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Role of pre and post oral and IV contrast MDCT scan of the abdomen in assessment of early complications after laparoscopic sleeve gastrectomy (LSG)

Sally Y. Shokralla* and Sherif M. Abolyazid

Abstract

Background Laparoscopic sleeve gastrectomy (LSG) is a commonly performed bariatric surgical procedure. Abdominal CT scan is a preferred useful modality in detection of early post sleeve gastrectomy complications, namely staple line leakage, bleeding, mesenteric vascular thrombosis and splenic infarction. The aim of our study is to assess the value of abdominal MDCT in diagnosis of suspected early complications following laparoscopic sleeve gastrectomy operations.

Methods Data collection included clinical and laboratory data from the referral requests written by the surgeons. MDCT scan then was performed for all patients. Follow-up clinical data for all patients and follow-up surgical findings for some patients who needed surgical intervention were collected and correlated with the CT findings.

Results This prospective study included 75 patients referred by their surgeons as clinically suspected to have acute post LSG complications. MDCT scan was done for all those patients and detected multiple post-operative complications in 68 patients (91%) with the most common one was staple line gastric leak in 30 patients (40%), other complications were also detected as intra-abdominal abscess, porto-mesenteric thrombosis, splenic infarction and pulmonary complications. CT findings were correlated with the clinical, surgical and laboratory data of the patients as well as the follow-up findings.

Conclusions MDCT scan is a reliable imaging modality for detecting acute post LSG complications and correlates well with both the clinical presentation and patient's follow-up data.

Keywords Post LSG complications, MDCT abdomen, Sleeve gastrectomy

Background

Laparoscopic sleeve gastrectomy (LSG) is one of the most commonly performed bariatric surgical procedures for morbid obesity nowadays. It acts through two mechanisms; as a restrictive mechanism by reducing the volume

of food intake, as well as through a hormonal mechanism by decreasing ghrelin hormone production [1].

Post-operative complications are classified as early complications that occur in the first 30 days post-operative and late complications that take place afterward. Examples of early post-operative complications include staple line leakage, abscess formation, hematoma, wound infection, gastric fistula, splenic infarction and delayed gastric emptying. Other early complications include pleuropulmonary changes like basal pulmonary atelectasis and pleural effusion. Examples of late post-operative

*Correspondence:

Sally Y. Shokralla

sallykozman@yahoo.com

Department of Radiodiagnosis, Faculty of Medicine, Cairo University, Giza, Egypt

complications include dilatation of the gastric pouch and weight gain [2].

In recent years, CT machinery has undergone rapid development with improvement in diagnostic accuracy. The establishment of 64–320 MDCT scanners significantly improved spatial resolution by the use of thinner slice thickness, collimation, and reconstruction increment, which enabled fast execution and high resolution of the examination. Furthermore, it allows acquisition of Multiplanar Reformatted Images (MPR) very close to that of the axial plane. Combined evaluation by pre-contrast and post contrast MDCT with MPR has shown an increase in the effectiveness of the technique, especially for the detection of subtle complications [2, 3].

MDCT is very helpful in detecting post LGS operative complications such as leak. Moreover, CT allows diagnosing other complications such as abscess, infection and effusion which cannot be detected by other modalities like fluoroscopy and UGI series. CT can also provide other important data by showing pneumoperitoneum or extra-luminal accumulation of oral contrast material [3, 4].

The aim of this study is to emphasize the role and the proper protocol of MDCT scan in diagnosis of possible early post sleeve gastrectomy complications and its role in decision-making for proper management.

Patients and methods

This study is a prospective observational study to evaluate the value of MDCT scan in evaluation of early post sleeve gastrectomy complications.

Patients

This study included the evaluation by MDCT scan of 75 patients presented with acute post-operative symptoms within one month after laparoscopic sleeve gastrectomy for morbid obesity.

The study has been done at the department of Diagnostic Radiology, Faculty of Medicine, Cairo University, Egypt and the department of Diagnostic Radiology at International Medical Center Hospital in Jeddah, Saudi Arabia in the period between February 2022 and October 2022.

