after multiple EVT exchanges or an inability to maintain vacuum therapy.               | Operative cavity excision or anatomical revision.                                                                                                                                         | [8, 14, 56]   |
| Chronic epithelialized fistula (mature tract, delayed presentation).                                                                                                                      | Drainage–first strategies ± EVT or septotomy aimed at reversing epithelialization.                                                     | Persistent fistula patency despite the resolution of cavity infection and adequate internal drainage.                                | Formal surgical fistula takedown or reconstructive revision with definitive source control.                                                                                               | [6, 8]        |
| Functional luminal narrowing (non-fibrotic sleeve stenosis).                                                                                                                              | Serial graded balloon dilation restores luminal geometry without tissue disruption.                                                    | Early symptom recurrence after technically adequate dilation suggests an incorrect or non-reversible mechanism.                      | Revisional surgery addressing fixed geometry or sleeve twist.                                                                                                                             | [17, 18]      |
| Fixed fibrotic stricture (short, rigid stenosis).                                                                                                                                         | Limited diagnostic trial of dilation to confirm non-responsiveness.                                                                    | Immediate recoil or failure after one to two dilation sessions.                                                                      | Surgical revision or stricturoplasty.                                                                                                                                                     | [1, 17]       |
| Functional failure after RYGB (dumping syndrome or RWG with enlarged GJ anastomosis).                                                                                                     | TORe, restoring restrictive physiology without altering anatomy.                                                                       | Symptom recurrence in the absence of correctable outlet dilation or evidence of complex anatomical failure.                          | Surgical revision is only necessary when the anatomy is no longer endoscopically modifiable.                                                                                              | [9, 10]       |

**Table 3.**  
*Mechanism-driven inflection points defining the limits of endoscopic salvage and indications for surgical escalation in post-bariatric complications.*

physiologic disruption, and therapeutic flexibility, while preserving future surgical options if escalation becomes necessary [61].

In terms of morbidity, revisional bariatric surgery is consistently associated with higher complication rates than primary procedures, reflecting adhesions, altered anatomy, and compromised tissue planes. Emergency or semi-urgent reoperations for leaks, fistulae, or bleeding further amplify this risk profile [12, 13]. In contrast, endoscopic interventions demonstrate lower procedure-related morbidity and are typically performed without laparotomy, thereby reducing physiological stress and perioperative risk in patients who are often septic, malnourished, or metabolically fragile [62]. This benefit must be weighed against the need for repeated interventions and the recognition that endoscopic therapy may not provide definitive resolution in all cases.

Hospital resource utilization further differentiates these strategies. Endoscopic management is associated with shorter hospital stays, reduced need for intensive care, and earlier resumption of enteral nutrition in stable patients, particularly when drainage-based or remodeling strategies are applied in a staged fashion [7, 51]. Revisional surgery, by contrast, requires more resources [12].

Preservation of bariatric anatomy represents another critical distinction. Endoscopic therapies aim to correct the dominant failure mechanism while maintaining the original surgical construct, whether by controlling sepsis, restoring luminal patency, or recalibrating restrictive physiology. This anatomic preservation is particularly relevant in younger patients, those with future revisional needs, or individuals for whom additional surgery would compromise long-term metabolic outcomes [2]. Surgical escalation may take the form of either revisional or conversional intervention, with each pathway carrying different anatomic consequences and downstream implications. Revisional procedures involve alteration of an existing bariatric construct and, depending on the extent of tissue resection or reconstruction, can narrow subsequent endoscopic or operative options. Conversional approaches, instead, reconfigure the original operation into an alternative bariatric anatomy and are commonly selected to reestablish durability or metabolic benefit without necessarily limiting future therapeutic possibilities. Awareness of this distinction is integral to contemporary bariatric practice and is reflected in guideline recommendations that support anatomy preservation and staged treatment strategies whenever clinically appropriate [63, 64].

A further advantage of endoscopic management is its repeatability. Many endoscopic interventions are intentionally iterative, allowing stepwise adjustments based on biological responses rather than committing the patient to a single high-risk intervention. This flexibility aligns with the evolving nature of post-bariatric complications, particularly leaks, fistulae, and functional failure, where disease biology may change over time. Surgery is more definitive, and while it has a higher risk profile, it usually resolves the issue in a single operation [65].

