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**Original Research Article**

# Standardization of the endoscopic approach in early bariatric leaks: an evidence-based clinical algorithm

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## ABSTRACT

Gastrointestinal leaks remain a critical complication following bariatric surgery, associated with significant morbidity and mortality. Success in management has shifted toward a multidisciplinary approach where therapeutic endoscopy plays a central role. This study aims to standardize the endoscopic management of early leaks (postoperative days 3-7) through a clinical-technical algorithm based on current evidence. A comprehensive review of current literature (2020-2025) was conducted, analyzing 16 key studies focused on endoscopic interventions for leaks following laparoscopic sleeve gastrectomy (LSG) and Roux-en-Y gastric bypass (RYGB). The analysis included clinical success rates for primary closure (clips/suturing), diversion (stents), and internal drainage (pigtails/vacuum therapy). The evidence suggests a "window of opportunity" between days 3 and 7. For defects <10 mm in healthy tissue, primary closure with over-the-scope clips or endoscopic suturing is preferred. Larger defects (>10 mm) or those involving ischemic tissue require derivative therapy with mega-stents or vacuum-assisted closure (EVT). In RYGB, endoscopic suturing is the gold standard for anastomotic leaks, while in LSG, internal drainage via the EDEN protocol allows early enteral nutrition and reduces stent-related intolerance. Standardizing the endoscopic approach based on defect size and tissue biology is essential to optimize outcomes. Hemodynamically stable patients benefit from early endoscopic intervention, which reduces hospital stays and prevents the progression to chronic fistulas. The proposed algorithm provides a structured decision-making tool for the surgical team.

**Keywords:** Bariatric surgery, Gastrointestinal leak, Therapeutic endoscopy, Postoperative complications

## INTRODUCTION

Bariatric and metabolic surgery has established itself as the most effective treatment for morbid obesity and its comorbidities. Currently, LSG and RYGB represent the vast majority of procedures performed worldwide due to their safety profile and metabolic outcomes.[1,2] Despite the refinement of surgical techniques, gastrointestinal leaks remain the most feared complication, associated with significant morbidity and a mortality rate that can range between 0.14% and 1.5% in high-volume centers.[1,3] The success in rescuing these complications has shifted from a purely surgical approach to a multidisciplinary model where therapeutic endoscopy plays a leading role. However, the success of this rescue depends on a strict chronological classification that allows for targeted intervention; thus, the effectiveness of these therapies is intrinsically dependent on the timing of diagnosis.

## DEFINITIONS

One of the main challenges in the literature is the inconsistency in chronological timeframes.[4] For the purposes of this unified algorithm, we will adopt a classification based on tissue maturation and the inflammatory response:

***Acute leak (48-72 hours)***

Usually related to technical failures in the staple line or immediate tissue ischemia. These often manifest with early hemodynamic instability.

***Early leak (3-7 days)***

During this period, tissues have not yet developed dense fibrosis, allowing endoscopic tools to achieve their highest clinical success rate.[2,5]

***Late leak (>7 days)***

These often evolve into chronic fistulous tracts and require different therapeutic approaches. This group of complications is outside the scope of this review.

## EPIDEMIOLOGY

The reported incidence of leaks varies by procedure, ranging between 1% and 2% for LSG and between 0.5% and 1.5% for gastric bypass (RYGB/OAGB).[6,7] The most frequent anatomical location (>85%) in LSG is the esophagogastric junction, near the Angle of His; factors such as high intraluminal pressure and precarious vascularization in the upper part of staple line contribute to its pathogenesis.[1] In RYGB, most leaks occur at gastrojejunal anastomosis/the gastric pouch staple line.[7]

## IMPORTANCE OF STANDARDIZATION

The variability in reporting endoscopic outcomes is largely due to the lack of uniform definitions.[4]

By focusing this algorithm on the early leak, we aim to optimize resource use and improve patient prognosis, preventing progression toward chronic complications that are difficult to resolve.