The reason for referral by the surgeons was the emergence of acute post-operative symptoms or signs such as abdominal pain, tachycardia, tachypnea, abdominal distension and/or fever.

Inclusion criteria

- All patients referred from the surgery department with clinical suspicion of acute post sleeve gastrectomy complications, such as persistent abdominal

pain, abdominal distension, abdominal tenderness, persistent vomiting, tachycardia, tachypnea, and pallor.

- Both sexes and all age groups are included.

Exclusion criteria

- Vitally unstable, critically ill patients with advanced sepsis.
- Patients with known allergies to contrast media.
- Patients presented with symptoms took place one month after the LSG operation.
- Pregnant patients.

Methods

Data collection included the following:

- Assessment of patient data regarding clinical complaints, associated symptoms and their performed laboratory tests as stated at the referral MDCT scan request by the surgeon. This included data obtained from the clinical assessment done by the referring physician.
- The performed MDCT study findings.
- Correlation of the CT findings with the patient's symptoms (Table 5).
- Follow up and clinical outcome of the management protocol.

Protocol for MDCT

Patient preparation

Each patient fulfilling the inclusion criteria was asked to be fasting for 6 h prior to the CT examination. The patient was positioned supine on the MDCT table. Intravenous wide bore cannula was installed.

CT Technique

Imaging was performed using Aquilion ONE / PRISM Edition dynamic volume CT system 320-detector row system or a multidetector 64-detector row helical CT scanner (GE; Medical systems). Imaging parameters included section collimation of 3–5 mm, high-quality mode, table speed of 7.5 mm/sec, 50% overlap reconstruct. Two sets of images were performed. The first set of images (precontrast phase) was taken before oral or intravenous contrast administration. The patient was asked to hold their breath. CT study of abdomen and pelvis started from the level of the lower chest and extended caudally to the level of the inguinal region. Then the patient was asked to swallow diluted water-soluble

contrast material, an amount of 100 mL as tolerated. A bolus of 100 ml contrast media [Omnipaque, 350 mg Iodine/ml (Iohexol, GE healthcare Ireland, Cork, Ireland)] was injected then the patient was asked to hold his breath and CT images including portovenous phase were performed. Estimated radiation dose per each patient ranged from 15.2 to 47.8 mSv according to the machine used, the DLP and the patient's BMI.

Data analysis and interpretation

Revision of the CT slices on Vitrea workstation where 2D multiplanar axial, coronal, sagittal and curved reformatted images as well as 3D volume-rendering, multiplanar reformatted (MPR), and/or maximum-intensity-projection (MIP) were obtained.

Outcome measures

Data was gathered in an electronic database and analyzed. Parameters of interest were patient demographics and early post-operative complications.

Early surgical complications were defined as complications occurring during the first 30 days after LSG. The primary endpoint was the efficacy of CT scan examination in diagnosing surgical complications.

Secondary endpoints were the global rate of post-operative early surgical complications, including gastric staple line leak, hematoma, collection, splenic injury, portomesenteric vein thrombosis and gastric fistula.

Results

This study was conducted on 75 patients with suspected post sleeve gastrectomy acute complications referred by the surgery department for CT imaging to confirm or to exclude the presence of complications. The majority of cases in this study were females (51) while the number of male patients was 24 (Table 1). The age of patients ranged from 19 to 59 years old, with a mean age of 39 years. The body mass index (BMI) of the included patients ranged from 35 to 60 kg/m².

Results included 88 complications in 68 patients out of 75 patients (91%) referred for CT assessment, considering that some patients had more than one complication and others may have no radiological findings suggestive of complications.

Table 1 Demographic data (Sex distribution) among the study population

Sex	Number of patients	Percentage (%)
Females	51	68
Males	24	32
Total	75	100

The most common complication was gastric leak (30 patients) (Figs. 1,2,3), followed by abscess formation (20 patients) (Fig. 4), hematoma (15 patients) (Figs. 3,5), pleural effusion and basal lung atelectasis (15 patients) (Figs. 3,6). Porto-mesenteric vein thrombosis was seen in 3 patients (Fig. 7). Splenic infarction was detected in 5 patients (Fig. 8). Some patients had more than one complication (Figs. 3,8). MDCT examination was able to detect all 88 complications and showed sensitivity and specificity of 100% (Table 2).

