REVIEW ARTICLE

Imaging in bariatric surgery: service set-up, post-operative anatomy and complications

¹S SHAH, MRCP, FRCR, ¹V SHAH, MRCP, FRCR, ²A R AHMED, FRCS and ¹D M BLUNT, MRCP, FRCR

¹Department of Imaging and ²Department of Bariatric Surgery, Imperial College Healthcare NHS Trust, London, UK

ABSTRACT. Obesity is an increasingly prevalent and costly problem faced by the healthcare system. The role of bariatric surgery in managing obesity has also increased with evidence showing a reduction in long-term morbidity and mortality. There are unique challenges faced by the radiology department in providing an imaging service for this population of patients, from technical and staffing requirements through to the interpretation of challenging post-surgical images. We describe these challenges and provide an overview of the most frequently performed procedures, normal post-operative imaging findings and the appearance of common complications.

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Obesity

Obesity is a multifactorial disease, which is increasing in incidence and prevalence. In 2006, 67% of men and 56% of women were classified as being either overweight or obese in England [1]. Overall, 24% of adults were classified as obese, an increase from 15% in 1993, and 16% of children aged 2–15 years were classified as obese, an increase from 11% in 1995. Estimates suggest that at the current rate of increase, by 2010 there will be 12 million adults and 1 million children categorised as obese. The body mass index (BMI, kg m⁻²) is the most widely used measure of obesity; BMI between 25 and 30 signifies being overweight and BMI greater than 30 signifies obesity. BMI greater than 35 with obesity-related serious comorbidities or greater than 40 with or without comorbidities is defined as morbid obesity.

It is increasingly recognised that the consequences of obesity on general health are far reaching. Comorbidities associated include hypertension, diabetes mellitus, ischaemic heart disease, dyslipidaemia, osteoarthritis, obstructive sleep apnoea and psychological morbidity. As well as a burden on the general health of the population, there is a huge financial burden associated with obesity. The Health Select Committee reported that the cost of obesity and being overweight is between £6.6 and £7.4 billion per year. If current trends in obesity continue, these costs may rise to between £7.5 and £8.4 billion per year [2]. Therefore, a 1% reduction in the prevalence of obesity may yield a saving between £66 and £74 million per year.

Lifestyle and pharmacological interventions have been the main options available to health professionals caring

for this population. However, there is an increasing volume of literature expounding the benefits of bariatric surgery. Recent studies suggest that as well as inducing significant weight loss it may help reverse some of the metabolic consequences of obesity [3]. In addition, there is now evidence that bariatric surgery reduces long-term mortality by 29–40% [4, 5].

The National Institute for Health and Clinical Excellence (NICE) published updated guidance in 2006 regarding the management of obesity (Table 1) [2]. The estimated cost of implementing the NICE guidance is £63 million in the first year; the cost savings of a 1% reduction in obesity prevalence would return this sum.

NICE emphasise the importance of undertaking surgery only at centres where a multidisciplinary team approach is used. Optimum outcomes are achieved where the multidisciplinary team consists of surgeons trained adequately in the appropriate techniques as well as allied health professionals such as dietitians, psychiatrists and specialist nurses. In addition, rigorous selection criteria should be applied and surgery should only be undertaken at high-volume centres; these factors may help reduce in-hospital deaths [6]. NICE also state that an essential component in a successful service is the provision of a diagnostic and interventional radiology service by well-trained radiologists and radiographers.