## CLINICAL CLASSIFICATION AND STRATIFICATION

***Stratification according to hemodynamic stability***

The patient's clinical status is the primary determinant of the algorithm's arm. Early leaks usually present with an evolving inflammatory cascade:[1,8]

*Group A*

Unstable patient (Severe sepsis/septic shock). Presents with persistent tachycardia (>120 bpm), hypotension, high fever, or signs of generalized peritoneal irritation. In these patients, immediate surgical reintervention for washing, drainage, and damage control is recommended. Endoscopy in this scenario is only considered as a complementary measure.[1]

*Group B*

Stable patient or compensated sepsis. Presents with moderate tachycardia, localized abdominal pain, or general malaise, but without systemic hemodynamic compromise. This is the ideal candidate for the endoscopic approach, supported by percutaneous drainage if localized collections exist.[2,9]

***Anatomical classification according to the procedure***

The location (Tables 1 and 2) of the defect dictates the endoscopic tool to be used. Unifying these criteria is vital for the reproducibility of the algorithm[4]:

**Table 1: Anatomical classification of leaks for sleeve gastrectomy.**

| Location | Description |
|---|---|
| **Type I (Proximal)** | Located at the esophagogastric junction or Angle of His. It is the most common and complex due to the high-pressure zone. |
| **Type II (Mid/distal)** | Along the gastric body or antrum. It usually shows a better response to primary closure with clips. |

**Table 2: Anatomical classification of leaks for RYGB.**

| Location | Description |
|---|---|
| **Gastrojejunal anastomosis** | The most frequent site of leakage in the pouch. |
| **Jejuno-jejunal anastomosis** | Although it occurs in less than 1% of cases, its presentation is usually more insidious or presents with rapid progression to peritonitis due to biliopancreatic flow.<br>Its endoscopic approach is technically more complex due to the anatomical distance.[7] |
| **Gastric pouch** | Along the staple line of the upper gastric remnant. |
| **Distal gastric remnant** | Uncommon, but requires a different approach (usually surgical or via enteroscopy). |

### *Radiological classification and magnitude of the defect*

The integration of computed tomography (CT) with oral contrast is mandatory to stratify severity:[2]

*Grade I (Contained)*

Contrast extravasation limited to a collection adjacent to the suture line, without massive pneumoperitoneum.

*Grade II (Uncontained)*

Free contrast dissemination in the abdominal cavity or presence of distant collections.

### *Predictive factors for endoscopic success*

An innovative point of this algorithm is the inclusion of factors that predict the failure of endoscopic therapy (FET). According to the Leeds score, the following variables should be considered at admission:[10]

*Defect size*

Orifices >20 mm have a significantly lower success rate with simple closure techniques (clips) and usually require diversion (stents) or vacuum therapy (EVT).[3,6]

*C-reactive protein (CRP)*

Persistently elevated levels after 48 h of initial management suggest drainage failure and the need to escalate therapy.[11]

## DIAGNOSIS

The success of an algorithm lies in reducing the time between clinical suspicion and intervention. Diagnosis must be an integration of clinical findings, biochemical markers, and imaging.

### *Clinical suspicion*

Within the 3-to-7-day window, the clinical presentation is often subtle but persistent. According to the review by Gjeorgjievski et al the most sensitive sign is persistent tachycardia (>120 bpm), which often precedes fever or intense abdominal pain.[1] Patients typically present with tachycardia, tachypnea, and referred pain to the left shoulder, which is frequent in sleeve leaks. A jejuno-jejunal (JJ) leak may present with greater abdominal distension and pain in the mesogastrium compared to a leak at the Angle of His.

### *Diagnostic imaging*

CT with oral and intravenous contrast is the gold standard for initial stratification.[2] Key findings include contrast extravasation, localized extraluminal gas bubbles, and collections adjacent to the anastomosis. However, a negative CT does not exclude a leak if clinical suspicion is high, especially in the first 48-72 hours, when the orifice may be punctiform.

