



# Splenic Abscess Following Sleeve Gastrectomy: A Systematic Review of Clinical Presentation and Management Methods

Nasser Sakran<sup>1,2</sup>  · Roxanna Zakeri<sup>3</sup> · Brijesh Madhok<sup>4</sup> · Yitka Graham<sup>5,6</sup> · Chetan Parmar<sup>3</sup> · Kamal Mahawar<sup>5,7</sup> · Chanpreet Arhi<sup>8</sup> · Kamran Shah<sup>9</sup> · Sjaak Pouwels<sup>10</sup> · on behalf of the Global Bariatric Research Collaborative

Received: 15 December 2020 / Revised: 21 March 2021 / Accepted: 25 March 2021 / Published online: 1 April 2021  
© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2021

## Abstract

**Background** Splenic abscess is a rare complication following sleeve gastrectomy.

**Methods** We performed a systematic review to clarify its clinical significance, presentation, and management. PubMed, Embase, MEDLINE, Google Scholar, and the Cochrane Library were searched up to the 19th of July 2020.

A total of 18 patients were included, of which 11 were female and 7 were male. The mean age was  $34.1 \pm 12.3$  years, and the mean body mass index was  $45.8 \pm 7.6$  kg/m<sup>2</sup>. Type 2 diabetes mellitus was reported in 11.1% of patients and hypertension in 22.2%. Fever was the most common presenting symptom seen in 17 (94.4%) patients, followed by abdominal pain in 10 (55.6%). The mean duration from surgery to presentation was  $98.6 \pm 132.7$  days (range 10–547 days). Computed tomography was used for investigations in 17/18 (94.4%) patients. Seven patients had reported leak, three reported bleeding, and 2 reported pleural effusion. Thirteen patients had unilocular abscess. All patients were treated with antibiotics. Four patients needed total parenteral nutrition, and three were given proton pump inhibitor. In total, 11 patients needed percutaneous drainage as a part of treatment and 11 patients needed total splenectomy and 1 needed partial splenectomy.

**Conclusion** Splenic abscess following sleeve gastrectomy is a rare identity. The etiology of formation of splenic abscess needs further studies. A computed tomography of the abdomen with contrast is the preferred diagnostic tool. There is no gold standard treatment for splenic abscess.

**Keywords** Splenic abscess · Bariatric surgery · Sleeve gastrectomy · Leaks · Complications · Obesity

## Introduction

Splenic abscess is an uncommon complication of other infections, which occurs after hematogenous spread or local dissemination [1].

The most frequent factors are bacterial endocarditis or in cases of splenic ischemia or infarction that are secondarily infected. Other sources are pyogenic and abdominal infections, gastrointestinal perforations, arteriovenous malformation, pneumonia, diabetes, neoplasia, hemoglobinopathies

✉ Nasser Sakran  
sakranas@gmail.com

<sup>1</sup> Department of Surgery, Emek Medical Center, 21 Izhak Rabin Blvd, 1834111 Afula, Israel

<sup>2</sup> Technion – Israel Institute of Technology, Haifa, Israel

<sup>3</sup> Department of Surgery, Whittington Health NHS Trust, London, UK

<sup>4</sup> East Midlands Bariatric and Metabolic Institute, University Hospital of Derby and Burton NHS Foundation Trust, Derby, United Kingdom

<sup>5</sup> Faculty of Health Sciences and Wellbeing, University of Sunderland, Sunderland, UK

<sup>6</sup> Facultad de Psicología, Universidad Anahuac Mexico, Mexico City, Mexico

<sup>7</sup> Bariatric Unit, South Tyneside and Sunderland NHS Trust, Sunderland, UK

<sup>8</sup> Department of Surgery, University Hospital Lewisham, London, UK

<sup>9</sup> Bariatric and Upper GI Department, GB Obesitas Skaane, Malmö, Sweden

<sup>10</sup> Department of Intensive Care Medicine, Elisabeth-Tweesteden Hospital, Tilburg, the Netherlands

such as sickle-cell anemia and thalassemia, AIDS, immunodeficiency, urogenital infections, trauma, and metastatic infection [2, 3].

The incidence of splenic abscess varies between 0.14 and 0.7% in the autopsy series [4, 5].

Splenic abscess is an extremely rare condition, but if untreated, mortality may be as high as 70%, reducing to 1% with appropriate treatment [6].

