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Endoscopic management of post-bariatric surgery complications

Mena Boules, Julietta Chang, Ivy N Haskins, Gautam Sharma, Dvir Froylich, Kevin El-Hayek, John Rodriguez, Matthew Kroh

Mena Boules, Julietta Chang, Ivy N Haskins, Gautam Sharma, Dvir Froylich, Kevin El-Hayek, John Rodriguez, Matthew Kroh, Department of General Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, OH 44195, United States

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Correspondence to: Matthew Kroh, MD, Director of Surgical Endoscopy, Associate Professor of Surgery Cleveland Clinic Lerner College of Medicine, Department of General Surgery, Digestive Disease Institute, Cleveland Clinic, 9500 Euclid Avenue, A100, Cleveland, OH 44195, United States. krohm@ccf.org
Telephone: +1-216-4446664
Fax: +1-216-4442153

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Abstract

Understanding the technical constructs of bariatric surgery is important to the treating endoscopist to maximize effective endoluminal therapy. Post-operative complication rates vary widely based on the complication of interest, and have been reported to be as high as 68% following adjustable gastric banding. Similarly, there is a wide range of presenting symptoms for post-operative bariatric complications, including abdominal pain, nausea and vomiting, dysphagia, gastrointestinal hemorrhage, and weight regain, all of which may provoke an endoscopic assessment. Bleeding and anastomotic leak are considered to be early (< 30 d) complications, whereas strictures, marginal ulcers, band erosions, and weight loss failure or weight recidivism are typically considered late (> 30 d) complications. Treatment of complications in the immediate post-operative period may require unique considerations. Endoluminal therapies serve as adjuncts to surgical and radiographic procedures. This review aims to summarize the spectrum and efficacy of endoscopic management of post-operative bariatric complications.

Key words: Bariatric surgery; Weight loss surgery; Bariatric complications; Endoscopy; Bariatrics

Core tip: There are minimal reviews in the literature discussing therapeutic options for endoscopic management of bariatric surgery complications. Treatment of bariatric complications in the post-operative period

may require unique considerations. Endoluminal therapies serve as adjuncts to surgical and radiographic procedures. This review aims to summarize the spectrum and efficacy of endoscopic management of post-operative bariatric complications.

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INTRODUCTION

Obesity is an increasing health concern in the United States and worldwide. According to the World Health Organization, obesity has doubled since 1980. In 2014 alone, more than 1.9 billion adults were classified as overweight, of which 600 million were obese[1]. Durable medical therapy for morbid obesity is limited. As an alternative, many studies have demonstrated the benefits of bariatric surgery in terms of excess weight loss and improvement or resolution of weight-related co-morbid diseases[2-6]. As of 2013, the most commonly performed laparoscopic bariatric procedures worldwide are Roux-en-Y gastric bypass (RYGB) (45%), sleeve gastrectomy (SG) (37%) and adjustable gastric banding (AGB) (10%)[7].

Peri-procedural complications have been reduced by the development and widespread use of laparoscopic techniques, improved training and credentialing, and establishment of comprehensive and dedicated bariatric surgery programs[4,5,8]. Nevertheless, bariatric surgery related complications remain a clinical challenge. Traditional management of these complications has been performed using surgical and interventional radiology techniques. Recently, however, endoscopic therapies have been introduced as an alternative and minimally invasive approach to peri-procedural complications[9].

Endoluminal treatment of peri-procedural complications following bariatric surgery may help to minimize patient morbidity. In order for endoscopic therapies to be successful, the treating endoscopist must be cognizant not only of the anatomical constructs of bartiatric surgery but also of any newly constructed anastomosis or staple line[9-11]. This review aims to summarize the spectrum and efficacy of endoscopic management of post-operative bariatric complications.

EARLY COMPLICATIONS (< 30 D POST-OPERATIVELY)

Gastrointestinal bleeding

Gastrointestinal (GI) bleeding usually presents in the immediate post-operative period secondary to technical complications. Most commonly, this occurs as intra-luminal bleeding, but extra-luminal bleeding can occur. Bleeding primarily occurs from the submucosal vessels along the staple line at the gastro-jejunostomy, jejuno-jejunostomy, or along the staple lines of the gastric pouch.