### *Initial diagnostic endoscopy*

In this algorithm, endoscopy is not only therapeutic but also the definitive diagnostic tool when radiological doubts exist.[3] The objective is to accurately locate the defect, measure its diameter (a determinant for the Leeds score), and evaluate the vitality of the tissue edges (presence of ischemia or fibrin).[10] It should be performed under direct vision with minimal insufflation (preferably $CO_2$) to avoid tension pneumoperitoneum or the disruption of a contained leak.

### *Biomarkers*

CRP is a fundamental follow-up marker. According to recent studies, a CRP value >150 mg/L on the third postoperative day has a high predictive value for major complications.[11] An upward trend in CRP between day 3 and day 5, despite initial antibiotic management, should trigger the execution of the interventional arm (endoscopy or surgery).

## ENDOSCOPIC INTERVENTION TOOLS

The endoscopic armamentarium for managing postoperative leaks is divided according to its mechanical objective: diverting luminal flow, draining collections, or closing the primary defect.

### *Diversion therapy: self-expanding metal stents (SEMS)*

The use of fully covered stents is one of the most widespread strategies for treating leaks in LSG and RYGB. They act by excluding the defect from the passage of saliva, acid, and food, allowing healing by second intention.[5,12] In LSG, the use of large-diameter and long stents (Mega-stents) is preferable to minimize migration, an adverse event frequently reported with conventional prostheses due to the tubular anatomy of the sleeve.[12,13] They are highly effective when the defect is large or there is a distal functional stenosis component that increases intraluminal pressure. However, their intolerance (nausea and retrosternal pain) is a limiting factor that must be managed with potent antiemetics and analgesics.[13]

### *Internal drainage: double pigtails*

Endoscopic internal drainage (EID) has gained ground as a physiological alternative, especially in stable patients. One or two pigtail catheters are placed through the leak orifice. This allows fluid from the perigastric cavity to drain into the gastric lumen, favoring the collapse of the external collection.[3,9] Unlike stents, pigtails allow immediate oral nutrition ("EDEN": Endoscopic internal drainage with enteral nutrition), which is fundamental for the patient's immunological status in the early phase.[2,9] It is a technique of choice when the orifice is wide enough to allow the passage of the guide but the surrounding tissue is too friable for clips.

***Endoscopic vacuum therapy (EVT) and VACStent***

Vacuum therapy represents a paradigm shift for complex leaks or those with large infected cavities. The endo-VAC utilizes a sponge connected to continuous negative suction, placed endoscopically within the leak cavity. This cleans debris, reduces edema, and accelerates the formation of granulation tissue.[6,14] This device combines the benefits of a stent (maintaining luminal patency and nutrition) with a vacuum section that treats the leak simultaneously. It is particularly useful in early leaks of the esophagogastric junction where local infection control is a priority.[6]

***Closure sevices: Clips (OTSC) and endoscopic suturing***

Direct mechanical closure seeks the immediate obliteration of the leak orifice, preventing continuous extraluminal contamination.

*Over-the-scope clips (OTSC)*

These are effective in defects smaller than 15-20 mm detected very early, where the tissue edges do not yet present excessive necrosis or fibrosis. They are particularly useful in staple line leaks of the gastric sleeve in mid or distal locations.[2,15]

*Endoscopic suturing (OverStitch-type systems)*

Endoscopic suturing has emerged as a versatile tool that allows for full-thickness primary closure, emulating manual surgical technique.[15,16] It is the technique of choice for leaks in the gastrojejunal anastomosis of RYGB. Because the gastric pouch and anastomosis offer a wider space than the sleeve, the suturing system can be maneuvered with greater precision to place U-stitches or continuous sutures that seal the orifice.[14,15]

*Hybrid technique (Suture + Sealants)*

In early leaks with friable edges, the combination of endoscopic suturing to reduce tissue tension, followed by the application of tissue adhesives (such as fibrin glue), has been shown to improve the success rate of primary sealing.[2,7]

## METHODS

A comprehensive literature review was performed to identify current evidence-based strategies for managing postoperative leaks in bariatric surgery. The search was conducted using databases such as PubMed, Scopus, and Google Scholar, covering the period from January 2020 to April 2026.