Staple line leak was the commonest complication encountered. In most of the cases, the leak was detected at the proximal stomach near the gastroesophageal junction (28 cases) and in only 2 cases it was at the distal stomach. All the leak cases were detected within the first week after surgery (Table 3).

Other less frequent complications as abscess formation was most common in the second week, while thrombotic events were most common between the second and third weeks after surgery. On the other hand, pulmonary complications, splenic infarction and hematoma were found mostly in the first week following LSG similar to staple line leak (Table 4).

Table 5 demonstrates the clinical presentations among the common acute complications of LSG as stated in the referral request.

Although this study was carried out in two different institutions, yet, the results were comparable with no significant difference.

Discussion

Laparoscopic sleeve gastrectomy became a commonly performed surgical procedure of morbid obesity which has been a common health problem. Early detection of complications after LSG is critical in the post-operative

Table 2 Types of acute post LSG complications among the studied cases

Complication	Number of patients	Percentage of patients (%)
Staple line leakage	30	40
Collection and / or abscess	20	27
Haematoma	15	20
Pleural effusion and basal atelectasis	15	20
Portal and mesenteric thrombosis	3	4
Splenic infarction	5	7
Number of complications	88	
Number of patients with complication	68	91
Number of patients with normal post-operative findings	7	9
Total number of patients	75	100

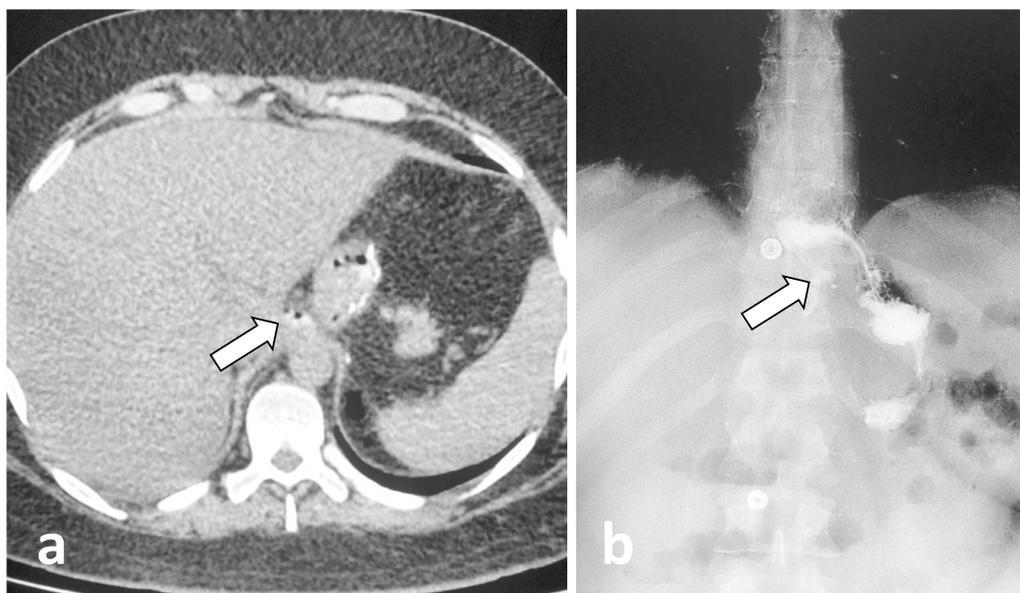


Fig. 1 Post LSG **a** Axial-enhanced MDCT and **b** Water-soluble UGI fluoroscopic examination showing evidence of contrast leakage related to the superior aspect of the staples line with evidence of extra-luminal oral contrast and air foci more evident in the CT image (arrows)