The most common pathogens detected in the most series include *Staphylococcus*, *Streptococcus*, and Enterobacteriaceae members, especially *Escherichia coli* [4, 7, 8].

Sleeve gastrectomy (SG) is currently the most commonly performed bariatric surgery procedure worldwide [9]. It is a relatively simple and safe procedure with low morbidity and mortality and results in significant, durable weight loss [10]. SG reported complications include staple-line bleeding, leak, stricture, spiral rotation, delayed gastric emptying, gastric dilation, intra-abdominal abscess, splenic injury, and splenic abscess [10–13].

Splenic abscess following SG is an uncommon finding but can be potentially fatal. Only a few cases have been reported in the literature. The incidence of splenic abscess following SG is thought to be growing due to the increasing number of the procedure. A computed tomography (CT) scan and abdominal ultrasonography (US) are the best modalities to diagnose a splenic abscess. The risk of abscess formation increases with poor blood supply, such as infarction of the upper pole of the spleen, which is not uncommon following SG [14, 15].

The clinical manifestations of splenic abscesses usually include abdominal pain, exclusively located or, at least, more intensely described in the upper-left-quadrant area. Fever, nausea, vomiting, and anorexia may be also present in various combinations [8, 16, 17].

Laboratory findings are consistent with the acute phase of infection, but their exact nature is determined by the pathogen isolated from the abscess [18, 19].

The splenic abscess management is based on medical therapy with antibiotics and splenectomy or percutaneous abscess drainage (PCAD), with good results. However, the optimal treatment remains unclear [20, 21].

The present review aims to understand the presentation and management of splenic abscess after SG in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines [22]. To the best of our knowledge, this is the first systematic review on this topic.

## Methods

A multi-database search was conducted to identify all published cases of splenic abscess after SG. PubMed, Embase, MEDLINE, Google Scholar, and the Cochrane Library were searched from up to 19th of July 2020. The search strategy

used the following keywords and was modified for each database: [(splenic abscess) and (sleeve gastrectomy)].

Authors NS, CP, and SP individually screened and selected studies based on title and abstract. After primary selection, both authors reviewed the selected studies' full text and determine suitability for inclusion based on the established selection criteria. For further eligible studies, cross-references were screened. A discussion with each other solved disagreements until consensus was reached.

Only original articles, case reports, and case series published in the English language were included. Review papers were excluded. Due to inconsistent reporting of outcome measures and a low number of included studies (e.g., patients), a meta-analysis was not performed.

## Results

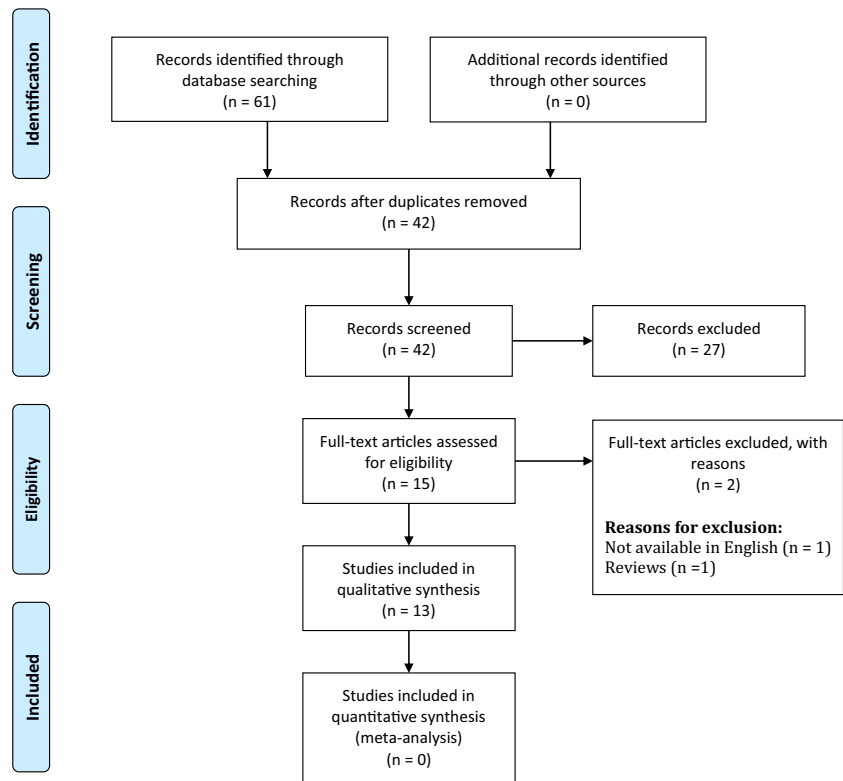
The initial literature search produced 61 results, including 19 duplicates. After screening for title and abstract, 15 potentially relevant studies were found and underwent a full-text critical appraisal. Two of these were excluded; one was a review, and the other was not in English language. Thirteen studies [23–35] were included in this systematic review. Figure 1 presents the PRISMA flowchart.