Service set-up

As with any new service set-up, there is an analysis of the demand for the service against the costs, health and financial benefits of providing the service. The commissioners of the service must ensure that the service is integrated with other local health and weight management programmes [2]. They must also ensure that

Address correspondence to: Dr S Shah, Department of Imaging, Imperial College Healthcare NHS Trust, London, UK. E-mail: sachit.shah@doctors.org.uk

Table 1. National Institute for Health and Clinical Excellence guidance regarding surgical management of obesity [2]

Consider surgery for people with severe obesity if:
BMI ≥ 40 kg m ⁻² or more, or 35–40 kg m ⁻² and other significant disease (e.g. Type II diabetes or hypertension) that could be improved if they lost weight
All appropriate non-surgical measures have been tried but have failed to achieve or maintain adequate, clinically beneficial weight loss for at least 6 months
They are receiving or will receive intensive management in a specialist obesity service
They are generally fit for anaesthesia and surgery
They commit to the need for long-term follow-up
Consider surgery as a first-line option for adults with a BMI >50 kg m ⁻² in whom surgical intervention is considered appropriate; consider orlistat before surgery if the waiting time is long.

BMI, body mass index.

appropriate referral and assessment criteria are established, and frequent review of the clinical outcomes is undertaken to maintain a high-quality service. Under the new payment by results (PbR) system, a fixed tariff is paid by the primary care trust (PCT) to the hospital trust for specific procedures. There is also an additional inflationary cost added to reflect the local population. This income is then used to pay the overheads for the service, recruitment and employment of surgeons and specialist nurses. Allocated amounts are paid to the theatres, imaging and pathology departments. Generally, the income distributed to the imaging department is a fixed proportion of the surgical department's income, regardless of the types of operation being performed. Whilst some operations require no imaging follow-up, many do, and the cost of providing the imaging service has to be met by the fixed income from the surgical department. In the near future, many imaging departments may move to a similar PbR-type system, *i.e.* they are paid for individual units of work rather than a lump sum.

The specific challenges faced by the imaging department can be divided into three categories: technical factors, training issues and service provision. With regards to technical factors there are issues relating to weight and size limits, image quality and radiation dose imparted. The weight and size limits of individual pieces of imaging equipment need to be outlined specifically in a policy document prior to the initiation of such a service. Typical and representative examples from our own department include: diagnostic and fluoroscopic radiology (weight limit 137 kg), CT (width limit 70 cm, weight limit 200 kg), MRI (width limit 60 cm, weight limit 200 kg), interventional radiology (weight limit 200 kg), ultrasound (weight limit 175 kg) and nuclear medicine (weight limit 175 kg). The width limits usually refer to the shoulder-to-shoulder distance. However, in this group of patients, it is often the abdomen which exceeds the width limit. Being able to acquire images of diagnostic quality is a further challenge; owing to the large volume of soft tissue there is increased absorption of the X-ray beam and higher currents need to be used. There is also increased scatter of radiation; both these factors mean that there is an increased radiation dose imparted on the patients and the operators. The contrast resolution of these studies is compromised. This is important because often the key question is whether there is a leak of water-soluble contrast from the site of surgery, and detecting small volumes of leaked contrast

may be extremely difficult owing to poor image resolution. Similarly, ultrasound is often an unsatisfactory modality to use in these patients because of the absorption and poor reflection of ultrasound waves by the large volume of soft tissue.

The surgical procedures performed on these patients are unique and it is important that radiologists are specifically and adequately trained in the appropriate imaging techniques and normal and abnormal imaging appearances. When the service was started at our institution, the lead surgeon provided a lecture on the surgical techniques used, their expected normal post-operative imaging findings and common complications. Similar to a surgeon learning operative techniques, there is a learning curve for radiologists in imaging these patients. For the first 6 months, regular meetings were held between the surgical and radiology teams to discuss specific cases with a view to establishing experience and a "database" of normal and abnormal findings. This is an important facet in the training of both junior radiologists and surgeons involved in the service. As well as the radiologists specifically involved in gastrointestinal (GI) imaging, all other radiologists providing an "on-call" service, radiographers and interventional radiology nurses needed to be trained in issues specific to the imaging of bariatric patients. In many parts of the UK, training of radiologists is moving towards a modular programme based on tutorials on the Radiology-Integrated Training Initiative (RITI) website [7]. A module on imaging following bariatric surgery is currently not available. In light of the increasing use of these surgical techniques, a module would be extremely useful for radiology trainees.