Importantly, positioning endobariatrics as an alternative to surgery does not imply competition between disciplines. Rather, evidence supports a complementary model in which endoscopy serves as a bridge, a definitive solution in selected cases, or a means of stabilizing patients before delayed surgical intervention when necessary [66]. The optimal approach is, therefore, not endoscopy versus surgery, but sequencing based on patient stability, mechanism of failure, and likelihood of durable resolution.

## **8. Treatment sequencing and algorithmic frameworks**

The expanding role of endobariatrics in post-bariatric complication management has been accompanied by a shift in the literature from single-modality reports toward stepwise, mechanism-based treatment strategies. Across different reviews, meta-analyses, and large institutional series, there is increasing convergence on the principle that durable outcomes depend less on the initial tool selected than on correct sequencing, early reassessment, and timely escalation when the biological response fails to progress [37, 67].

Algorithmic decision pathways, therefore, serve a specific purpose in endobariatric care. Rather than replacing clinical judgment, they provide a shared model that aligns surgeons, endoscopists, radiologists, and intensivists around common decision points, particularly in time-sensitive or high-risk scenarios. The following algorithms synthesize patterns consistently reported across the literature and reflect how endoscopic and surgical interventions are sequenced in high-volume centers.

### **8.1 Leak and fistula management algorithm**

Leak management algorithms have evolved substantially over the past decade, moving away from isolated luminal closure toward management priorities that explicitly prioritize source control, cavity management, and biological progression. Multiple reviews and expert consensus statements now converge on a stability-based triage pathway, in which hemodynamically unstable patients or those with diffuse peritonitis proceed directly to surgical intervention, while stable patients undergo structured endoscopic evaluation and staged therapy [12,13].

In stable patients, algorithmic pathways consistently emphasize early identification of associated collections, followed by drainage-based endoscopic strategies when cavities are present. Large clinical series support internal drainage as a foundational step, with escalation to vacuum therapy in the presence of large, infected, or refractory cavities [7, 14]. Diversion or closure techniques are incorporated selectively based on tissue viability and response to initial therapy rather than being applied universally. Failure to demonstrate objective improvement within defined reassessment intervals is consistently identified as the threshold for surgical escalation, underscoring that algorithms function as dynamic pathways rather than linear checklists [51].

These convergent principles define a reproducible sequencing approach that prioritizes biological response and reassessment over early definitive closure. The stability-based, drainage-first sequencing framework, with predefined reassessment and escalation thresholds, is illustrated in **Figure 1**.

### **8.2 Stricture and obstruction management algorithm**

Algorithmic pathways prioritize close reassessment following an initial dilation to track clinical response and evolving luminal morphology. In many cases, functional obstruction reflects postoperative edema or transient motility disturbance and tends to resolve as healing progresses, making delayed, staged dilation a more appropriate strategy. Failure to improve or early symptom recurrence should prompt

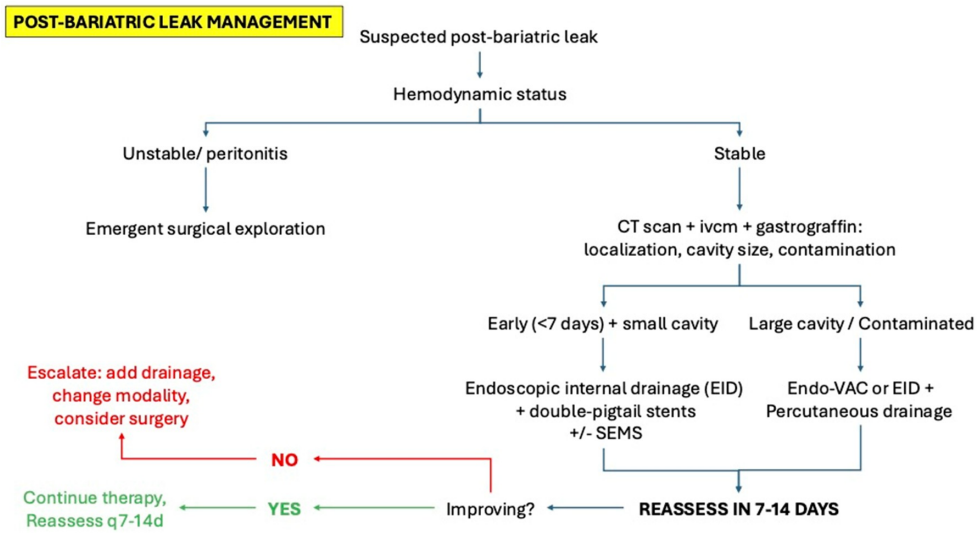


**Figure 1.**

Stepwise management of post-bariatric leaks and fistulae with stability-based triage, drainage-first strategies, and predefined reassessment and escalation criteria.