### Study Characteristics

Table 1 gives an overview of the characteristics of the included studies. A total of 18 patients were included, of which 11 (61.%) were female and 7 (38.9%) male. The age of the patients was  $34.1 \pm 12.3$  years (range from 19 to 68 years). Body mass index (BMI) was reported in 13 of 18 patients (this corresponds with 10 of the 13 included studies) and ranged from  $45.8 \pm 7.6$  kg/m<sup>2</sup>. Regarding comorbidities, hypertension was reported in four patients (22.2%) and type 2 diabetes mellitus in 2 (11.1%).

### Initial presentation, Symptomatology, and Diagnostic Modalities

Table 2 and Fig. 2 give an overview of the initial presentation, symptoms, and diagnostics modalities used. Fever was the most common presenting symptom, found in 17 (94.4%) patients, followed by abdominal pain in 10 (55.6%). The mean duration from surgery to presentation was  $98.6 \pm 132.7$  days. A computed tomography (CT) scans were used to diagnose a splenic abscess in 17/18 (94.4%) cases, in combination with esophagoduodenogastroscopy (EGD) in 4 (22.2%) cases and/or upper gastrointestinal (UGI) series in 2 (11.1%). Echocardiography was performed in 4 (22.2%) patients to exclude sources of septic emboli.

**Fig. 1** PRISMA flow chart of the included studies

## Laboratory Investigations, Cultures, and Initial Treatment

Table 3 gives an overview of the initial laboratory investigations and treatment. The majority (15/18; 83.3%) of the patients had an elevated white blood cell (WBC) count and, to a lesser extent, an elevated c-reactive protein (CRP). In 15/18 cases, WBC was noted as elevated. In the remaining three cases, no mention was made of lab results. All patients were treated with antibiotics. Total parenteral nutrition (TPN) was required for 4 (22.2%) patients, and 3 (16.7%) patients were given proton pump inhibitors (PPI).

Figure 3 gives an overview of the results of the microbial culture results. Cultures were reported in 10 of the 13 included studies. *S. aureus* and *E. coli* (20% each) were the most common bacteria isolated from the patients in this study, followed by *K pneumoniae* (11%). In about 11% of the patients, multiple organisms were isolated.

## Surgery and Postoperative Course

Table 4 gives an overview of the surgical approach. Eleven (61.1%) patients needed percutaneous drainage as a part of their initial treatment. Unsuccessful resolution with percutaneous management led to three (16.7%) patients undergoing laparoscopic drainage. Eleven (61.1%) patients eventually needed a total splenectomy, and 1 (5.6%) needed a partial splenectomy. None of the patients died.

Table 5 shows the postoperative course and abscess characteristics. Abscess duration ranged from 2 weeks to 18 months. The majority of the abscesses were unilocular single abscesses. No patient died from the disease or its treatment. Postoperative complications were inconsistently reported. Of the studies that reported postoperative complications, leak and bleeding were most common. Eleven of the eighteen patients with a splenic abscess had a preceding complication (of which seven were leakage, others were not specifically mentioned) during the initial sleeve operation.

## Discussion

This systematic review demonstrates that a splenic abscess is a rare entity after SG. It is usually a unilocular abscess and treated with antibiotics in conjunction with percutaneous drainage and/or splenectomy. Some patients may need TPN. Based on the included studies, we propose the following treatment algorithm to treat splenic abscess following SG (Fig. 4).

In this review, 7 of the 18 splenic abscesses were associated with a staple line leak, suggesting investigations must be carried out to rule out the latter. Hence a large proportion of the patients included here underwent some form of imaging of the sleeve. However, another 7 cases had an uneventful SG without any obvious complication, demonstrating the exact mechanism of post-SG splenic abscess is incompletely understood.