There are several logistical factors involved in providing such a service. Fluoroscopy is one of the main imaging modalities used in the post-operative period and commonly patients are imaged in the first 48 hours following the procedure. There must be adequate space on the routine fluoroscopy lists to be able to accommodate these patients at short notice and if there are no planned lists there must be fluoroscopy facilities, radiographers and radiologists available to provide the service as and when required. This may impact significantly on the out-of-hours service if there is a high volume of patients being operated on or if theatre lists are scheduled for the latter part of the working week. Similarly, there will be an expected increase in the use of CT and interventional radiology services for these patients.

Bariatric surgical procedures

There are three main categories of surgical procedure: restrictive procedures induce weight loss by substantially reducing gastric capacity and promoting early satiety, examples include laparoscopic adjustable gastric banding (LAGB) and sleeve gastrectomy (SG); malabsorptive procedures (*e.g.* jejunioileal bypass and biliopancreatic diversion) surgically alter the gut to limit nutrient absorption from the small intestine, but are not now commonly performed; and combined restrictive and malabsorptive approaches include the Roux-en-Y gastric bypass (RYGB), although the primary mechanism of weight loss is thought to be restrictive rather than malabsorptive [8]. Many of the procedures are now performed laparoscopically with the advantages of decreased recovery time and reduced number of complications. Currently, the two most commonly performed procedures worldwide are RYGB and LAGB, followed by sleeve gastrectomy [9, 10].

Roux-en-Y gastric bypass

Surgical technique

Originally introduced in the 1960s and 1970s, RYGB is now the most commonly performed bariatric procedure in North America [10, 11]. Several variations are currently in use, but in general involve the following steps (Figure 1). First, a gastric pouch is formed by separating it from the rest of the stomach, now referred to as the gastric remnant. This is achieved by physically

dividing the pouch from the remnant using a cutting stapler. Next, the jejunum is divided approximately 50 cm distal to the ligament of Treitz, and brought up to create a gastrojejunostomy with the gastric pouch, usually via a side-to-side (functionally end-to-side) anastomosis. This anastomosed jejunal loop is referred to as the Roux or alimentary limb and can be placed “retrocolic” through an opening created in the transverse mesocolon or “antecolic” in front of the transverse colon (Figure 2a), it can also be placed ante- or retro-gastric. To complete the operation a jejunojejunostomy is created approximately 100–150 cm distal to the gastrojejunostomy to connect the alimentary limb and biliopancreatic (BP) limb (*i.e.* remnant stomach, native duodenum and proximal jejunum) (Figure 2b). The small bowel from this point to the terminal ileum is referred to as the common channel.

Normal post-operative imaging appearance

Upper GI fluoroscopy using an oral water-soluble contrast is the first line technique to assess for post-operative complications. The normal post-operative fluoroscopic anatomy is presented in Figure 1b. As a rule of thumb the gastric pouch should be of a size similar to that of a lower thoracic or lumbar vertebral body (15–20 ml). This comparison allows simple and reliable detection of a pouch that is either too large or too small. Contrast may remain in the distal oesophagus and gastric pouch for a variable period before passing through the anastomosis and filling the short blind limb and alimentary (Roux) limb.

Figure 1. Normal appearances following Roux-en-Y gastric bypass. (a) Schematic illustration; (b) contrast study; P, gastric pouch; A, alimentary limb; BL, blind limb; (c) CT image; P, gastric pouch; GR, gastric remnant.

Figure 2. Normal CT appearances following Roux-en-Y gastric bypass. (a) Antecolic position of alimentary limb; A, alimentary limb; TC, transverse colon; (b) jejunojunctional anastomosis; arrow shows the anastomosis between alimentary and biliopancreatic (BP) limbs.

CT is not commonly performed in the post-operative assessment following RYGB, but can be useful when fluoroscopic examinations are equivocal or for the evaluation of extraluminal complications such as intra-abdominal fluid collections. Normal post-operative findings at CT are demonstrated in Figure 1c and Figure 2.

