

**American College of Radiology  
ACR Appropriateness Criteria®  
Preoperative and Postoperative Imaging for Bariatric Procedures**

**Variant 1:                    Adult. Bariatric procedure. Routine preprocedure planning.**

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy biphasic esophagram	May Be Appropriate	☼☼☼
Fluoroscopy single contrast esophagram	May Be Appropriate	☼☼☼
Fluoroscopy upper GI series	May Be Appropriate	☼☼☼
US abdomen	Usually Not Appropriate	○
Radiography abdomen	Usually Not Appropriate	☼☼
Fluoroscopy small bowel follow-through	Usually Not Appropriate	☼☼☼
MRI abdomen without and with IV contrast	Usually Not Appropriate	○
MRI abdomen without IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☼☼☼
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☼☼☼
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☼☼☼☼

**Variant 2:                    Adult. Bariatric procedure. Routine immediate postprocedure evaluation.**

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy upper GI series	May Be Appropriate	☼☼☼
CT abdomen and pelvis with IV contrast	May Be Appropriate	☼☼☼
CT abdomen and pelvis without IV contrast	May Be Appropriate	☼☼☼
US abdomen	Usually Not Appropriate	○
Radiography abdomen	Usually Not Appropriate	☼☼
Fluoroscopy biphasic esophagram	Usually Not Appropriate	☼☼☼
Fluoroscopy single contrast esophagram	Usually Not Appropriate	☼☼☼
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☼☼☼
MRI abdomen without and with IV contrast	Usually Not Appropriate	○
MRI abdomen without IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☼☼☼☼

**Variant 3:****Adult. Less-invasive bariatric procedure. Suspected complication. Postprocedure evaluation.**

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy upper GI series	May Be Appropriate	⊕⊕⊕
Radiography abdomen and pelvis	May Be Appropriate	⊕⊕⊕
CT abdomen and pelvis with IV contrast	May Be Appropriate	⊕⊕⊕
CT abdomen and pelvis without IV contrast	May Be Appropriate	⊕⊕⊕
US abdomen	Usually Not Appropriate	○
Fluoroscopy biphasic esophagram	Usually Not Appropriate	⊕⊕⊕
Fluoroscopy single contrast esophagram	Usually Not Appropriate	⊕⊕⊕
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	⊕⊕⊕
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

**Variant 4:****Adult. Bariatric procedure. Suspected complication. Postprocedure evaluation.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	⊕⊕⊕
Fluoroscopy upper GI series	May Be Appropriate	⊕⊕⊕
CT abdomen and pelvis without IV contrast	May Be Appropriate	⊕⊕⊕
US abdomen	Usually Not Appropriate	○
Fluoroscopy biphasic esophagram	Usually Not Appropriate	⊕⊕⊕
Fluoroscopy single contrast esophagram	Usually Not Appropriate	⊕⊕⊕
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	⊕⊕⊕
Radiography abdomen and pelvis	Usually Not Appropriate	⊕⊕⊕
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

## PREOPERATIVE AND POSTOPERATIVE IMAGING FOR BARIATRIC PROCEDURES

Expert Panel on Gastrointestinal Imaging: Jason A. Pietryga, MD<sup>a</sup>; Cynthia S. Santillan, MD<sup>b</sup>; Elena K. Korngold, MD<sup>c</sup>; James H. Birkholz, MD<sup>d</sup>; Brooks D. Cash, MD<sup>e</sup>; Bari Dane, MD<sup>f</sup>; Nattaly Horvat, MD, PhD<sup>g</sup>; Avinash R. Kambadakone, MD<sup>h</sup>; Peter S. Liu, MD<sup>i</sup>; Ann M. Rogers, MD<sup>j</sup>; Ashley E. Vorenkamp, MD<sup>k</sup>; Chadwick L. Wright, MD, PhD<sup>l</sup>; Kathryn J. Fowler, MD.<sup>m</sup>

### Summary of Literature Review

#### **Introduction/Background**

Obesity, which is defined as an excessive accumulation of body fat resulting in a body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup>, is a chronic health condition and an increasing worldwide epidemic, nearly tripling in prevalence since 1975 [1]. According to the Centers for Disease Control and Prevention, the estimated prevalence of obesity among adults ( $\geq 20$  years of age) in the United States is approximately 42%, with 9% having severe obesity [2]. Obesity is associated with chronic low-grade inflammation, which has been linked to metabolic diseases and organ tissue complications [3]. Specifically, obesity is a risk factor for numerous medical conditions including diabetes, hypertension, dyslipidemia, nonalcoholic fatty liver disease, chronic kidney disease, and multiple types of cancer [4]. It is estimated that up to 21% of health care expenditures in the United States go toward treating obesity-related diseases [5].