reconsideration of the underlying process rather than reflexive balloon upsizing, particularly soon after surgery, when aggressive dilation may increase risk without conferring durable benefit [33].

The value of the algorithm lies in defining when persistence represents appropriate iteration versus when it constitutes delayed escalation. This sequencing clarifies when persistence reflects appropriate iteration and when a lack of progression should prompt escalation to surgical correction [8].

This mechanism-driven, stepwise algorithm for stricture and obstruction management is illustrated in **Figure 2**.

### 8.3 Functional failure and weight recurrence algorithm

Algorithms addressing functional complications reflect a broader conceptual shift toward managing obesity as a chronic disease with evolving physiology. In contrast to structural complications, these pathways begin with confirmation of the dominant failure mechanism, most commonly dilation of the GJ anastomosis after RYGB, before any interventional decision is made [61, 68].

Systematic reviews support TORe as an effective intervention when outlet dilation is the primary driver of dumping syndrome or RWG, with algorithms positioning TORe as an anatomy-preserving alternative to revisional surgery in appropriately selected patients. Importantly, published pathways emphasize that failure to respond to TORe should prompt reassessment of underlying drivers rather than reflexive repetition, reinforcing the role of multidisciplinary evaluation before escalation [9, 10, 69].

Surgical revision remains an integral component of these algorithms, reserved for patients with non-endoscopically correctable anatomy or persistent failure despite mechanism-targeted endoscopic intervention. This approach emphasizes

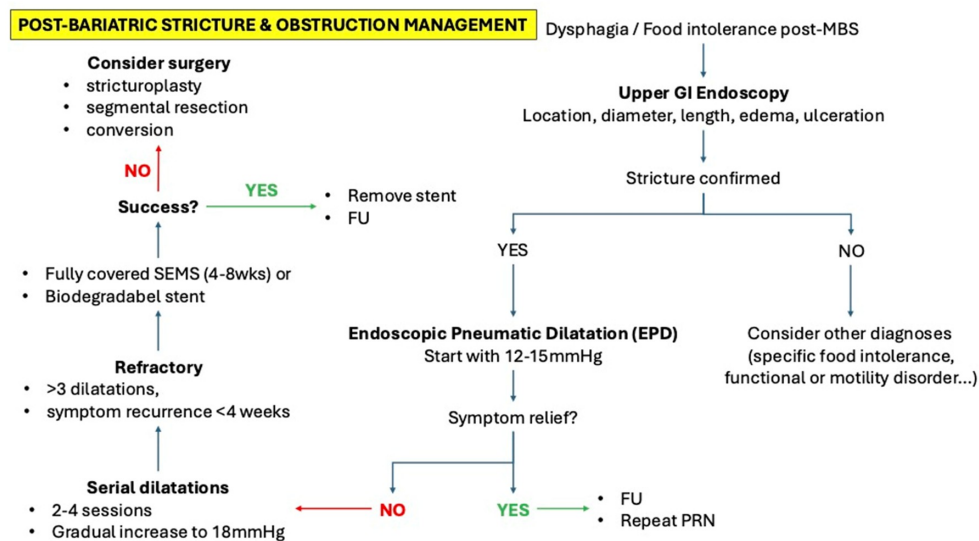


**Figure 2.**  
*Stepwise endoscopic management of post-bariatric strictures and obstruction with predefined reassessment and escalation criteria.*

reassessment of underlying drivers and multidisciplinary review before advancing to irreversible anatomical revision.