**Table 1** Characteristics of the included studies

No	Study	Sample Size	Age (years)	Gender	BMI kg/m <sup>2</sup> prior SG	Comorbidities
1	Sakran et al. 2012 [11]	2	36	Female	X	X
			35	Female	X	X
2	Genser et al. 2015 [12]	1	26	Female	38.6	Hypertension
3	Nassour et al. 2017 [13]	3	22	Female	48	X
			39	Male	42	T2DM, OSA, GERD
			68	Female	39.3	Hypertension, T2DM, CAD, Hypothyroidism
4	Abdelhady et al. 2017 [14]	2	22	Female	44	No
			26	Male	47	No
5	Aoun et al. 2020 [15]	1	21	Male	45	No
6	Singh et al. 2015 [16]	1	44	Male	42	No
7	Cervera-Hernandez et al. 2017 [17]	1	45	Female	X	Hypertension, asthma
8	Avallone et al. 2018 [18]	1	52	Female	44.2	Severe arthritis
9	Khuri et al. 2017 [19]	2	29	Female	X	X
			28	Female	X	X
10	Abbas et al. 2020 [20]	1	41	Female	42	No
11	Shanti et al. 2017 [21]	1	34	Male	69.9	Hypertension
12	Schiavo et al. 2015 [22]	1	26	Male	44	X
13	Avulov et al. 2018 [23]	1	19	Male	49	No

Abbreviations: *X* not reported, *BMI* body mass index, *SG* sleeve gastrectomy, *T2DM* type 2 diabetes mellitus, *OSA* obstructive sleep apnea, *GERD* gastroesophageal reflux disease, *CAD* coronary artery disease

A necessary step in SG is a division of the gastrosplenic ligament while sacrificing the short gastric arteries to mobilize the stomach's major curvature and, in particular, the fundus. As a result, splenic vascular compromise may become apparent intraoperatively as arterial demarcation of, typically, the upper pole of the spleen. Other possible causes of infarction following a SG include splenic vein thrombosis and inadvertent ligation of the upper terminal splenic artery branches [14]. Such infarction has also been noted during Nissen's fundoplication [13, 15] procedures. Sakran et al. [17] hypothesized that infection of the splenic infarct results either from direct extension from local infection or through hematological spread, aided by temporary immunosuppression in the immediate postoperative period. The latter may be aggravated by rapid weight loss and reduced oral intake.

Other potential causes of splenic abscess unrelated to bariatric surgery include metastatic infection from other sites, such as bacterial endocarditis, infection following splenic infarction due to hemoglobinopathies, trauma to the spleen, immunodeficiency state, and contiguous infection by direct spread [29, 36, 37]. As such, patients with any of these predisposing factors should be explained about the risk of formation of splenic abscess during the pre-operative counseling and consent process.

Due to the relative rarity of splenic abscesses following SG, and the fact that splenic infarction has no clinical relevance in

the majority of patients [38, 39], the splenic abscess is often not considered in the initial work-up. Patients are mostly admitted to the hospital with nonspecific complaints such as upper quadrant pain, fever, feeling cold, and trembling. For this reason, diagnosis of splenic abscess is not always easy and may lead to a delay in diagnosis.

The triad of fever left upper quadrant pain and a tender mass was suggested by Sarr and Zuidema [40]. However, we did not find that a tender mass was part of the common symptom triad.

Fever was the most common symptom seen in our series, followed by left upper quadrant abdominal pain and chills as reported in Fig. 2, and the combination should prompt an urgent CT scan.

The most frequently observed laboratory finding of the cases with splenic abscess is leukocytosis.

Splenic abscesses are typically bacterial in origin [41]. Both gram-negative and gram-positive organisms have been reported [14, 42]. The most frequent agent found in the splenic abscess is *Streptococcus*. *Staphylococcus* and microorganisms from the Enterobacteriaceae family are less frequent factors.

Rarely, fungi and protozoa are also encountered, especially in immuno-suppressed patients. Splenic abscesses tend to be polymicrobial, so they should be treated with broad-spectrum antibiotics. In our review, the most common organisms obtained from culture of the abscesses were *Streptococcus* species and *Escherichia coli*.