***Search strategy***

The search terms included "bariatric surgery leaks," "endoscopic management of sleeve gastrectomy leaks," "endoscopic vacuum therapy," and "bariatric surgical complications."

***Selection criteria***

Articles were selected based on their relevance to early leak management (3-7 days postoperatively), clinical success rates of endoscopic tools (stents, clips, suturing, and vacuum therapy), and the quality of evidence provided in indexed journals. A total of 16 key studies were analyzed and synthesized to develop the clinical-technical algorithm proposed in this study.

***Algorithm development***

The algorithm was structured based on two main clinical variables: hemodynamic stability (Group A and B) and anatomical/biological characteristics of the defect (size, tissue vitality, and procedure type).

## CLINICAL-TECHNICAL ALGORITHM FOR THE MANAGEMENT OF EARLY BARIATRIC LEAKS

***Phase I: initial evaluation and damage control***

Upon clinical suspicion (tachycardia >120 bpm, abdominal pain) and CT confirmation, a hemodynamic stability assessment must be performed. In an unstable patient, the objective is peritoneal lavage, external drainage, and, if tissue quality permits, suture reinforcement. Endoscopy is not recommended as a primary therapy in this phase.[1] In stable patients, a conservative-interventional management is preferred; if the CT scan shows collections >3 cm, image-guided percutaneous drainage should be performed simultaneously or prior to endoscopy to control the extraluminal infectious focus (Figure 1).[2,9]

***Phase II: endoscopic characterization (day 3-7)***

Once the patient is stabilized, a diagnostic/therapeutic endoscopy is performed using minimal insufflation (preferably $CO_2$) to categorize the defect.

***Phase III: selection of therapy according to technical scenario***

The intervention algorithm is divided according to endoscopic findings, based on size, the quality of the surrounding tissue, and the presence of infection. When placing a fully covered mega-stent (minimum 18-23 cm), suture fixation at the proximal end is recommended to prevent migration.[8,12] The use of transmural double pigtails is recommended if the goal is to maintain immediate oral nutrition and avoid stent intolerance.[3,9] The VACStent requires exchanges every 3-5 days until the wound bed granulates.[2,6]

In gastrojejunal anastomosis leaks, endoscopic suturing (OverStitch) can be performed for total closure of the defect, as the pouch space allows for proper maneuverability.[16]

In JJ anastomosis leaks, due to the distance, an approach with enteroscopy or a wide-channel therapeutic endoscope is attempted if the patient is stable.

If the defect is visible, OTSC clips are the preferred option. If suspicion is high but access is difficult, the threshold for surgical re-exploration should be low due to the risk of biliary peritonitis.[7]

***Phase IV: follow-up and nutrition***

*EDEN protocol*

If pigtails or stents with a permeable lumen were used, a clear liquid diet should be initiated within 24-48 hours.[9]

*Biochemical control*

CRP monitoring every 48 hours. A 25-30% decrease from the peak value is a predictor of success for the algorithm.[11]

*Re-evaluation*

A follow-up endoscopy is performed at 4-6 weeks for the removal of stents or pigtails if closure is confirmed by imaging (barium swallow or direct visualization).