### 8.4 Role of algorithms in multidisciplinary practice

The purpose of these algorithms is not to standardize care rigidly but to reduce unwarranted variability while preserving clinical judgment. Across the literature, centers reporting the most favorable outcomes consistently apply early endoscopic involvement, predefined reassessment intervals, and clear thresholds for escalation – principles that are embedded within the proposed structures [1, 51].

By translating heterogeneous evidence into reproducible decision pathways, these algorithms function as cognitive scaffolds that support real-time decision-making, facilitate multidisciplinary communication, and align endoscopic and surgical interventions within a unified care model. Their value lies not in replacing expertise but in ensuring that expertise is applied consistently, transparently, and in a manner that maximizes the therapeutic window for minimally invasive intervention.

### 9. Limitations of current evidence

Despite increasing clinical adoption, the evidentiary foundation supporting endobariatric management of post-bariatric complications remains methodologically heterogeneous. A substantial proportion of published data originates from retrospective analyses, registry-based experiences, and single-center observational cohorts, frequently involving limited sample sizes and non-standardized inclusion criteria. While these designs have facilitated early

dissemination of novel techniques, they restrict inferential strength and complicate comparisons across institutions with differing expertise and patient populations [6].

Technical complexity and operator dependence represent additional constraints on generalizability. Reported outcomes for advanced interventions, such as endoscopic suturing, internal drainage, and vacuum-based therapy, frequently reflect experience from high-volume referral centers with established multidisciplinary pathways. Translation of these results to lower-volume settings may, therefore, be limited, particularly when procedural success is closely linked to judgment regarding timing, device selection, and escalation thresholds rather than to the intervention itself [7, 14].

Importantly, the strength of available data varies according to complication type. Management of post-sleeve leaks using drainage-oriented strategies is supported by comparatively robust evidence, including large case series and pooled analyses demonstrating high rates of cavity resolution and clinical success when treatment is applied in a staged manner [7, 14, 56]. Similarly, balloon dilation for post-bariatric strictures is underpinned by meta-analytic data supporting high efficacy with acceptable safety when performed using graded protocols [17, 18].

By contrast, long-term follow-up data remain limited for several endoscopic revisional approaches. Studies evaluating luminal remodeling procedures, including TORe and sleeve recalibration, frequently report follow-up periods insufficient to fully characterize recurrence patterns or delayed failure, and definitions of success vary across publications [2, 9, 10]. Evidence addressing chronic or refractory fistulae is similarly fragmented, with outcomes influenced by prior interventions and heterogeneous treatment sequencing, limiting direct comparisons between series [51].

A further limitation is the scarcity of prospective comparative studies evaluating endoscopic strategies against revisional surgery. Although ethical and logistical considerations complicate trial design in this population, the absence of standardized, forward-looking comparisons necessitates cautious interpretation of apparent superiority or durability claims derived from non-randomized data [12, 13].

Altogether, these constraints emphasize the need to interpret reported outcomes within their methodological context and clinical setting. Delineating areas supported by mature data from those requiring further validation is essential, both for responsible implementation and for identifying priorities that should guide future investigation.

## **10. Future directions, automation, intelligence integration, and structured adoption**

The next phase of endobariatric evolution is increasingly defined by efforts to improve procedural consistency, decision accuracy, and system-level reliability, rather than by the expansion of the technical armamentarium alone. As experience accumulates across large series and meta-analyses, limitations related to variability, delayed escalation, and uneven access to expertise have become more visible, directing attention toward solutions that support reproducible care delivery across centers [24].

Robotic and computer-assisted endoluminal platforms represent one avenue through which technical dispersion may be reduced. Advanced articulation systems, stabilized instrument control, and semi-automated suturing interfaces have been

developed to address challenges inherent to altered bariatric anatomy, particularly during complex closure or remodeling procedures. Early feasibility experiences suggest that such platforms may enhance precision during demanding intraluminal tasks, potentially lowering the technical threshold required for advanced interventions while preserving operator oversight [2]. Although outcome data remain preliminary, the direction parallels earlier shifts observed during the adoption of laparoscopic and robotic surgery, where structured assistance broadened access without displacing clinical judgment.