**Table 2** Initial presentation/symptoms, diagnosis, and exams

No	Study	Case No	Initial presentation/symptoms	Diagnosis/Exams
1	Sakran et al. 2012 [11]	1	Fever, abdominal pain	CT, Echocardiography
		2	Fever, abdominal pain	CT, Echocardiography, EGD
2	Genser et al. 2015 [12]	1	Fever, abdominal pain, nausea, vomiting	CT, EGD, UGS
3	Nassour et al. 2017 [13]	1	Fever, chills	CT, US
		2	Fever, abdominal pain	CT
		3	Fever, abdominal pain, chills	CT
4	Abdelhady et al. 2017 [14]	1	Fever, abdominal pain	CT, Echocardiography
		2	Fever, dyspnea	CT, EGD
5	Aoun et al. 2020 [15]	1	Fever, chills	CT
6	Singh et al. 2015 [16]	1	Fever, abdominal pain, chills	CT, Echocardiography
7	Cervera-Hernandez et al. 2017 [17]	1	Fever, abdominal pain, nausea, vomiting, chills	CT
8	Avallone et al. 2018 [18]	1	Fever, abdominal pain	CT
9	Khuri et al. 2017 [19]	1	Fever, nausea, vomiting, chills	CT
		2	Fever, nausea, vomiting	US
10	Abbas et al. 2020 [20]	1	X	CT, EGD
11	Shanti et al. 2017 [21]	1	Fever	CT
12	Schiavo et al. 2015 [22]	1	Fever, abdominal pain, dyspnea	CT, EGD, US, UGS
13	Avulov et al. 2018 [23]	1	Fever	CT, UGS

Abbreviations: *X* not reported, *CT* computed tomography, *EGD* esophagogastroduodenoscopy, *UGS* upper gastrointestinal series

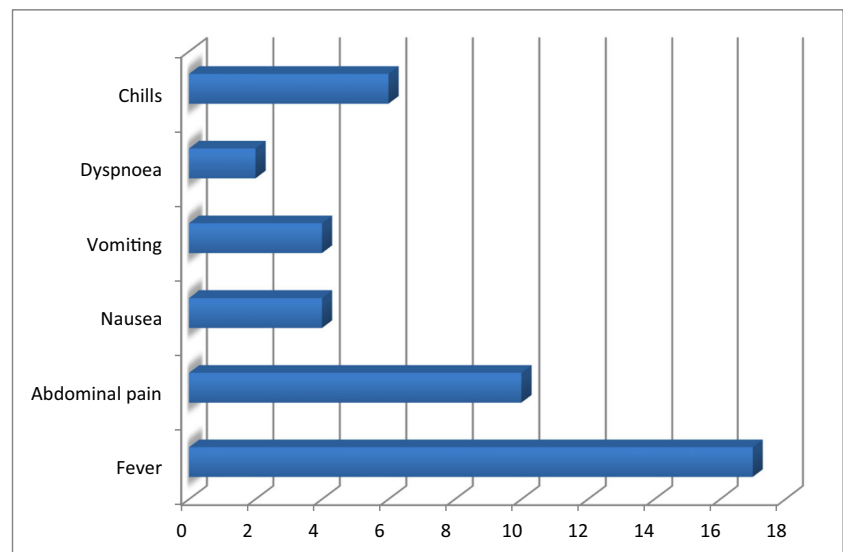
Diagnosis is often challenging due to non-specific presenting symptoms. Early diagnosis can readily be made on a CT scan in a patient with suggestive clinical and biochemical parameters [3].

CT scans can characterize the abscess cavity contents and reveal if it is unilocular or multilocular, which may have treatment implications. They may also reliably differentiate splenic abscesses from splenic cysts and hematomas. Additionally, it helps delineate the abscess's location in relation to the spleen and other visceral structures, thereby helping in planning for percutaneous and/or surgical drainage.

Splenic abscesses are, in general, associated with increased mortality and complication rates. Mortality rates of 12–70% have been reported [6, 43], although none of the patients in this review died due to this complication. This may be due to publication bias or some other hitherto unknown factor. It is further possible that those presenting with a splenic abscess without a local cause are sicker with widespread hematogenous spread of infection.