Bariatric surgery is an effective method to achieve long-term weight loss and to treat obesity-associated comorbidities [6]. Since the indications for the management of severe obesity were first defined in 1991 by the National Institutes of Health Consensus Development Panel, there have been advances in surgical techniques with the development of newer safer procedures. With these advances, and increases in experience with bariatric procedures, a review of the current literature with an update in the recommendations regarding bariatric procedures was performed jointly by The American Society for Metabolic and Bariatric Surgery (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) [7]. The ASMBS and IFSO recommend bariatric surgery for all individuals with a BMI  $\geq 35$  kg/m<sup>2</sup> and recommend that it be considered for non-Asian individuals with metabolic disease and BMI of 30 to 34.9 kg/m<sup>2</sup> and for Asian individuals with BMI  $\geq 27.5$  kg/m<sup>2</sup> [7]. The most commonly performed bariatric surgery worldwide is sleeve gastrectomy (SG), followed by Roux-en-Y gastric bypass (RYGB) and one-anastomosis gastric bypass [8]. Additional bariatric procedures include biliopancreatic diversion with duodenal switch, single-anastomosis duodenal switch, endoscopic sleeve gastroplasty, and intragastric balloons. Before bariatric surgery, patients are evaluated by a multidisciplinary team to minimize morbidity and mortality and optimize the postoperative outcome. Although there are no consensus guidelines for preoperative imaging, it is recommended that patients with significant gastrointestinal (GI) symptoms, biliary symptoms, or elevated liver function tests be evaluated with imaging [4]. The presence of a hiatal hernia, significant gastroesophageal reflux, and cholelithiasis can alter the surgical plan.

Bariatric surgeries are safe, with a complication rate of 4% and a mortality of 0.1% [9]. Complications vary depending on which procedure is performed; however, common complications include staple-line leak, hemorrhage, infection, internal hernia, and bowel obstruction. Early diagnosis and treatment of these complications is critical to minimize patient morbidity and mortality. Clinical evaluation for complications after bariatric surgery can be difficult due to limited physical examination (secondary to body habitus) and the nature of symptoms of bariatric complications, which are often insidious and nonspecific.

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## **Special Imaging Considerations**

In general, there has been a trend toward performing CT abdomen and pelvis without oral contrast regardless of whether or not intravenous (IV) contrast is administered. However, when imaging postoperative bariatric patients suspected of complication with CT, positive oral contrast is ideally used to help delineate anatomy and to help evaluate for complications, particularly gastric and bowel leaks.

### **Discussion of Procedures by Variant**

#### **Variant 1: Adult. Bariatric procedure. Routine preprocedure planning.**

Patients being considered for a bariatric procedure undergo extensive multidisciplinary preprocedural evaluation to ensure appropriate surgical candidacy and to determine the most appropriate surgical intervention. Routine imaging studies can be obtained to evaluate patient anatomy and to identify comorbid conditions that may impact which bariatric procedure is performed.

#### **CT Abdomen and Pelvis With IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis with IV contrast in the routine preprocedural planning for patients undergoing bariatric procedures. A single retrospective study of 521 patients who underwent routine preoperative CT abdomen and pelvis with IV contrast before bariatric surgery reported that only 3% (16 of 521) of patients had significant imaging findings and that only 1% (5 of 521) needed another procedure before bariatric surgery [10]. The preoperative procedures included transjugular intrahepatic portosystemic shunt placement, right colectomy, thyroidectomy, and iliac wing resection (bone tumor.)

#### **CT Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast in the routine preprocedural planning for patients undergoing bariatric procedures.

#### **CT Abdomen and Pelvis Without IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast in the routine preprocedural planning for patients undergoing bariatric procedures.

#### **Fluoroscopy Biphase Esophagram**

A biphase fluoroscopic esophagram can be used to diagnose pathology (eg, esophageal dysmotility, gastroesophageal reflux, and hiatal hernia) that can alter which bariatric procedure is performed [11,12]. However, there is no relevant literature to support the use of biphase fluoroscopic esophagram in the routine preprocedural planning for patients undergoing bariatric procedures. The American Association of Clinical Endocrinologists/American College of Endocrinology, The Obesity Society, American Society for Metabolic & Bariatric Surgery, Obesity Medicine Association, and American Society of Anesthesiologists (AAACE/TOS/ASBMS/OMA/ASA) 2019 perioperative bariatric procedure guidelines recommend that preoperative patients with significant GI symptoms be further evaluated with imaging but do not specify what specific imaging test to perform [4].