Complications

The incidence of anastomotic leak after RYGB is reported to be in the region of 2–5% [11, 12]. It is an early complication, usually within the first 10 days following surgery, and most commonly occurs at the gastrojejunal anastomosis. It is a potentially life-threatening complication and requires prompt diagnosis. However, clinical evaluation is difficult as patients may have no signs of peritonitis and may present with only fever, tachycardia and abdominal discomfort, which are relatively non-specific in the immediate post-operative period [13]. Fluoroscopy typically shows extravasated contrast material in the left upper quadrant (Figure 3). Abdominal drains should be scrutinised closely because some well-controlled leaks are evident only on the basis of opacification of the drainage catheter. It should also be noted that, although not commonly left *in situ*, the presence of a nasogastric tube with its tip in the alimentary limb may prevent visualisation of leakage from the anastomosis.

Abdominal fluid collection and subphrenic abscess occur in fewer than 2% of all bariatric surgery patients, but are extremely serious complications with a high morbidity and mortality [12, 14]. Plain radiographs may show an air-fluid level in the left upper quadrant, although this finding can be difficult to interpret because of air in the remnant stomach. However, CT has a critical role in the work-up as it will readily demonstrate the fluid collection. In addition, the presence of air-fluid levels or contrast material is highly suggestive of anastomotic leak as the underlying cause.

Anastomotic narrowing at the gastrojejunal anastomosis has a reported incidence ranging from 3% to 9% and is more common with a circular stapled gastrojejunostomy [11, 15]. Clinically, this presents with dysphagia, post-prandial pain and vomiting [14]. Fluoroscopy

demonstrates narrowing at the gastrojejunal anastomosis, expansion of the gastric pouch and delayed passage of contrast material into the Roux limb. In the immediate post-operative period this is usually the result of anastomotic oedema [16] (Figure 4a). In these cases, follow-up examinations should show improvement if the delay is caused by oedema. Persisting pouch distension on follow-up and air/contrast material levels in the pouch and oesophagus are suggestive of a stricture (Figure 4b). Stricture at the jejunojunctional anastomosis is rare, with an incidence of 0.8% [17]. On fluoroscopy, contrast material is seen in a distended alimentary limb (Figure 5). It can also result in distension of the biliopancreatic limb with air-fluid levels within the

Figure 3. Contrast study demonstrating leak at gastrojejunal anastomosis; arrow indicates leak; P, gastric pouch; A, alimentary limb.

Figure 4. Contrast studies demonstrating narrowing at gastrojejunal anastomosis. (a) Post-operative oedema: arrow indicates narrowing at gastrojejunal anastomosis; P, gastric pouch; A, alimentary limb; (b) stricture; arrow indicates stricture at gastrojejunal anastomosis; P, gastric pouch; A, alimentary limb.

Figure 5. Contrast study demonstrating jejunojejunal stricture; arrow indicates stricture at anastomosis between alimentary and biliopancreatic limbs; arrowhead indicates oedema in alimentary limb; A, alimentary limb; CC, common channel.

gastric remnant. Similar findings can also be seen in the early post-operative period and secondary to anastomotic oedema, endoluminal haematoma or bolus obstruction at the jejunojejunal anastomosis.

Small-bowel obstruction is reported in 4–5% of patients [18]. It is usually caused by internal hernias or adhesions, although other causes include mesocolic window stenosis, bezoar formation in the gastric pouch and intussusception [11, 12]. Compared with open procedures, the laparoscopic approach has reduced the prevalence of adhesions but has led to an increase in the prevalence of internal hernia formation. Internal hernias often develop through the opening in transverse mesocolon following retrocolic placement of the roux limb, and antecolic placement appears to have decreased the prevalence of internal hernias [18]. The herniated bowel is usually the Roux limb itself with a varying amount of additional small-bowel loops [12].