Signs and symptoms of bleeding, including a drop in hemoglobin levels, hematemesis, hematochezia, or melena, should be considered an indication to undergo further evaluation. Endoscopy is often used as a first-line modality for investigation of the source of bleeding. However, when post-operative bleeding is severe and associated with hemodynamic instability, surgical re-exploration may be required.

As the incidence of RYGB increases worldwide, so too does the frequency of post-operative upper GI bleeding in this patient population[12,13]. In the immediate 48 h after LRYGB, hemorrhage is reported to occur with an incidence between 1%-4%. Thirty to sixty-three percent of these occurrences require blood transfusion but are nonetheless self-limited[11,14,15]. Endoscopy is considered in the early period when patients have proven bleeding and this is refractory to supportive therapy[11]. Literature demonstrates therapeutic endoscopy interventions range between 6%-85% in these circumstances, and the culprit is often found at the G-J anastomosis[11-14,16].

Various endoscopic treatments have been shown to be effective for the management of bleeding peptic ulcers. A meta-analysis of randomized controlled trials demonstrated efficacy with the use of several endoscopic therapies, including thermal therapies (heater probe, mono and bi-polar electrocoagulation, argon plasma coagulation, and laser therapy), injections with epinephrine and various sclerosants, clips, and fibrin or thrombin glues[17]. We believe that the approaches described in this meta-analysis will be useful for the management of early post-operative bleeding in those patients undergoing bariatric surgery as the use of epinephrine injection with thermal coagulation, sclerosants, or clips, has previously been shown to be successful in the bariatric patient population[14]. The most common endoscopic interventions performed for the management of acute bleeding in this patient population are described below.

Thermal therapy for bleeding: Electrocautery is a thermal heat therapy. It is delivered through the form of mono-, bi-, or multi-polar electrocautery. Coaptation is the process of applying mechanical pressure using the probe in combination with heat or electrical stimulation to coagulate a blood vessel. Argon plasma coagulation is considered a form of non-contact heat therapy that uses argon gas to deliver thermal energy with resultant hemostasis of superficial tissues. Laser therapy is not commonly used due to cost, need for specific training, and safety[18].

Injection therapy for bleeding: The efficacy of injection therapy occurs by volume tamponade and fibroris and vasoconstriction when used with epinephrine.

The volume of fluid injected results in mechanical tamponade of the bleeding vessel. This effect is coupled with fibrosis from an inflammatory response and vasoconstriction that is induced by an alpha-receptor mediated response to epinephrine which leads to platelet aggregation[19].

The most important factor in the immediate control of bleeding is likely mechanical compression. Dual therapy with larger volumes of fluid combined with an epinephrine component result in better rates of hemostatic control, lower rates of re-bleeding, and decreased need for transfusion in patients with bleeding foregut ulcers[19]. Several randomized trials have established the efficacy of achieving hemostasis with the use of epinephrine to treat active bleeding[17]. In a recent study, single-therapy with epinephrine was shown to be less effective in the prevention of bleeding when compared to other single-therapy treatment modalities[17,20]. These findings were also confirmed in a meta-analysis conducted by Marmo *et al*[21] who found combination therapy to be a superior approach when compared to single agent epinephrine. A decreased rate of progression of the rate of bleeding was shown when epinephrine was used in combination with a second therapy such as bipolar electrocoagulation, injectable sclerosants, or clips[17,22].

Clip therapy for bleeding: Endoscopic clips are composed of two stainless steel ribbons (with various lengths as needed), with a range of 90 to 135 degree angles. The opening distance of clips range from 6-12 mm, allowing for flexibility in securing the desired amount of tissue. Clips typically slough off after a period of 2-4 wk but have be reported to remain in place up to one year after placement[23-27]. Advantages of clip placement for hemostasis include the ability to imbricate surrounding tissues for compression, the application of direct pressure to the targeted vessel, and ease of repeat clip placement[25,28,29].