#### **Fluoroscopy Single Contrast Esophagram**

A single contrast fluoroscopic esophagram can be used to diagnose pathology (eg, esophageal dysmotility, gastroesophageal reflux, hiatal hernia, ulcer, or stricture) that can alter which bariatric procedure is performed [11,12]. However, there is no relevant literature to support the use of single contrast fluoroscopic esophagram in the routine preprocedural planning for patients undergoing bariatric procedures. The AAACE/TOS/ASBMS/OMA/ASA 2019 perioperative bariatric procedure guidelines recommend that preoperative patients with significant GI symptoms be further evaluated with imaging but do not specify what specific imaging test to perform [4].

#### **Fluoroscopy Small Bowel Follow-Through**

There is no relevant literature to support the use of fluoroscopy small bowel follow-through in the routine preprocedural planning for patients undergoing bariatric procedures.

#### **Fluoroscopy Upper GI Series**

A fluoroscopic upper GI (UGI) series can be used to diagnose pathology (eg, esophageal dysmotility, gastroesophageal reflux, hiatal hernia, ulcer, or stricture), which can alter what bariatric procedure is performed [11,12]. In a retrospective study of 167 patients with preoperative UGI series, Sharaf et al [12] reported that only 5% (9 of 167) of the studies had findings that altered and/or delayed the surgical plan. Schneider et al [11] evaluated

the usefulness of routine UGI series in 1,178 patients being evaluated before SG or RYGB. The authors found that the UGI series identified hiatal hernias in 28% (325 of 1,178) of the patients (more than detected by upper endoscopy), 1 patient with achalasia, and another one with severe esophageal dysmotility. Within this patient cohort, 5% (60 of 1,178) had their surgical plan altered by their UGI series, 57 patients had an intraoperative hiatal hernia repair, and 3 patients switched their surgical plans from an SG to an RYGB. The AACE/TOS/ASBMS/OMA/ASA 2019 perioperative bariatric procedure guidelines recommend that preoperative patients with significant GI symptoms be further evaluated with an UGI series [4].

#### **MRI Abdomen Without and With IV Contrast**

There is no relevant literature to support the use of MRI abdomen without and with IV contrast in the routine preprocedural planning for patients undergoing bariatric procedures.

#### **MRI Abdomen Without IV Contrast**

There is no relevant literature to support the use of MRI abdomen without IV contrast in the routine preprocedural planning for patients undergoing bariatric procedures.

#### **Radiography Abdomen**

There is no relevant literature to support the use of abdominal radiography in the routine preprocedural planning for patients undergoing bariatric procedures.

#### **US Abdomen**

The routine use of abdominal ultrasound (US) in the preprocedural evaluation of patients undergoing bariatric procedures is controversial. In a retrospective study of 913 patients, Abou Hussein et al [13] found that routine abdominal US before bariatric surgery revealed US findings that delayed or canceled surgery in only 1% (11 of 913) of patients. These patients were found to have suspicious liver (n = 5) or renal (n = 6) lesions, which required further evaluation before surgery. In a retrospective study of 747 SG patients by Almazeedi et al [14], the authors evaluated the usefulness of routine abdominal sonography before surgery. Although they identified cholelithiasis in 11% (83 of 747) and hepatic steatosis in 57% (427 of 747) of patients, US did not add significantly to the preprocedural workup or change the course of the procedure. Schneider et al [11], in a retrospective study of 1,188 RYGB and SG patients who underwent routine preoperative abdominal sonography, reported that 18.5% (220 of 1,188) of patients had a change in therapy due to the sonographic findings. In this study, 220 patients with cholelithiasis underwent cholecystectomy at the time of bariatric surgery, 3 of whom also underwent endoscopic retrograde cholangiopancreatography for asymptomatic choledocholithiasis.

#### **Variant 2: Adult. Bariatric procedure. Routine immediate postprocedure evaluation.**

The routine use of imaging immediately after bariatric procedure is controversial [15]. Imaging after bariatric surgery involving primary stapling (eg, RYGB and SG) is performed to facilitate early detection and treatment of suture line/anastomotic leak but can also be used to evaluate for anastomotic stenosis/stricture, obstruction, and hemorrhage [16,17].