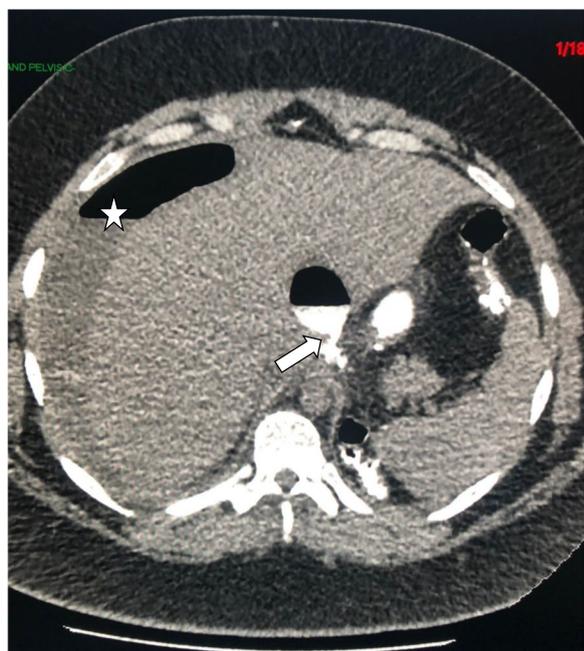


Fig. 2 Axial post contrast MDCT showing evidence of oral contrast leakage anterior to the superior aspect of the staples line after sleeve gastrectomy operation with formation of collection having air/contrast level (arrow). Hydro-pneumoperitoneum is also noted (star)

period, as it allows prompt and potentially less invasive management [1].

This study included 75 patients with suspected post sleeve gastrectomy acute complications referred by the

surgery department with acute symptoms within 30 days after surgery, for whom MDCT scan has been done. Complications were detected in 68 patients out of the 75 patients included in this study (91%).

A total of 88 complications were observed among 68 out of 75 patients studied, with some patients experiencing more than one complication. Additionally, 7 patients had no radiological evidence of complications.

The most common complication detected in this study was gastric leak (30 patients, 40%). Followed by abscess formation (20 patients, 27%), hematoma (15 patients, 20%). Pleural effusion and basal lung collapse (15 patients, 20%) and Porto-mesenteric vein thrombosis was also seen in 3 patients (4%) and splenic infarction in 5 patients (7%). MDCT examination was able to detect all 68 complications and showed sensitivity and specificity of 100% for each.

In a study done by Chivot et al., they reported that in the presence of a high clinical doubt of complications, and even when post-operative UGI images are normal, CT has to be performed to search for other associated complications such as abscess, minute leak and fistula. CT can also provide other important data by showing pneumoperitoneum or extra-luminal accumulation of oral contrast material. CT is considered the examination of choice in those patients with post-operative vague abdominal symptoms [3].

As mentioned formerly, staple line leak was detected in 30 patients. It appears as extra-luminal extravasation of the oral contrast. The timing of leak was mostly late as it

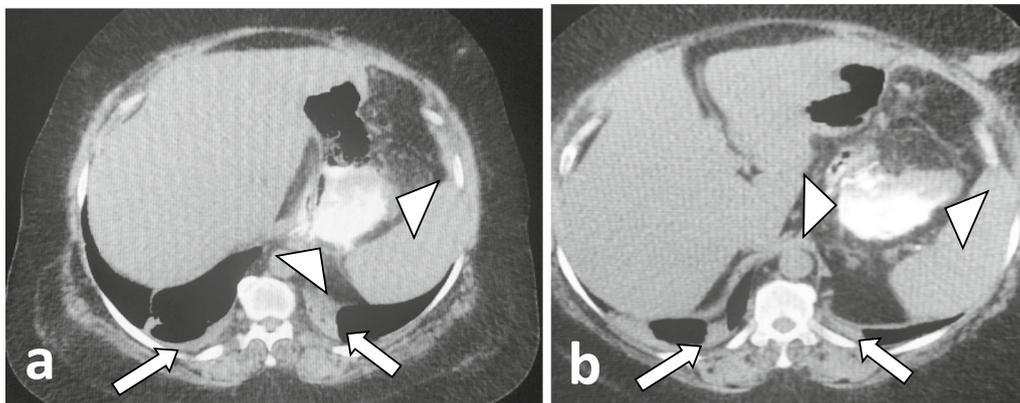


Fig. 3 a and b Axial post contrast MDCT showing evidence of marked oral contrast leakage and hematoma formation lateral to the staples line (arrow heads). The condition was associated with hemoglobin drop and was confirmed later during laparotomy. Associated bilateral pleural reaction and basal lung atelectasis were also noted (arrows)