It can be difficult to distinguish small-bowel obstruction caused by adhesions from that caused by internal hernia on CT. However, clustering of dilated small-bowel loops in the left upper quadrant is more suggestive of internal herniation [19]. In the case of herniation through the transverse mesocolon, the herniated cluster of bowel is located posterior to the stomach and transverse colon.

Stomal ulceration incidence is in the region of 10%. It is thought to occur as a result of increased acid production within the pouch and is, therefore, associated with larger gastric pouches [20]. Patients usually present with severe dyspepsia, burning retrosternal pain and vomiting. The diagnosis is usually made endoscopically; however, imaging studies may detect complications such as stricture, perforation and gastrogastic fistula.

Gastrogastic fistula is a connection between the gastric pouch and remnant and is a rare complication, with a reported incidence of <1%. It occurs secondary to leaks or stomal ulcer perforation [21, 22]. The primary finding on fluoroscopy is detection of contrast material in the gastric remnant (Figure 6).

Figure 6. Contrast study demonstrating gastrogastric fistula; P, gastric pouch; A, alimentary limb; GR, gastric remnant.

Adjustable gastric banding

Surgical technique

LAGB is a purely restrictive procedure that has traditionally been popular in Europe, but is now increasingly performed in North America; recent data suggest it is now the most commonly performed technique worldwide [10]. The surgical technique involves placing an adjustable silicon band around the proximal stomach, approximately 2 cm distal to the gastro-oesophageal junction to partition a small gastric pouch and create an adjustable stoma into the remainder of the stomach (Figure 7). The anterior gastric wall is often sutured over the band to the gastric pouch to decrease the chances of band slippage. The band is then connected via tubing to a port placed subcutaneously in the abdomen. Through percutaneous aspiration or injection of saline or radio-opaque contrast into the port, the size of the band is decreased or increased, thereby adjusting the stomal width [23]. In some units a contrast swallow study is performed at the same time as the band fill to objectively determine adequacy of band filling.

Normal post-operative imaging appearance

On fluoroscopic studies (Figure 7b), the gastric pouch should be relatively symmetric in shape and measure approximately 3–4 cm in maximum dimension when distended with contrast material. The stoma diameter should measure approximately 3–4 mm in diameter, with prompt emptying of the pouch [24]. In addition, the adjustable band, catheter and subcutaneous port can all be visualised. Another factor that should be assessed is the orientation of the gastric band, which should lie obliquely. This can be more formally measured using the phi angle, which is the angle created by intersecting a line drawn parallel to the spinal column with a line drawn parallel to the plane of the gastric band on an anteroposterior projection. Normally this angle should range from 4° to 58° [25].

Figure 7. Normal appearances following laparoscopic adjustable gastric banding. (a) Schematic illustration; (b) contrast study demonstrating phi angle; P, gastric pouch; arrow shows gastric band.

Complications

Stomal stenosis and acute concentric pouch dilatation are the most common complications after LAGB [26], and present with nocturnal reflux, vomiting and upper abdominal discomfort. It may be due to iatrogenic overfilling of the band, post-operative stomal oedema or blockage of the stoma by food bolus. Typical fluoroscopic findings include a narrowed or obstructed stoma with proximal concentric pouch dilatation, delayed passage of contrast material and oesophageal reflux.

Chronic pouch dilatation incidence is 3–8% [26, 27]. In contrast to acute pouch dilatation, it occurs in the presence of a normal stoma and is usually owing to chronic volume overload of the pouch secondary to overeating. As the pouch gets larger it allows for further overeating and further dilatation resulting in a “mega-pouch” (Figure 8). If left untreated it can result in oesophageal dysfunction and dilatation and eventually lead to a mega-oesophagus.

Pouch prolapse, also termed band slippage, is the superior herniation of the distal stomach wall and may occur despite adequate initial band placement. Incidence ranges from 3% to 13% and is decreasing with modifications to the surgical technique [26–29]. Anterior prolapse is more common and results in lateral eccentric gastric pouch enlargement, stomal narrowing and a horizontally orientated band, with a phi angle of greater than 58° (Figure 9) [11, 30]. In posterior prolapse, which is now uncommon, there is medial eccentric gastric pouch enlargement and a vertically lying band.