Many surgeons image bariatric patients within the first 2 days postoperatively, to screen for these complications as part of the routine postoperative care [18,19]. Others reserve imaging for symptomatic or high-risk patients [17,20]. Clinical signs of a suture line leak include tachycardia, respiratory distress, fever, abdominal pain, nausea, and vomiting [20]. In a position statement from the ASMBS, the society recommends that the decision to perform routine versus selective imaging after RYGB or SG for detection of leak be at the discretion of the surgeon [16].

#### **CT Abdomen and Pelvis With IV Contrast**

There is limited literature regarding the routine use of CT of the abdomen and pelvis in the immediate postprocedural bariatric patient. In a prospective study of 1,000 patients undergoing SG, Lainas et al [21] evaluated the routine use of postoperative day (POD) 2 CT. The specifics regarding the use of IV contrast for CT in this study were not reported. Routine early postoperative CT detected hemorrhage/hematoma in 3% of the patients (75% of whom were asymptomatic) and a gastric staple-line leak in 1% of the patients (23% of whom were asymptomatic). The sensitivity and specificity for detecting hemorrhage/hematoma on CT were 91% and 100%, respectively. The sensitivity and specificity for detecting staple-line leak on CT were 46% and 100%, respectively.

Lainas et al [17], in a study of 1,051 high-risk patients with severe obesity, evaluated the usefulness of routine POD 2 CT to detect hemorrhage/hematoma and gastric staple-line leak. The specifics regarding the use of IV contrast for CT in this study were not reported. Routine early postoperative CT detected hemorrhage/hematoma in 2% of the patients and staple-line leak in 1% of the patients. The sensitivity and specificity of CT for the detection of

hemorrhage/hematoma in this population were 96% and 100%, respectively. The sensitivity and specificity of CT for the detection of staple-line leak in this population were 43% and 100%, respectively.

### **CT Abdomen and Pelvis Without and With IV Contrast**

There is limited literature regarding the routine use of CT of the abdomen and pelvis in the immediate postprocedural bariatric patient. In a prospective study of 1,000 patients undergoing SG, Lainas et al [21] evaluated the routine use of POD 2 CT. The specifics regarding the use of IV contrast for the CT in this study were not reported. Routine early postoperative CT detected hemorrhage/hematoma in 3% of the patients (75% of whom were asymptomatic) and a gastric staple-line leak in 1% of the patients (23% of whom were asymptomatic). The sensitivity and specificity for detecting hemorrhage/hematoma on CT were 91% and 100%, respectively. The sensitivity and specificity for detecting staple-line leak on CT were 46% and 100%, respectively.

Lainas et al [17], in a study of 1,051 high-risk patients with severe obesity, evaluated the usefulness of routine POD 2 CT to detect hemorrhage/hematoma and gastric staple-line leak. The specifics regarding the use of IV contrast for the CT in this study were not reported. Routine early postoperative CT detected hemorrhage/hematoma in 2% of the patients and staple-line leak in 1% of the patients. The sensitivity and specificity of CT for the detection of hemorrhage/hematoma in this population were 96% and 100%, respectively. The sensitivity and specificity of CT for the detection of staple-line leak in this population were 43% and 100%, respectively.

### **CT Abdomen and Pelvis Without IV Contrast**

There is limited literature regarding the routine use of CT of the abdomen and pelvis in the immediate postprocedural bariatric patient. In a prospective study of 1,000 patients undergoing SG, Lainas et al [21] evaluated the routine use of POD 2 CT. The specifics regarding the use of IV contrast for CT in this study were not reported. Routine early postoperative CT detected hemorrhage/hematoma in 3% of the patients (75% of whom were asymptomatic) and a gastric staple-line leak in 1% of the patients (23% of whom were asymptomatic). The sensitivity and specificity for detecting hemorrhage/hematoma on CT were 91% and 100%, respectively. The sensitivity and specificity for detecting staple-line leak on CT were 46% and 100%, respectively.

Lainas et al [17], in a study of 1,051 high-risk patients with severe obesity, evaluated the usefulness of routine POD 2 CT to detect hemorrhage/hematoma and gastric staple-line leak. The specifics regarding the use of IV contrast for CT in this study were not reported. Routine early postoperative CT detected hemorrhage/hematoma in 2% of the patients and staple-line leak in 1% of the patients. The sensitivity and specificity of CT for the detection of hemorrhage/hematoma in this population were 96% and 100%, respectively. The sensitivity and specificity of CT for the detection of staple-line leak in this population were 43% and 100%, respectively.