Fig. 4 Axial post contrast MDCT after sleeve gastrectomy operation showing evidence of non uniform marginally enhancing encysted collection adjacent to the staples line denoting inflammatory process with an abscess formation (arrow heads). Minimal free abdominal fluid is also noted (arrow)

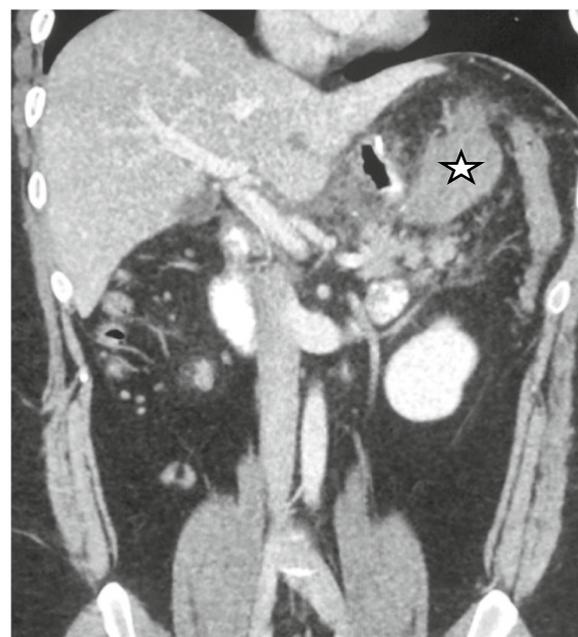


Fig. 5 Coronal post contrast MDCT after sleeve gastrectomy operation showing a large homogeneous hyperdense hematoma (star) lateral to the staples line with no evidence of extra-luminal oral contrast leak

was encountered in 26 cases (87%) after 48 h, while only in 4 patients (13%) was an early leak in the first 48 h suggesting technical error during surgery. Most of the post LSG staple line leaks reported in our study occurred in the proximal stomach (28 patients). Only two patients had leaks in the distal stomach. These findings agree with what was found in a study done by Gonzalez et al. who stated that due to the high pressure zone in the upper stomach most of the post sleeve gastrectomy leaks occur in the gastroesophageal area [5]. The detection rate for

leaks at the gastroesophageal junction after LSG encountered by CT is 60% to 80% [5, 6]. CT evidence of an abscess, phlegmon, or fluid collection should be considered as leak even if no extravasation of contrast is seen. Upper gastrointestinal (UGI) series can also be used to detect leaks, but are less sensitive for a leak at the gastroesophageal junction than MDCT [7].

The second most common finding detected in our study was operative bed collection with or without

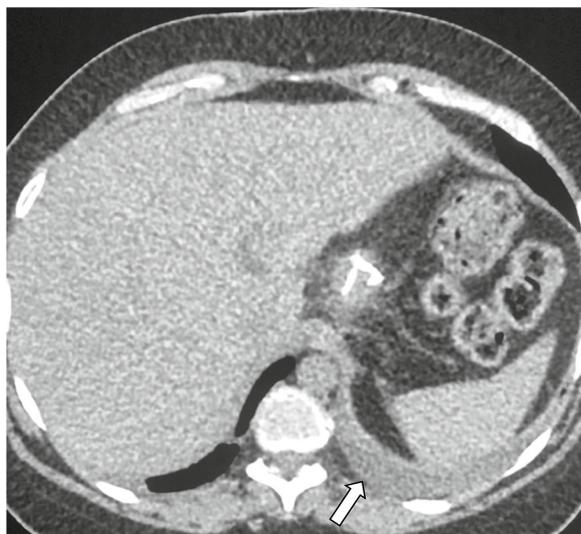


Fig. 6 Axial post contrast MDCT after sleeve gastrectomy operation showing left pleural effusion (arrow)