In a retrospective review of 742 patients that underwent LRYGB, post-operative bleeding was reported in 3.5% of the patients. Nineteen (2.6%) patients presented with early GI bleeding while 7 presented with late bleeding. A total of 5 patients with early GI bleeding were diagnosed by endoscopy and received a combination treatment with endoscopic clips and epinephrine injections. Similarly, a prospective study by Fernández-Esparrach *et al*[30] reported results of 381 LRYGB patients. Twenty-two (5.8%) patients were determined to have upper GI bleeding. Sixteen were managed without procedural intervention. Six patients required intervention, all of whom were managed successfully with endoscopic intervention with epinephrine injections either as a single therapy or in combination with polidocanol[30].

A retrospective study presented by Jamil *et al*[14] identified 933 patients that underwent LRYGB during a 5-year study period. Thirty patients presented with signs of upper GI bleeding, 27 of whom required endoscopic intervention. All bleeding occurred at the G-J anastomosis. Endoscopic findings revealed active oozing in 13 (48%) patients, a visible bleeding vessel in 7 (26%) patients, and an adherent clot in 7 (26%) patients. Twenty-three (85%) of these patients required endoscopic intervention, which included injection with epinephrine (n = 3, 13%), heat electrocautery (n = 4, 17%), dual therapy with epinephrine and heat electrocautery (n = 14, 61), and clips (n = 2, 9%). Hemostasis was eventually achieved in all patients but 5 (17%) patients required repeat endoscopic management for re-bleeding[14].

Anastomotic leak and fistulas

Anastomotic leaks following bariatric surgery are most commonly found along staple lines. Patients who undergo RYGB are most susceptible to anastomotic leak at the G-J anastomosis due to the single blood supply to the gastric pouch. Leak after SG is often at the EG junction and may be secondary to stenosis at the incisura. Leak after duodenal switch is typically at the duodenal-ileal staple line.

While the cause remains unclear, leaks are hypothesized to be due to technical factors including anastomotic tension, tissue ischemia, size of staple line, tissue thickness, and blood supply. Although rare, leaks are associated with significant morbidity and mortality. Overall incidence of anastomotic leak following bariatric surgery is reported to range from 1% to 6%. Specifically, LRYGB is associated with an incidence of 0.1% to 5.6% while SG is approximately 2.4%[31,32].

Bariatric surgery can be challenging for the novice surgeon. As surgeon experience in this field increases, the risk of anastomotic leak is often shown to decrease. In a study by Schauer *et al*[33], they defined the learning curve for laparoscopic bariatric surgery to be 100 cases, at which time there was a significant decrease in operative time and technical complications. In a prospective study by DeMaria *et al*[34], 281 consecutive LRYGB operations were performed, with a decrease in the rate of anastomotic leak as surgeon experience with the laparoscopic approach increased.

In the early post-operative period, extra-luminal leaks may lead to a wide array of sequelae including abscess formation, peritonitis, sepsis, multi-organ failure, and death. Clinical signs of a leak, such as tachycardia, abdominal pain, or fever warrant prompt evaluation by the surgeon in order to minimize associated morbidity[35]. The principles of managing these patients include infection control, nutritional support, and the appropriate therapeutic intervention. We recommend the use of non-surgical, endoscopic interventions for patients without hemodynamic instability in order to minimize the additional stress and risk of iatrogenic injury associated with reoperation. On the other hand, we recommend surgical re-exploration for all critically ill patients and for those patients who do not improve with endoscopic interventions. The types of endoscopic interventions for post-operative anastomotic leaks will be further discussed below.

Endoscopic stents: The use of endoscopic stents for

the management of post-operative anastomotic leaks is the most commonly used endoscopic modality in our experience. Self-expandable stents have gained popularity and can be a useful tool for management of leaks in the acute period (ref). There are several types of stents available, with fully covered and partially covered self-expanding metal stents (SEMS) being the most useful for management of bariatric complications. These stents work by means of omitting the site of leakage from esophago-gastric secretions, ultimately preventing further contamination and enhancing healing of the leak site. Patients may also resume oral liquid intake after the leak is excluded, which has been shown to lead to an improvement in the patient's nutritional status and therefore faster healing of the anastomotic or staple line leak[35,36].