In parallel, data-driven analytic approaches are beginning to influence how post-bariatric complications are evaluated and triaged. Within bariatric literature, predictive risk models incorporating clinical parameters, imaging findings, and procedural variables have been proposed to identify patients at elevated risk for persistent leaks, recurrent stenosis, or suboptimal response to endoscopic revision [70]. While current applications remain exploratory, integration of machine learning models into multidisciplinary workflows may support earlier recognition of non-responders and facilitate more timely selection between endoscopic salvage and operative intervention, particularly in borderline stability scenarios.

Equally consequential is the manner in which endoscopic interventions are integrated into structured and protocolized management pathways. Across the literature, superior outcomes are reported when endoscopic therapy is applied within defined escalation frameworks that incorporate physiological assessment, cavity characteristics, and predetermined reassessment intervals, rather than through ad hoc decision-making. Such approaches promote timely recognition of non-response, reduce the risk of prolonged ineffective therapy, and help mitigate delayed surgical referral in complex cases, where indecision or unstructured persistence can adversely affect outcomes [6, 71].

The convergence of structured decision support, analytic follow-up, and standardized sequencing marks a shift toward endobariatric care that is less dependent on individual practice patterns and more consistently embedded within institutional systems. Automation, as referenced here, simply describes the use of predefined clinical checkpoints – for instance, scheduled reassessment or lack of objective improvement – to prompt timely review, adjustment of therapy, or escalation of care. By enabling earlier recognition of non-response and clearer thresholds for intervention, such approaches have the potential to shorten time to definitive management, improve durability through earlier mechanism-matched treatment, and extend the safe use of endoscopic therapy before clinical deterioration necessitates emergency surgery [30, 71].

At present, the widespread adoption of advanced endobariatric therapies remains concentrated in high-volume bariatric and therapeutic endoscopy centers, most commonly within high-income healthcare systems where specialized expertise, advanced endoscopic platforms, multidisciplinary support teams, and longitudinal follow-up pathways are readily available. In contrast, implementation in many low- and middle-income countries may be constrained by limited access to advanced equipment, training opportunities, and institutional resources. As bariatric surgery volumes continue to increase globally and therapeutic endoscopy becomes more widely available, broader dissemination of endobariatric techniques, standardized training programs, and international collaborative initiatives may help reduce these disparities and expand access to minimally invasive management strategies worldwide.

## **11. Clinical implications for contemporary bariatric practice**

The evidence reviewed in this chapter supports a growing paradigm shift in the management of post-bariatric complications, with endoscopic intervention increasingly integrated into standard bariatric care pathways rather than being reserved solely for salvage therapy. Contemporary data suggest that, in appropriately selected and clinically stable patients, endobariatric interventions can provide effective source control, preserve surgically altered anatomy, reduce procedural morbidity, and potentially delay or avoid revisional surgery.

One of the most important clinical implications is the need for early multidisciplinary involvement. Optimal outcomes are achieved when bariatric surgeons, therapeutic endoscopists, interventional radiologists, nutrition specialists, and critical care teams participate in coordinated decision-making from the earliest stages of complication recognition. Such collaboration facilitates timely diagnosis, appropriate patient selection, and mechanism-matched intervention while reducing delays that may limit minimally invasive treatment opportunities.

The findings also support a mechanism-based approach to complication management. Rather than selecting therapies according to procedural preference or institutional tradition, treatment should be guided by the dominant pathophysiologic process. Structural disruptions, such as leaks and fistulae, benefit from drainage-oriented strategies and source control, whereas luminal narrowing is best addressed through graded dilation protocols. Functional disorders, including dumping syndrome and RWG, require careful physiologic assessment before consideration of endoscopic revision procedures, such as TORe.

An additional implication is the increasing importance of treatment sequencing. Current evidence suggests that successful management often depends less on the individual device used and more on the appropriate timing and integration of complementary therapies. Early identification of patients unlikely to respond to endoscopic treatment is equally important, as prolonged ineffective intervention may delay definitive source control and increase morbidity. Establishing predefined reassessment intervals and objective thresholds for escalation should, therefore, become a routine component of clinical practice.

The growing role of anatomy-preserving interventions may also influence future treatment algorithms. By maintaining existing bariatric constructs while addressing specific complications, endobariatric therapies offer an opportunity to preserve long-term metabolic benefits and maintain future revisional options. This is particularly relevant in younger patients and in those with complex surgical histories, for whom additional operative interventions may carry substantial risk.