Fig. 7 Axial post contrast MDCT after sleeve gastrectomy operation showing evidence of a non-enhancing hypodense filling defect partially obliterating the main portal vein representing partial portal vein thrombosis (arrow)

abscess formation. This finding was encountered in 20 patients out of 75 patients (27%). Operative bed collection and abscess formation are considered an important CT finding suggesting leak even in the absence of clear contrast extravasation. Intra-abdominal abscess usually presents with symptoms of abdominal pain, fever/chills or nausea and vomiting, however, local examination may be limited due to increased patient's body habitus. MDCT scan is considered the investigation of choice for suspected intra-abdominal abscess following LSG. Enhanced CT is important to differentiate between

operative bed collection and an abscess, with the latter showing a rim like marginal enhancement. In a series of 164 patients undergoing LSG, Lalor and colleagues reported 1 patient with an abscess (0.7%) [8, 9].

Extra-luminal bleeding with haematoma formation is another common complication following LSG and is often underdiagnosed unless it is severe. In our study, we detected 15 patients (20%) as having post-operative haematoma. In pre- and post contrast MDCT, a hematoma appears as a high density collection that does not change in density after oral and IV contrast administration [9]. In one study, post-operative bleeding that requires intervention occurs in up to 11% of cases after LSG. Fortunately, 85% of patients are likely to stop without surgical intervention [10].

Hemodynamic instability or failure of non-operative management mandates emergency surgical management. The staple line is the most common site of bleeding after an LSG, but splenic injury is also possible. In another study, the risk of post-operative bleeding has been reported to be between 1 and 6% after LSG [11, 12].

Post-operative pulmonary complications namely basal lung atelectasis and left pleural effusion are among the common post LSG complications and usually present with dyspnea, tachypnea and fever. These complications are usually associated with other complications and often managed conservatively. In our study MDCT scan was able to detect 15 patients (20%) having chest complications.

Post-operative portal and mesenteric vein thrombosis are major complications which might follow LSG, but fortunately they are not common as most of morbidly obese patients receive routine thromboembolic prophylaxis. They usually occur in the second or third week after surgery and present with abdominal pain and vomiting [13]. In our study, MDCT scan was able to detect three patients (4%) as having portal and mesenteric vein thrombosis who were treated by long-term anticoagulation and none of them required surgical intervention or bowel resections. Although portovenous thrombosis is a less common post LSG complication, it requires precise diagnosis and prompt management; otherwise, it might progress to bowel ischemic as stated by Jacob et al. in 2012 [14, 15].

Although considered as a minor complication after LSG, splenic infarction was detected in 5 patients in our study (7%). It usually occurs at the upper pole of the spleen as a result of devascularisation of the gastric fundus during dissection as stated by Chaudhry et al. Splenic infarction usually presents with left hypochondrial pain which responds well to analgesics. Chaudhry et al. reported the importance of CT scan with IV contrast in diagnosis of post sleeve gastrectomy splenic

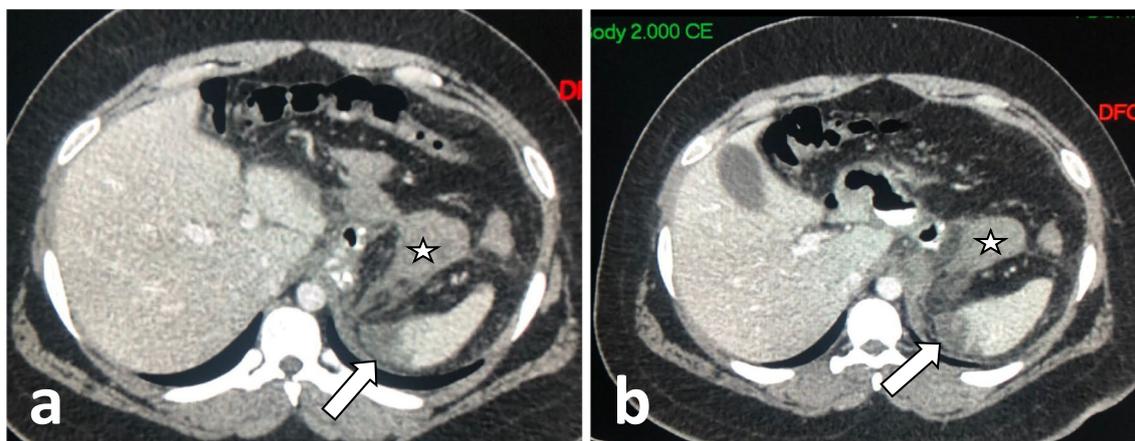


Fig. 8 a and b Axial post contrast MDCT after sleeve gastrectomy operation showing a small splenic infarct (arrows) and a large hematoma posterolateral to the staples line (stars)