There is no gold standard treatment for splenic abscess. Traditional treatment includes appropriate antimicrobial

**Fig. 2** Overview of clinical symptoms at initial presentation (the x-axis shows absolute numbers)



**Table 3** Laboratory investigations and initial treatment

No	Study	Case No	Laboratory investigation	Initial treatment
1	Sakran et al. 2012 [11]	1	Elevated WBC	TPN, ATB, PPI, NPO
		2	Elevated WBC	ATB
2	Genser et al. 2015 [12]	1	Elevated WBC	Elevated CRP, ATB
3	Nassour et al. 2017 [13]	1	Elevated WBC	TPN, ATB
		2	Elevated WBC	ATB
		3	Elevated WBC	ATB
4	Abdelhady et al. 2017 [14]	1	Elevated WBC	ATB
		2	Elevated WBC	ATB
5	Aoun et al. 2020 [15]	1	Elevated WBC	Elevated CRP, ATB
6	Singh et al. 2015 [16]	1	Elevated WBC	ATB
7	Cervera-Hernandez et al. 2017 [17]	1	Elevated WBC	ATB
8	Avallone et al. 2018 [18]	1	Elevated WBC	Elevated CRP, ATB, TPN, PPI
9	Khuri et al. 2017 [19]	1	X	ATB
		2	Elevated WBC	ATB
10	Abbas et al. 2020 [20]	1	X	ATB
11	Shanti et al. 2017 [21]	1	Elevated WBC	TPN, ATB, NPO
12	Schiavo et al. 2015 [22]	1	Elevated WBC	X
13	Avulov et al. 2018 [23]	1	X	ATB, PPI

Abbreviations: *X* not reported, *WBC* white blood cells, *CRP* c-reactive protein, *TPN* total parenteral nutrition, *ATB* antibiotics, *PPI* proton pump inhibitor, *NPO* nothing per os

therapy and/or CT-guided percutaneous aspiration with or without splenectomy [44].

Solitary splenic abscesses can usually be treated with percutaneous or laparoscopic drainage allowing for preservation of the spleen. When symptoms persist, or the abscess is multilocular, a splenectomy might be needed [36, 45].

There are a number of studies in favor of spleen preservation and management using percutaneous aspiration or drainage (PCAD) [20, 46].

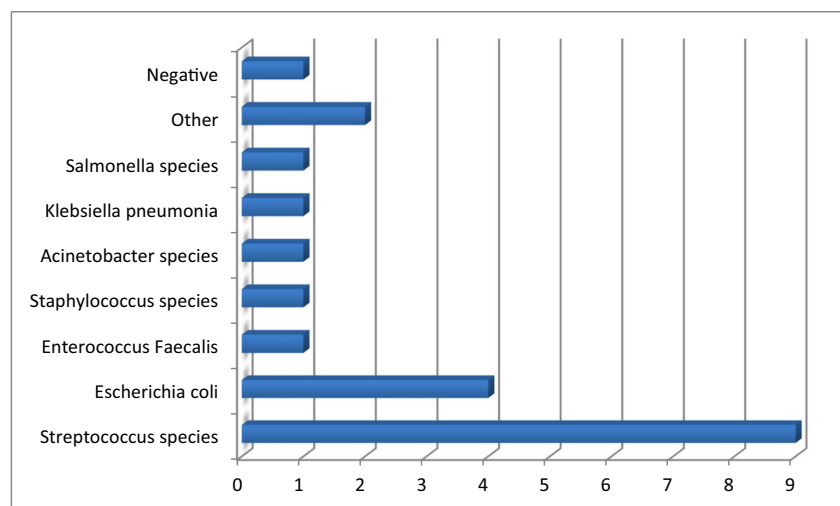
PCAD may be used as a bridge to surgery, allowing non-operative healing for splenic abscess patients who are at risk

for surgery, and helps avoid the risk of a fulminant and potentially life-threatening infection. The success rate for PCAD in our series was 22% (4 of the 18 patients).

While splenectomy is the most preferred treatment method, today, conservative methods such as PCAD are also applied, especially in solitary, thick-walled cases of abscess [20, 46].

Further studies are needed to elucidate the role of splenic ischemia in abscess formation. One suggestion could be to examine the spleen at the end of the procedure and note any obvious demarcation, especially of the upper pole, which could be a precursor to splenic infarction abscess.