Authors of a small study reported successful endoscopic treatment of leaks in three patients and concluded that endoscopic treatment may serve as a less invasive and feasible alternative when compared to surgical management[37]. A prospective study by Yimcharoen *et al*[9] from the Cleveland Clinic evaluated the use of three different stents [silicone tube (prototype salivary), fully or partially covered expandable metal stents, or a silicone-coated polyester stent] for post-bariatric surgery complications in 18 patients. The study reported success in achieving symptom improvement in 17 (89%) patients and complete resolution of the anastomotic leak in 11 (85%) patients[9]. Our group also presents results in a retrospective review of 47 patients that underwent endoscopic SEMS placement for anastomotic complication following upper GI surgery. Symptomatic improvement after stent placement was achieved in 70.9% (n = 38) of patients. Majority (68.1%, n = 32) of patients were able to initiate oral nutrition within 48 h of stent placement, with 57% of patients with anastomotic ort staple-line leak and 89% of patient with strictures and stenosis able to initiate oral nutrition[23]. A meta-analysis analyzing the use of SEMS in anastomotic leaks after bariatric surgery reports successful leak closure of 88%, with only 9% of patient's required further revisional surgical intervention for persistent anastomotic leak[38].

The use of stents for the management of bariatric complications remains under investigation and is not without associated risks. The possibility of stent migration must be considered when deciding to proceed with stent insertion. Multiple techniques have been described in an effort to decrease migration of fully covered stents by means of clipping or suturing[9,23]. Surgeons at our institute prefer the use of partially covered stents as these types of stents effectively exclude the leak while minimizing the risk of stent incorporation into the native tissues.

Clips: There is minimal data evaluating the role of endoscopic clips for management of anastomotic or staple line leaks. In a recent retrospective study by Keren *et al*[39], the over-the-scope clip (OTSC) (Ovesco Endoscopy, TEndosco, Germany) was used in 26 patients that developed leaks post-SG. The study concluded that 21 (80.7%) patients were successfully treated with the OTSC device[39]. At our institute, clips are used to compliment other management modalities, primarily stenting.

Suturing: The use of endoscopic suturing platforms has gained popularity for management of bariatric complications, including gastric pouch dilation and weight recidivism. This may be useful in both the acute and long-term setting. Current endoscopic suturing devices include the Apollo Overstitch (Apollo, Austin, TX) and the G-Prox (USGI Medical, San Capistrano, CA). Suturing *via* the Apollo Overstitch device allows for full thickness suturing for tissue approximation in the GI tract. This device has been implicated in the early use of marginal ulcers, stoma reduction after gastric bypass surgery, and closure of fistulas[40,41]. The use of endoscopic plication will be further discussed under the management of long-term complications following bariatric surgery.

Fibrin glue: Fibrin glue or sealant is described in a brief review as a two-component hemostatic and sealant with tissue adhesive capabilities. Fibrin glue is composed of fibrinogen and thrombin[42]. Once injected endoscopically at the site of leakage, the constituents promote occlusion at the site of defect, hindering the progression of the leak. Fibrin glue is rarely used a single modality but rather in combination with endoscopic stenting[43-46]. Two endoscopic techniques have been described by several authors. Bolin and colleagues applied the fibrin glue under direct vision, through a double lumen catheter, leading to coagulation and the formation of a clot which plugged the defect[47]. Victorzon *et al*[48] described the process as a promotion in swelling and consolidation of the defect after endoscopic injection leading to a plug of the defect. Several studies in the literature indicate success in closure of gastrocutaneous fistulas using endoscopic injection of fibrin glue. Papavramidis *et al*[49] reported success in two patients that received fibrin glue for high-output gastrocutaneous fistulas occurring post-vertical banded gastroplasty (VBG).

Late complications

Management of strictures: Endoscopic management of strictures continues to increase in an effort to avoid the higher morbidity of revisional procedures. The incidence of strictures varies according to the underlying bariatric operation[50]. Strictures are more common post-LRYGB, with an estimated incidence rate ranging between 3%-28%[51-53]. The cause of stricture development continues to remain unclear and is likely multifactorial. Tissue ischemia caused by the stapler, anastomotic tension, edema, and even foreign body reactions are believed to contribute to the development of anastomotic strictures[51]. The development of stenosis maybe from the aforementioned factors, but some authors would agree the rate of stenosis may also be linked to the technique used for creation of the gastric reservoir

or anastomosis. Circular staplers have been implicated to have higher stricture rates *vs* hand-sewn or linear techniques. Common symptoms that should increase the index of suspicion for stricture development include nausea, vomiting, dysphagia, malnutrition, or significant weight loss over a short period of time.