Table 3 Site and time of leak

	Number of cases	Percentage of total leaks (%)
<i>Site of leak</i>		
Proximal stomach	28	94
Distal stomach	2	6
<i>Time of leak</i>		
< 48 h	4	13
> 48 h	26	87

Table 4 Time of occurrence of complications

Complication	Time		
	1st week	2nd week	3rd week
Leak	30	–	–
Hematoma	9	6	–
Splenic infarction	4	1	–
Abscess formation	–	8	7
Pulmonary/pleural complications	15	–	–
Thrombotic events	–	1	2

infarction and its characteristic appearance as an area of non enhancement usually at the superomedial aspect of the spleen [16].

Finally, reviewing the different clinical presentations of acute post LSG complications symptoms such as abdominal pain, tachycardia and tachypnea (Table 5), it was found that there is a great overlap of the symptoms of different complications that need different ways of management. Adding to that, clinical assessment is of a limited value due to increased patient’s body habitus. All these factors raise the importance of MDCT performed in pre- and post-IV and oral contrast administration for proper diagnosis and to guide in deciding the plan of management. This agrees with Chivot et al. who reported that in the presence of a high clinical doubt of complications, and even when post-operative UGI series images are normal, CT has to be performed to search for other associated complications. CT is considered the examination of choice in those patients with post-operative vague abdominal symptoms [3].

Conclusions

In conclusion, MDCT scan done in a biphasic manner; pre contrast series and post oral and IV enhanced series, is an extremely valuable imaging modality in diagnosing

Table 5 The different clinical presentations of the acute post LGS complications

Complication	Clinical presentation
Leak	Abdominal pain, tachycardia, tachypnea, fever, abdominal tenderness
Hematoma	Abdominal pain, tachycardia, pallor and tachypnea
Splenic infarction	Abdominal pain and low grade fever
Abscess	Abdominal pain, fever, tachycardia and abdominal tenderness
Pulmonary complications	Dyspnea, tachypnea, fever and tachycardia
Thrombotic events	Abdominal pain, vomiting and distension

acute post LSG complications when clinically suspected. In addition, it correlates well to the clinical presentations of the patients, and it has a major role to guide the plan of management.

Abbreviations

BMI	Body mass index
CT	Computed tomography
IV	Intravenous
LSG	Laparoscopic sleeve gastrectomy
MDCT	Multi detector computed tomography
MIP	Maximum intensity projection
MPR	Multiphase reformatted
SMA	Superior mesenteric artery
SMV	Superior mesenteric vein
UGI	Upper gastrointestinal

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Author contributions

S.A. shared in the study's conception and design, acquired, analyzed and interpreted data, processed CT findings at the CT workstation, revised clinical data, and contributed to the drafting and revising of the manuscript. S.S. contributed to the study's conception and design, collected patients' data, processed CT findings at the CT workstation, and shared in writing and revising the manuscript. All authors mentioned read and approved the final manuscript.

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Availability of data and materials

The sets of data used and/or analyzed during the study are available upon sensible request.

Declarations

Ethics approval and consent to participate

No individual data was included in the study. This study was approved by the Research Ethics Committee of the Radiology Department of the Faculty of Medicine at Cairo University in January, 2022. Reference number of approval: 57-2022. All patients participating in this study were informed of what it entails and gave verbal informed consent to take part in this research. If the patient was unconscious at the time of the study, written informed consent for their participation was provided by their legal guardian.

Consent for publication

Revision of the patients records included in this study revealed that all patients gave written informed consent to use and publish the data obtained within this study. If the patient was unconscious when consent for publication was requested, written informed consent for the publication was provided by their legal guardian.

Competing interests

The authors of this study declare that they have no competing interests.

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