### **Fluoroscopy Biphasic Esophagram**

There is no relevant literature to support the use of biphasic fluoroscopic esophagram in the routine immediate postprocedural evaluation of bariatric procedure patients.

### **Fluoroscopy Single Contrast Esophagram**

There is no relevant literature to support the use of single contrast esophagram in the routine immediate postprocedural evaluation of bariatric procedure patients.

### **Fluoroscopy Upper GI Series**

Fluoroscopic UGI series is the most commonly performed imaging examination in the routine immediate postprocedural evaluation of bariatric procedure patients, although its routine use is controversial. In a retrospective study of 712 SG patients, Wahby et al [22] report a leak rate of 1.4%, with none of the leaks detected on the UGI series performed within the first 2 POD. Similarly, Mittermair et al [19] evaluated the usefulness of POD 1 UGI series in 161 SG patients. Although there was a 1.3% leak rate, none of the leaks were detected on the UGI series. In a study evaluating the usefulness of routine POD 1 UGI series after RYGB or SG, Diaz Vico et al [15] reported that neither the 1 patient with a gastric leak nor the 1 patient with a small bowel obstruction (SBO) was diagnosed on UGI series. A meta-analysis by Mbadiwe et al [18] of 19 studies (10,139 patients) evaluated UGI series performed within 2 days after bariatric surgery. They reported an overall sensitivity of 54% and a specificity of 100% for the detection of leak via UGI series, with a positive predictive value (PPV) of 67% and negative predictive value (NPV) of 98%. In a retrospective study of 101 SG patients, Gniecchi et al [23] reported that although only 1 patient had a leak detected on UGI series, 32% of patients had gastroesophageal reflux, 16% had delayed gastroesophageal transit, and 13% had delayed gastric emptying.

### **Fluoroscopy Upper GI Series with Small Bowel Follow-Through**

There is no relevant literature to support the use of fluoroscopic UGI series with small bowel follow-through in the routine immediate postprocedural evaluation of bariatric procedure patients.

### **MRI Abdomen Without and With IV Contrast**

There is no significant relevant literature regarding the use of MRI abdomen without and with IV contrast in the routine immediate postprocedural evaluation of bariatric procedure patients.

### **MRI Abdomen Without IV Contrast**

There is no significant relevant literature regarding the use of MRI abdomen without IV contrast in the routine immediate postprocedural evaluation of bariatric procedure patients.

### **Radiography Abdomen**

There is no significant relevant literature regarding the use of abdominal radiography in the routine immediate postprocedural evaluation of bariatric procedure patients.

### **US Abdomen**

There is no significant relevant literature regarding the use of abdominal US in the routine immediate postprocedural evaluation of bariatric procedure patients.

### **Variant 3: Adult. Less-invasive bariatric procedure. Suspected complication. Postprocedure evaluation.**

Less-invasive bariatric procedures are good options for patients with severe obesity who are not good surgical candidates or for those who do want a more invasive procedure. Examples of less-invasive bariatric procedures include gastric band placement, intragastric balloon placement, and endoscopic sleeve gastropasty. Although these procedures do not involve creation of a bowel anastomosis or bowel resection (eg, RYGB and SG), they can still present with complications.

### **CT Abdomen and Pelvis With IV Contrast**

There is limited literature regarding the use of CT in the evaluation of suspected complications after minimally invasive bariatric procedures. In a retrospective study of 67 patients, Burt et al [24] evaluated the use of CT for the diagnosis of gastric band slippage. They describe 4 potential findings indicative of a slipped gastric band with sensitivities ranging from 67% to 89% and specificities ranging from 86% to 100%. Additional gastric band complications that have been reported on CT include gastric perforation, intraluminal gastric band erosion, and device-associated infection [5,25]. CT can be used to detect complications of intragastric balloon placement including spontaneous hyperinflation, balloon deflation with migration and bowel obstruction, and gastric perforation [26].

### **CT Abdomen and Pelvis Without and With IV Contrast**

There is limited literature regarding the use of CT in the evaluation of suspected complications after less-invasive bariatric procedures. Specifically, no relevant literature regarding the additional benefit of CT abdomen and pelvis without and with IV contrast beyond single phase CT was identified.