Strictures can be diagnosed by several modalities, including endoscopy. Although other modalities may suffice, the ability to have direct, visual diagnostic and therapeutic capabilities gives endoscopy the upper hand[54]. Endoscopic findings include the presence of a stenotic lumen, dilation of the gastric pouch, or non-digested food particles[55].

Although less frequent, stricture development post-SG may present a greater management challenge. Incidence in patients undergoing SG is reported to be between 0.2% to 4%[56]. Possible causes of post-SG stenosis development include the use of a small bougie. Post-SG strictures commonly occur at the proximal to mid stomach, incisura, or the gastro-esophageal junction. As in post-LRYGB, endoscopy plays a vital role in diagnosis and management of these strictures.

Endoscopic balloon dilation: Endoscopic balloon dilation has become first-line treatment and standard of care for the management of strictures post-LRYGB[51]. There are many endoscopic balloons available for use, all of which are designed from polymers that have the ability to expand to the desired diameter. These balloons are geometrically designed to advance through the working channel (2.8 mm) of an endoscope with or without a guide wire.

The first step when performing endoscopic balloon dilatation is to identify the anatomy and properly estimate the size of the stricture. If the scope is unable to advance, a standard pediatric scope should be tried. The choice of balloon should then be decided based on the ability of the endoscope to traverse the stricture.

The balloon should be positioned at the site of maximum luminal narrowing. The balloon should be expanded slowly to its maximum diameter and held under tension for one minute. A prospective study conducted by Ahmad *et al*[57], evaluating balloon dilation for strictures in patients that underwent LRYGB, concluded that balloon dilation is safe, effective and can be reproduced with minimal adverse effects. Additional studies have also shown that balloon dilation is a durable therapy for both the short- and long-term management of anastomotic strictures[58,59].

Management of strictures post-SG includes observation, endoscopic dilation with or without stenting, seromyotomy, or ultimately converting to a LRYGB. It is important to differentiate true stenosis from sleeve rotation or torsion which may mimic obstructive symptoms. This may also be managed through endoscopic dilation, myotomy or surgical revision.

Stenting: Stenting may also be used in the management of strictures. In a prospective series presented by Eubanks *et al*[36], the authors report an 83% stent success rate in managing strictures in six patients that had been refractory to repeated balloon dilations. Nevertheless, a common concern of stent application is stent migration, which is reported to occur in 58% to 66% of stents placed[9,60,61]. Controversies seem to exist regarding the rate of stent migration with the use of covered or partially covered stents. Some studies did not find a difference, while other studies reported a greater incidence of migration associated with fully covered stents. Covered stents are least likely to be incorporated by the native tissues which may lead to the higher rate of tent migration[9].

Weight loss failure or weight recidivism: Weight loss failure is a broad term with no agreed upon definition amongst bariatric surgeons. As best we can tell, the incidence of weight recidivism is estimated to be 10%-20%[62]. Technical failure may play a role in the development of initial weight loss failure post-bariatric surgery or recidivism after initial weight loss. Several other factors such as non-dietary compliance, large gastrojejunal anastomoses, dilation of the gastric pouch, and gastrogastric fistula development may contribute to weight loss failure or weight recidivism[59,63]. Endoscopic therapies for weight regain continue to advance, providing a visible assessment of the anatomy as well as therapeutic intervention.

Endoscopy allows for the reduction in the stoma size of the gastrojejunal anastomosis by means of four quadrant endoscopic injection of sodium morrhuate into the seroma, which leads to scar formation, effectively reducing the stoma size[59,63]. An alternative approach to the management of a dilated pouch is plication of the gastric pouch or stoma[64]. This is an emerging technology and data on the long-term efficacy of this approach is not currently available. Nevertheless, in an effort to reduce pouch size, utilization of endoscopic suturing devices permit a non-surgical revision of the gastrojejunal anastomoses. Further studies demonstrating the durability and feasibility in the long-term are warranted[65].