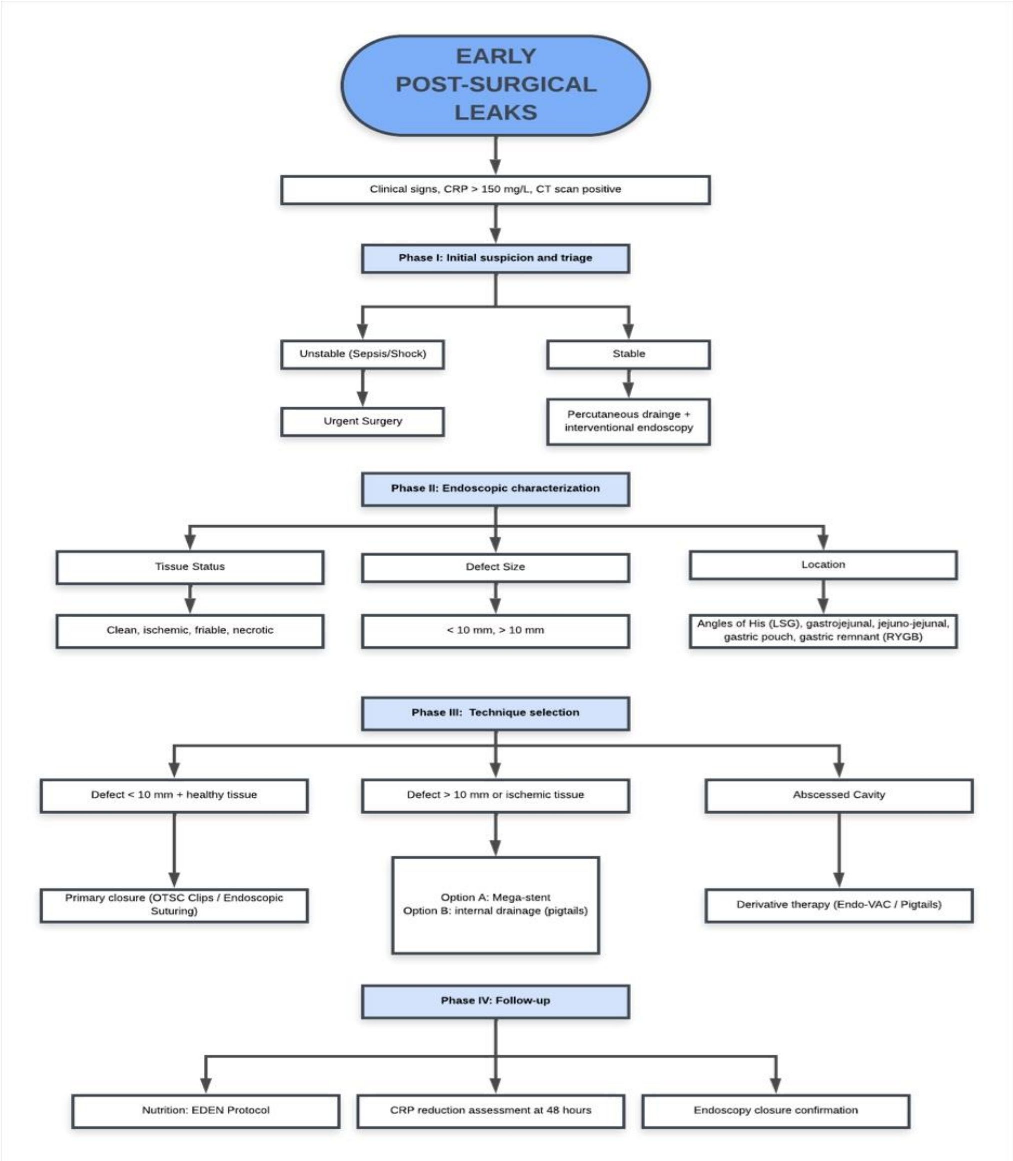


**Figure 1: Proposed clinical-technical algorithm for the management of early bariatric leaks (postoperative days 3-7) according to hemodynamic stability and defect characteristics.**

## DISCUSSION

### *The paradigm shift*

Historically, the detection of a leak following LSG or RYGB was synonymous with immediate re-laparoscopy. However, the evidence accumulated in this review, primarily by Rogalski et al and Gjeorgjievski et al suggests that reintervention in inflamed and friable tissues carries a suture failure rate of up to 50%, perpetuating the cycle of sepsis.[1,2] The current paradigm proposes that, in the early leak phase (3-7 days), the surgeon should act as a manager of the complication, prioritizing control of the infectious focus (drainage) and exclusion of the defect (endoscopy). This "organ-preserving" approach not only reduces surgical morbidity but also allows for a more physiological recovery by avoiding multiple laparotomies in patients with a systemic pro-inflammatory state.