### **CT Abdomen and Pelvis Without IV Contrast**

There is limited literature regarding the use of CT in the evaluation of suspected complications after less-invasive bariatric procedures. In a retrospective study of 67 patients, Burt et al [24] evaluated the use of CT for the diagnosis of gastric band slippage. They describe 4 potential findings indicative of a slipped gastric band with sensitivities ranging from 67% to 89% and specificities ranging from 86% to 100%. Additional gastric band complications that have been reported on CT include gastric perforation, intraluminal gastric band erosion, and device-associated infection [5,25]. CT can be used to detect complications of intragastric balloon placement including, spontaneous hyperinflation, balloon deflation with migration and bowel obstruction, and gastric perforation [26].

### **Fluoroscopy Biphasic Esophagram**

There is no relevant literature to support the use of biphasic fluoroscopic esophagram in the evaluation of suspected complication after less-invasive bariatric procedures.

### **Fluoroscopy Single Contrast Esophagram**

There is no relevant literature to support the use of single contrast fluoroscopic esophagram in the evaluation of suspected complication after less-invasive bariatric procedures.

### **Fluoroscopy Upper GI Series**

There is limited literature regarding the use of fluoroscopic UGI series in the evaluation of suspected complication after less-invasive bariatric procedures. Complications of gastric band placement that have been reported on UGI series include, stomal stenosis, slipped gastric band, intraluminal gastric band erosion, gastric perforation, and gastric volvulus [25].

### **Fluoroscopy Upper GI Series with Small Bowel Follow-Through**

There is no relevant literature to support the use of fluoroscopic UGI series with small bowel follow-through in the evaluation of suspected complication after less-invasive bariatric procedures.

### **MRI Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature regarding the use of MRI abdomen without and with IV contrast in the evaluation of a suspected complication after a less-invasive bariatric procedure.

### **MRI Abdomen and Pelvis Without IV Contrast**

There is no relevant literature regarding the use of MRI abdomen without IV contrast in the evaluation of a suspected complication after a less-invasive bariatric procedure.

### **Radiography Abdomen and Pelvis**

There is limited literature regarding the use of radiography of the abdomen and pelvis in the evaluation of a suspected complication after a less-invasive bariatric procedure. In a retrospective study of 84 gastric band patients, Swenson et al [27] investigated the usefulness of 4 radiographic signs for the diagnosis of a slipped gastric band. These radiographic signs had sensitivities ranging from 33% to 95% and specificities ranging from 52% to 100% for the diagnosis of a slipped gastric band. Complications of intragastric balloon that have been reported on radiography include balloon deflation and SBO [26].

### **US Abdomen**

There is limited literature regarding the use of abdominal US in the evaluation of a suspected complication after a less-invasive bariatric procedure. In a study of 151 patients with intragastric balloon placement, Francica et al [28] reported that they were able to detect balloon complications including partial deflation, complete collapse, and migration into the bowel with US.

### **Variant 4: Adult. Bariatric procedure. Suspected complication. Postprocedure evaluation.**

Bariatric procedures are among the most commonly performed surgeries today. Although they are effective and safe, complications do arise. Because the symptoms of these complications can be nonspecific and physical examination can be limited, particularly in patients with obesity, imaging plays a key role in the diagnosis of bariatric surgical complications [29].

### **CT Abdomen and Pelvis With IV Contrast**

Contrast-enhanced CT is commonly performed for the evaluation of bariatric patients with a suspected complication. In a retrospective review of 155 postoperative bariatric patients with a suspected complication, Morandeira et al [30] reported that 96% of the patients with complications were diagnosed via contrast-enhanced CT. Duprée et al [31] examined the diagnostic value of CT in the diagnosis of postoperative complications in 73 bariatric patients. They report an overall sensitivity and specificity of CT in correctly identifying a postoperative complication of 54% and 98%, respectively.

CT is often used for the evaluation of a suspected postoperative leak in bariatric patients. Bingham et al [32], in a retrospective study comparing CT and UGI series for the diagnosis of staple-line leak, found CT to have a sensitivity of 95% and specificity of 100%, with a PPV of 100% and NPV of 97% for the detection of leak. The authors of this study did not specify whether or not these CTs were performed with IV contrast. In a meta-analysis of 18 studies including 7,516 patients, Musella et al [33] evaluated the diagnostic usefulness of CT for the detection of leak in postoperative bariatric patients. The authors report a pooled sensitivity of 91% and mean specificity of 99.7% of CT for the detection of postoperative leak, with a PPV of 100% and NPV of 98%. The authors of this meta-analysis did not specify whether or not the CTs were performed with IV contrast.