Band misplacement is a technical complication rarely observed. The band may be misplaced in perigastric fat, over the gastro-oesophageal junction or the lower part of

Figure 8. Contrast study demonstrating a megapouch (MP).

Figure 9. Contrast study demonstrating anterior pouch prolapse and increased phi angle; P, gastric pouch.

stomach, and may result in poor weight loss, dysphagia or gastric outlet obstruction.

Port- and band-related complications are reported in 0–7% of cases, and include leakage, infection and band erosion [26]. Leakage can occur from the band, catheter or access port and should be suspected when there is loss of eating restriction or insufficient deflation volume. Causes of leak include trauma to the band balloon or catheter, or a defective device. Band erosion is usually a rare and late complication and is diagnosed by the intraluminal position of the band, with contrast outlining both inside and outside of the band.

Acute gastric perforation is rare, occurring in <1% of cases, and is usually owing to surgical trauma to the stomach wall [26, 28]. It has an extremely variable clinical presentation and can lead to life threatening sepsis. Fluoroscopy and CT may demonstrate leak of contrast into the left upper quadrant.

Sleeve gastrectomy

Surgical technique

The laparoscopic sleeve gastrectomy (SG) is a relatively new technique and was first performed in 1999 [31]. It was originally proposed as the first part of a two-stage operation in super-obese patients with a BMI $>60 \text{ kg m}^{-2}$ or in high-risk patients [32]. However, more recently its use has become more widespread and it now accounts for approximately 5% of bariatric procedures [10]. It is an essentially restrictive intervention performed by vertically dividing the stomach along the greater curve, thus removing the fundus and greater curvature and leaving a thin, banana-shaped gastric pouch of

Figure 10. Normal appearances following sleeve gastrectomy. (a) Schematic illustration; (b) contrast study; S, gastric sleeve; (c) CT image; S, gastric sleeve; arrow shows gastric suture line.

approximately 100 ml along the lesser curve (Figure 10). The size of the sleeve is calibrated using a bougie tube within the stomach and the procedure reduces the size of the stomach by about 75%.

Normal post-operative imaging appearance

Upper GI fluoroscopy after SG is the first line study to detect leaks and other post-operative complications. The normal post-operative fluoroscopic anatomy is presented in Figure 10b, demonstrating the thin tubular pouch, the diameter of which varies according to the size of the

bougie tube used. In the majority of cases contrast passes freely through the sleeve to the antrum, with a slight delay at the pyloric valve. However, in some cases, there can be failure to propel contrast with a hold up in the proximal sleeve [33]. This is thought to be due to gastric antral malfunction or “stunning” in the early post-operative period, but usually settles with time and the aid of a prokinetic agent. A linear streak of contrast may be seen within non-excised fundus, which may be mistaken for an extraluminal leak (Figure 11).

Complications

Gastric dilatation is one of the primary drawbacks of this procedure, and reoperations are required in up to 4.5% of cases [31]. This presents clinically as inadequate weight loss or weight regain. Fluoroscopy demonstrates increased diameter of the sleeve, with loss of the normal tubular appearance.

Gastric leak and abdominal collections as a result of disruption of the staple line are a potential concern following SG because of the significant gastric resection and long staple line, although the literature suggests a low incidence of approximately 0.9% [31]. The commonest site of leak is from the proximal stomach at the angle of His [34]. Fluoroscopy demonstrates extravasation of contrast material into the left upper quadrant (Figure 12a). Intra-abdominal abscess is a potential sequelae (incidence 0.1%) and may be detected on plain radiography as an air-fluid level in the left upper quadrant as there is no remnant stomach. However, CT is the imaging modality of choice in cases where this is suspected (Figure 12b).