Collectively, these findings support the incorporation of endobariatric expertise into comprehensive bariatric programs and reinforce the concept that endoscopic and surgical therapies should be viewed as complementary components of a unified treatment strategy, rather than competing alternatives.

## **12. Conclusion**

Endobariatric therapy has become an integral component of contemporary management for complications following MBS. By providing minimally invasive, anatomy-preserving, and repeatable treatment options, endoscopic interventions

can effectively address a broad spectrum of structural and functional complications while reducing the need for revisional surgery in appropriately selected patients.

Successful management depends on early recognition, accurate characterization of the underlying failure mechanism, multidisciplinary collaboration, and timely escalation when endoscopic therapy is unlikely to achieve durable resolution. As therapeutic endoscopy continues to evolve through advances in endoluminal technologies, artificial intelligence, and standardized treatment pathways, endobariatric strategies are expected to play an increasingly central role in comprehensive bariatric care. Future efforts should focus on generating higher-quality comparative evidence, refining patient selection, and developing standardized algorithms to further optimize outcomes and establish best practices.

## **Conflict of Interest**

The authors declare no conflicts of interest relevant to the content of this chapter.

## **Author details**

Michail Koutentakis<sup>1,2,3</sup>, Aman Goyal<sup>4,5</sup>, Manoel Galvão Neto<sup>6</sup>, Benjamin L. Clapp<sup>7</sup>, Athanasios G. Pantelis<sup>8,9</sup>, Chetan Parmar<sup>10,11,12</sup>, Juan Santiago Azagra<sup>13</sup>, Beniamino Pascotto<sup>13</sup>, Edmundo Inga-Zapata<sup>14,15,16</sup>, Abhirami Babu<sup>17</sup>, Safwan Taha<sup>18</sup>, Adel Abou-mrad<sup>19</sup>, Mehmet Mahir Ozmen<sup>20</sup>, Adolfo Pérez-Bonet<sup>21</sup> and Rodolfo J. Oviedo<sup>22,23,24\*</sup>

1 Doctoral School, Medical University of Warsaw, Warsaw, Poland

2 Department of Experimental and Clinical Pharmacology, Medical University of Warsaw, Center for Preclinical Research and Technology (CEPT), Warsaw, Poland

3 Department of Surgery, Liv Hospital Ankara, Ankara, Turkey

4 Department of General Surgery, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth University, Puducherry, India

5 Department of Surgery, Adesh Institute of Medical Sciences and Research, Bathinda, India

6 Bariatric Research, Orlando Health Weight Loss and Bariatric Surgery Institute, Orlando, USA

7 Department of Surgery, Texas Tech University, El Paso, USA

8 Athens Medical Group, Psychiko Clinic, Athens, Greece

9 1st Department of Propaedeutic Surgery, National and Kapodistrian University of Athens, Athens, Greece

10 Department of Surgery, Whittington Hospital, London, UK

11 University College London, London, UK

12 Apollo Hospitals Education and Research Foundation, Hyderabad, India

13 General and Minimally Invasive (Laparoscopic and Robotic) Surgery Department, Centre Hospitalier de Luxembourg, Luxembourg, Luxembourg

14 Surgical Research Lab/DRAA-Larkin Health System, Miami, USA

15 Facultad de Medicina, Unidad de Cirugía, Universidad de San Martín de Porres, Lima, Peru

16 Department of Surgery, Hospital Nacional Hipólito Unánue, Lima, Peru

17 College of Medicine, Our Lady of Fatima University, Valenzuela City, Philippines

18 The Metabolic and Bariatric Surgery Center of Excellence (SRC), Mediclinic Airport Road Hospital, Abu Dhabi, United Arab Emirates

19 Department of Surgery, Center Hospitalier Universitaire d'Orléans, Orléans, France

20 MOC Obesity and Cancer Clinic, Ankara, Turkey

21 Department of Surgery, Gloria Patricia Pinzón Clinic, Florencia, Colombia

22 Department of Surgery, Nacogdoches Medical Center, Nacogdoches, USA

23 University of Houston, Tilman J. Fertitta Family College of Medicine, Houston, USA

24 Sam Houston State University College of Osteopathic Medicine, Conroe, USA

\*Address all correspondence to: roviado3@central.uh.edu

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