Internal hernia, herniation of bowel through a mesenteric defect, is a well-known complication after laparoscopic RYGB and a common cause of SBO in these patients. Patients with internal hernias can present with acute abdominal symptoms or chronic intermittent abdominal symptoms and have an associated mortality of 1% [34]. Many consider CT to be the imaging study of choice in RYGB patients with clinical suspicion of an internal hernia



[35]. There are numerous published studies and CT signs of internal hernia with varying results. In a retrospective study of 50 RYGB patients suspected of having an internal hernia, Altieri et al [36] reported the sensitivity and specificity of CT to be 76% and 60%, respectively. Frøkjær et al [37], in a retrospective study of 117 patients, determined the sensitivity and specificity of CT for detecting an internal hernia to be 80% and 91%, respectively. Dilauro et al [34], in a retrospective study of 154 RYGB patients, found the sensitivity and specificity of CT for the diagnosis of internal hernia to be 96% to 99% and 90% to 99%, respectively. Ederveen et al [38] evaluated the effect of structured reporting on the ability of CT to diagnose internal hernia in 463 RYGB patients. CTs with structured reports (using a template with 10 CT signs of internal hernia) had a sensitivity of 81%, a specificity of 96%, a PPV of 81%, and an NPV of 96% for the detection of internal hernias and CTs, and conventional reports had a sensitivity of 79.5%, a specificity of 89%, a PPV 56%, and an NPV 96%. Overall accuracy of CT improved with structured reports, 93% versus 87%.

Small bowel intussusception can occur in patients after RYGB, typically at or near the jejunojunal anastomosis. Although these can be transient and clinically insignificant, small bowel intussusception can be a rare cause of an SBO [25]. In a retrospective study of 35 RYGB patients with small bowel intussusception, Zaigham et al [39] investigated the usefulness of CT to determine which intussusceptions are clinically significant. They report that an intussusception length >10 cm on CT had a sensitivity of 80% to 100% and a specificity of 86% to 93% for predicting intussusception causing an SBO.

### **CT Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature regarding the use of CT abdomen and pelvis without and with IV contrast in the evaluation of postoperative bariatric patients suspected of having a complication.

### **CT Abdomen and Pelvis Without IV Contrast**

CT is often used for the evaluation of a suspected postoperative leak in bariatric patients. Bingham et al [32], in a retrospective study comparing CT and UGI series for the diagnosis of staple-line leak, found CT to have a sensitivity of 95% and specificity of 100%, with a PPV of 100% and NPV of 97% for the detection of leak. The authors of this study did not specify whether or not these CTs were performed with IV contrast. In a meta-analysis of 18 studies including 7,516 patients, Musella et al [33] evaluated the diagnostic usefulness of CT for the detection of leak in postoperative bariatric patients. The authors report a pooled sensitivity of 91% and mean specificity of 99.7% of CT for the detection of postoperative leak, with a PPV of 100% and NPV of 98%. The authors of this meta-analysis did not specify whether or not the CTs were performed with IV contrast.

### **Fluoroscopy Biphasic Esophagram**

A single study evaluating the usefulness of contrast esophagram in the evaluation of symptomatic RYGB patients was identified. In a retrospective study of 54 RYGB patients who had a contrast esophagram and subsequent upper endoscopy, Patel et al [40] reported that although 15% of the patients had pathology detected on the contrast esophagram, 70% of the patients with a normal contrast esophagram had pathology identified on subsequent upper endoscopy (most commonly anastomotic stricture). They found the sensitivity of contrast esophagram for a gastrojejunal stricture to be 3%. The authors do not specify whether the esophagrams in this study were single contrast, biphasic, or a combination of the 2.

### **Fluoroscopy Single Contrast Esophagram**

A single study evaluating the usefulness of contrast esophagram in the evaluation of symptomatic RYGB patients was identified. In a retrospective study of 54 RYGB patients who had a contrast esophagram and subsequent upper endoscopy, Patel et al [40] reported that although 15% of the patients had pathology detected on the contrast esophagram, 70% of the patients with a normal contrast esophagram had pathology identified on subsequent upper endoscopy (most commonly anastomotic stricture). They found the sensitivity of contrast esophagram for a gastrojejunal stricture to be 3%. The authors do not specify whether the esophagrams in this study were single contrast, biphasic, or a combination of the 2.

### **Fluoroscopy Upper GI Series**

UGI series is one of the most commonly performed radiologic studies in the evaluation of postoperative bariatric patients who are suspected of having a staple-line leak. In a retrospective study comparing the usefulness of UGI versus CT in the evaluation of bariatric surgical patients with clinical suspicion of a postoperative leak, Bingham et al [32] reported the sensitivity and specificity of UGI series for the detection of a leak to be 79% and 95%, respectively. In a meta-analysis evaluating UGI series and CT for the detection of leak after bariatric surgery, Musella et al [33] reported a pooled sensitivity of 49% for the detection of leak in symptomatic patients.