SG is thought to predispose the patient to post-operative reflux symptoms because the gastric resection adversely affects the angle of His. Studies have demonstrated incidences of up to 21% at 1 year, reducing to 3% at the 3 year follow-up [35]. Reflux of contrast into the oesophagus can be readily demonstrated on fluoroscopy,

Figure 11. Contrast study demonstrating a pitfall in imaging following sleeve gastrectomy; S, gastric sleeve; arrow indicates intraluminal contrast within fundus mimicking a leak.

Figure 12. Post-operative leak from gastric suture line following sleeve gastrectomy. (a) Contrast study; arrow indicates leak from gastric suture line; S, gastric sleeve; (b) CT; S, gastric sleeve; arrow indicates fluid collection in left upper quadrant.

although in the early post-operative period, this may occur secondary to gastric antral dysfunction as outlined above.

As the procedure is relatively recent, long-term follow-up studies are relatively scarce. Other reported complications include stricture (0.7%), particularly at the incisura from intra-operative stapling error. There is also evidence of both delayed and accelerated gastric emptying following SG. Indeed, the latter is hypothesised to play a central role in the beneficial metabolic effects seen following surgery [36].

Other techniques

Vertical-banded gastroplasty

This is an older, purely restrictive procedure and its use has decreased significantly with the popularity of the RYGB, the advent of laparoscopic adjustable gastric banding and problems with long-term weight loss [37]. The technique involves vertically partitioning the stomach to create a small gastric pouch based on the lesser curvature of the stomach. Using a circular stapler, the anterior and posterior walls of the stomach are then stapled together and an incision is made through the excluded gastric walls to create a circular window, through which a polypropylene mesh or band is placed and wrapped around the stomach, creating a small proximal gastric pouch and a small stoma into the remainder of the stomach. Imaging is important to help bariatric surgeons plan revisional surgery.

Jejunioileal bypass

Created by Kremen et al in 1954, the jejunioileal bypass (JIB) was the original bariatric surgical procedure [38]. Today, the JIB has long since been abandoned because of the severe malnutritional state and the resultant side-effects [39]. The general procedure involves creating an end-to-side jejunioileostomy with a short jejunal limb approximately 35 cm long anastomosed to the terminal ileum. Despite the fact that JIB is no longer used to treat

patients who underwent this procedure knowledge of the procedure is important for radiological imaging.

Role of interventional radiology

One of the most frequently requested interventional procedures is ultrasound or fluoroscopically guided percutaneous access to the port for LAGB adjustment, which cannot be accessed clinically owing to excess adipose tissue. Indeed, in some centres these are routinely performed by radiologists. Operators should be aware that a specialist needle (Huber) should be used to access the port. This is a non-cutting needle allowing puncture of the port without damaging the membrane.

Several complications in bariatric-surgery patients can also be successfully managed with interventional radiology techniques. Indeed, in many cases, image-guided percutaneous procedures can obviate the need for emergency surgical exploration, and commonly performed techniques include aspiration and drainage of abdominal fluid collections. Other techniques that may be required include imaging-guided placement of jejunal feeding tubes in cases of gastrojejunal complications in RYGB, and imaging-guided gastrostomy of the gastric remnant for temporary decompression in cases of BP limb distension secondary to obstruction at the jejunojejunostomy [40]. Although most often performed via endoscopy, stenosis at the gastrojejunal anastomosis can also be dilated with the aid of fluoroscopic guidance [41]. In addition, percutaneous transhepatic techniques can be used in the management of biliary complications such as choledocholithiasis in RYGB patients, as conventional endoscopic access to the biliary tree is limited in this group [42].

Conclusion

Bariatric surgery is increasingly performed to control morbid obesity. The imaging of this group of patients following surgery is a vital component of their

management and presents unique and varied challenges. We have described the issues faced when setting up such an imaging service and have presented an overview of the most frequently performed surgical procedures, the normal post-operative imaging findings and the details and appearances of common complications.

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