### *The evolution of luminal therapy*

Although fully covered SEMS offer immediate sealing, the literature reports migration rates of up to 20-30% in sleeve gastrectomy.[5,13] The use of mega-stents has partially mitigated this by crossing the pylorus and stabilizing the prosthesis, but at the cost of a high incidence of nausea, vomiting, and severe reflux, which often force their premature removal.[12,13]

Authors such as Spota et al advocate for internal drainage with pigtails; this technique is disruptive because it accepts the existence of the leak but converts it into a controlled tract toward the gastric lumen.[9] The most significant advantage is immediate enteral nutrition (EDEN protocol), which optimizes the immune response and healing compared to the prolonged fasting or total parenteral nutrition required with some types of stents.

One of the most relevant findings, such as the work by Ahrens and the VACStent report is the superiority of vacuum therapy in the presence of large perigastric collections or necrotic tissue.[6,14] While the stent simply "covers" the orifice, EVT actively cleans the cavity. The introduction of the VACStent appears to resolve the nutrition dilemma, allowing for vacuum and the simultaneous passage of food, which could consolidate it as the first line of treatment for early leaks-primarily those of the esophagogastric junction-in the near future.

### *Success analysis*

It is imperative to address the critique made by El Ansari and Hany.[4] Most studies report success in a binary fashion (closure or no closure). However, in clinical practice, success should be measured by the time to return to oral intake and the avoidance of chronicity. The use of predictive models such as the Leeds score is a qualitative advancement.[10] By integrating defect size and markers such as CRP, the surgeon can predict from day 5 whether endoscopic therapy will fail, allowing for escalation to more aggressive therapies before the patient deteriorates irreversibly.

Despite the enthusiasm for endoscopy, technical and logistical limitations exist. The JJ anastomosis leak in RYGB remains the "Achilles' heel" of endoscopic management due to the difficulty of access with conventional equipment.[7] Likewise, primary closure with endoscopic suturing or OTSC clips in the early phase requires a steep learning curve; a poorly executed closure in ischemic tissue can enlarge the original defect.

## CONCLUSION

The variability in outcomes reported in the literature underscores the lack of a global consensus. The algorithm proposed in this work attempts to bridge that gap by linking the technical tool (VACStent, pigtail, suturing) not only to the anatomy but also to the biology of the leak (orifice size and tissue status).

Detection within the early window is ultimately the most important prognostic factor: it represents the critical period where endoscopic therapy reaches its highest success rate. A delayed diagnosis transforms a manageable leak into a recalcitrant fistula that may require months of treatment. In hemodynamically stable patients, endoscopic management has proven superior to systematic surgical reintervention, significantly reducing hospital stays and avoiding the cascade of complications associated with re-laparoscopy in friable tissues. There is no single universal tool. Success depends on the strategic combination of techniques: diversion (stents) for exclusion, internal drainage (pigtails) for collection control, and vacuum therapy (EVT) for cleaning complex cavities. The shift toward protocols such as EDEN, which allow for early enteral nutrition despite the leak, has been shown to improve healing and decrease metabolic complications associated with total parenteral nutrition.

Upon any persistent tachycardia between days 3 and 7, the leak suspicion protocol must be activated, regardless of the absence of fever or abdominal pain. The proposed algorithm does not replace the surgeon; instead, it positions them as the coordinator of a team that includes endoscopists and radiologists, ensuring that unstable patients are operated on without delay.

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