Marginal ulcer: Marginal ulcers occur at the gastrojejunal anastomosis with a reported incidence of 1% to 16% after RYGB. It typically occurs within the first several months post-operatively[66-70]. Multiple factors have been identified in the development of ulcers, which include but are not limited to, ischemia, use of non-steroidal anti-inflammatory medications, disruption along the staple line, suture or staple erosion, gastrogastric fistula, increased gastric acidity, or tobacco use[63,71]. The association of *Helicobacter pylori* (*H. pylori*) with the development of marginal ulcers remains unknown[72]. Marginal ulcer may also be a cause of late bleeding post-bariatric surgery. Morbidity and mortality may be attributed to bleeding and perforation from marginal ulcers. Most common presenting symptoms include epigastric or abdominal pain, bleeding, nausea, vomiting, iron deficiency anemia, heme-positive stools, and in certain

instances patient may be asymptomatic.

In a study evaluating the incidence of marginal ulceration one month after gastric bypass, the ulcer rate was 4.1% after open RYGB and 12.3% after LRYGB patients. The study also noted that 28% of the ulcers were asymptomatic at the time of evaluation[73]. Ulcers may be managed non-operatively by means of anti-acid, proton pump inhibitor medications and buffers such as sucralfate and discontinuation of the use of ulcer enhancing medications or lifestyles[63]. Azagury *et al*[74] reported a 68% ulcer healing rate when combining medical therapies with eradication of possible risk factors.

The role of endoscopy in dealing with marginal ulcers is primarily to aid in establishing a diagnosis. In certain cases when eroded sutures are identified at the anastomosis, the sutures can be cut with endoscopic scissors and removed. If marginal ulcers are diagnosed during endoscopy, a meticulous examination for fistulas should be performed. If ulcers are refractory to medical treatment or are severe in nature, operative management may be required in an effort to prevent complications such as recurrent bleeding, perforation, and strictures[75].

VBG: VBG was a popular procedure in the 1980s but has since been replaced by the AGB. VBG can be thought of as a combination of a SG with a non-AGB[76]. In other words, this was a restrictive procedure that created a smaller stomach pouch with a non-adjustable band at the distal aspect of the pouch that controlled the rate at which nutrients reached the rest of the GI tract. The VBG procedure was ineffective at long-term weight loss and a majority of patients suffered from band erosion, outlet stricture, and gastro-gastric fistula causing weight regain[76,77]. These complications can all be diagnosed on endoscopy but are best managed with surgical revision. Options for revision of VBG include RYGB or VBG reversal *via* gastrogastrostomy[77].

Band erosion, migration and slippage: Since VBG and AGB were once the most commonly performed bariatric procedure, there is a large population at risk of their associated complications, including band erosion, migration, and slippage. The incidence of band erosions is reported to occur in 0.1% to 7.7% of all patients[78-82]. This complication is commonly diagnosed endoscopically by the erosion of the band into the stomach lumen.

Upon discovery of erosion of a VBG, the band may be severed endoscopically just as long as the band has remained encapsulated[63,83,84]. If uncertain about the state of capsulation, a computed tomography scan should be obtained for further evaluation prior to endoscopic intervention. On the other hand, patients who have undergone AGB may have diagnosis of band erosion on endoscopy but cannot undergo endoscopic intervention due to the presence of tubing that connects the band subcutaneously for adjustment.

Band slippage is a possible complication for both VBG and AGB but is more common with AGB. This is typically diagnosed through an upper GI series but may be observed on endoscopy by visualization of a larger than expected stomach pouch with narrowing of the gastric lumen distally[63,83,84]. Band slippage is a surgical emergency as it may lead to necrosis of the stomach.

CONCLUSION

Flexible endoscopy has become an essential tool in managing bariatric surgery patients. Endoscopy offers the benefit of providing both diagnostic and therapeutic applications. Endoscopy should be performed by an experienced endoscopist familiar with bariatric anatomies and with advanced skills in their therapeutic armamentarium. Endoscopic procedures in the post-bariatric surgery patient presents unique challenges unlike other endoscopic procedures because of altered anatomy, and specifically, access to the biliopancreatic limb, remnant stomach, and jejunojejunostomy. Common complications after bariatric surgery include: Bleeding, leaks/fistulas and strictures. Increasingly, endoscopist are gaining the experience to successfully diagnose and treat post-bariatric surgery patients and their complications.

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