Furthermore, the authors report a mean specificity, PPV, and NPV for UGI series of 99.7%, 54%, and 96%, respectively.

### **Fluoroscopy Upper GI Series with Small Bowel Follow-Through**

There is no relevant literature to support the use of UGI series with small bowel follow-through in the evaluation of postoperative bariatric patients suspected of having a complication.

### **MRI Abdomen and Pelvis Without and With IV Contrast**

Although there are a few studies regarding the use of noncontrast MRI, there is no relevant literature regarding the use of MRI abdomen without and with IV contrast in the evaluation of a postoperative bariatric patient with a suspected complication.

### **MRI Abdomen and Pelvis Without IV Contrast**

There are a few studies regarding the use of MRI abdomen without IV contrast in the evaluation of a suspected complication after a bariatric procedure. In a study of 15 pregnant RYGB patients suspected of having an internal hernia, Krishna et al [41] found the sensitivity and specificity of noncontrast MRI for the diagnosis of internal hernia to be 75% to 88% and 86% to 100%, respectively. Similarly, in a study of fast MRI T2-sequence for the diagnosis of internal hernia in 31 pregnant patients after RYGB, Van Berkel et al [42] reported the sensitivity, specificity, and NPV of MRI to be 89% to 100%, 80% to 87% and 87% to 100%, respectively. Bonouvrie et al [43], in a study of 27 pregnant RYGB patients clinically suspected of SBO, evaluated the usefulness of noncontrast MRI for the diagnosis of SBO. They reported the sensitivity, specificity, PPV, and NPV of MRI for the detection of SBO in this patient cohort to be 67%, 67%, 93%, and 22%, respectively.

### **Radiography Abdomen and Pelvis**

There is no relevant literature to support the use of abdominal/pelvic radiography in the evaluation of a suspected complication in a postoperative bariatric patient.

### **US Abdomen**

There is no relevant literature to support the use of abdominal US for the evaluation of a suspected complication in a postoperative bariatric patient.

### **Summary of Highlights**

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1:** For routine preprocedure planning of an adult bariatric patient, a fluoroscopic biphasic esophagram, single contrast esophagram, or UGI series may be appropriate because these studies can diagnose pathology, which can alter which bariatric procedure is performed. These imaging studies are equivalent alternatives.
- **Variant 2:** Routine immediate postprocedure imaging evaluation of adult bariatric patients is controversial; however, a fluoroscopic UGI series, CT abdomen and pelvis with IV contrast, or CT abdomen and pelvis without contrast may be appropriate. Many bariatric surgeons order routine postprocedure imaging within the first 2 days to evaluate for suture line and/or anastomotic leaks/stenoses, gastric/bowel obstruction, and hemorrhage before it becomes clinically evident. Other bariatric surgeons reserve immediate postprocedure imaging for symptomatic or high-risk patients.
- **Variant 3:** In adult patients who have undergone a less-invasive bariatric procedure who are clinically suspected of having a complication, further evaluation with fluoroscopic UGI series, abdominal/pelvic radiography, or CT abdomen and pelvis with IV or without IV contrast may be appropriate. Abdominal/pelvic radiography and CT abdomen and pelvis can detect complications from a gastric band or gastric balloon. Fluoroscopic UGI series can evaluate patients with a gastric band for complications.
- **Variant 4:** In evaluating an adult bariatric patient suspected of having a complication, imaging with CT abdomen and pelvis with IV contrast is usually appropriate. CT can detect common complications such as postoperative leaks, bowel obstructions, and internal hernias. In adult bariatric patients who are suspected of having a postoperative leak and in whom a CT abdomen and pelvis with IV contrast is not performed, further evaluation with fluoroscopic UGI series or CT abdomen and pelvis without IV may be appropriate.

## Supporting Documents

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, click [here](#).

## Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health [44].

## Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

## Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document [45].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
⊕	<0.1 mSv	<0.03 mSv
⊕⊕	0.1-1 mSv	0.03-0.3 mSv
⊕⊕⊕	1-10 mSv	0.3-3 mSv
⊕⊕⊕⊕	10-30 mSv	3-10 mSv
⊕⊕⊕⊕⊕	30-100 mSv	10-30 mSv

\*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.