**Fig. 3** Overview of culture results (the x-axis shows absolute numbers)



**Table 4** Endoscopic and potential follow surgical approach (in case endoscopic treatment was not successful)

No	Study	Case No	Endoscopic approach	Type of operation
1	Sakran et al. 2012 [11]	1	-	Total splenectomy
		2	Percutaneous drainage	Laparoscopic drainage
2	Genser et al. 2015 [12]	1	Pneumatic balloon, Internal drainage	Total splenectomy
3	Nassour et al. 2017 [13]	1	Percutaneous drainage	Total splenectomy
		2	Percutaneous drainage	Total splenectomy
		3	-	Total splenectomy
4	Abdelhady et al. 2017 [14]	1	Percutaneous drainage	Total splenectomy
		2	Endoscopic stent insertion	Total splenectomy
5	Aoun et al. 2020 [15]	1	Percutaneous drainage	No
6	Singh et al. 2015 [16]	1	Percutaneous drainage	Total splenectomy
7	Cervera-Hernandez et al. 2017 [17]	1	Percutaneous drainage	No
8	Avallone et al. 2018 [18]	1	-	Laparoscopic drainage
9	Khuri et al. 2017 [19]	1	-	Total splenectomy
		2	-	Total splenectomy
10	Abbas et al. 2020 [20]	1	Percutaneous drainage	Partial splenectomy
11	Shanti et al. 2017 [21]	1	Percutaneous drainage	No
12	Schiavo et al. 2015 [22]	1	Percutaneous drainage	No
13	Avulov et al. 2018 [23]	1	Percutaneous drainage	Total splenectomy

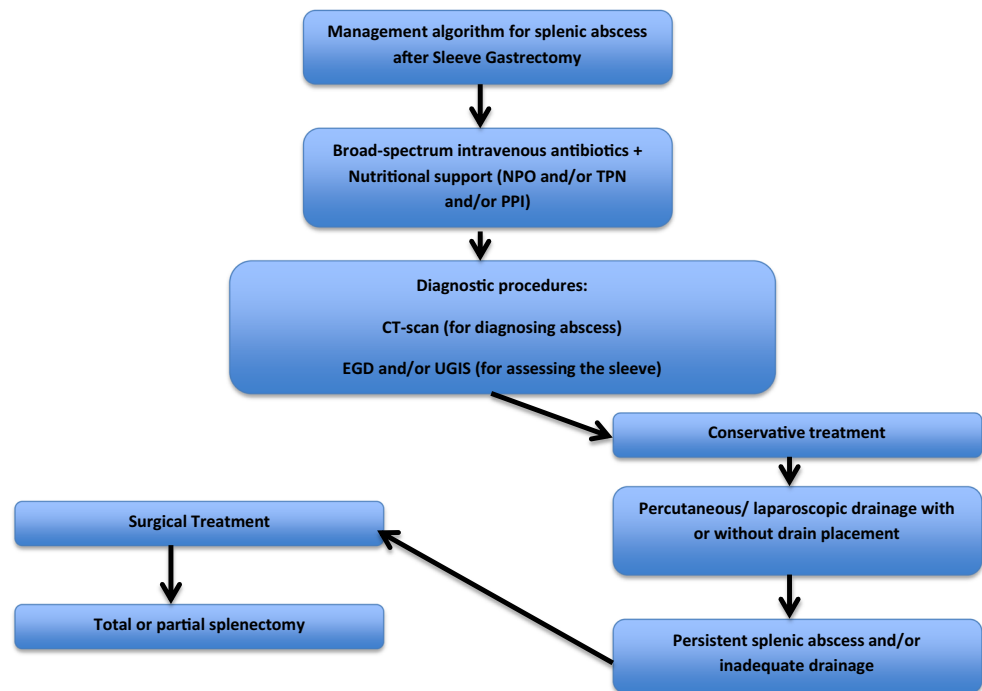
The initial management of postoperative splenic infarction is conservative with pain control and serial observation [15]. Symptoms can persist for 2 days to 2 weeks until complete resolution [15]. For patients with persistent symptoms, further investigations might help rule out an abscess formation or other complications.

In a series by Nores et al. [37], 34% of patients with splenic infarction required splenectomy for persistent pain. Larger volumes of infarction lead to greater rates of splenic infarct complications such as abscess, cyst, rupture, or hemorrhage. The management of these complications remains varied, ranging from observation to splenectomy [37]. Percutaneous

**Table 5** Postoperative course and splenic abscess characteristics

No	Study	Case No	Time of splenic abscess	Type of abscess	Postoperative complications	Mortality
1	Sakran et al. 2012 [11]	1	60 days	Multiple	-	No
		2	75 days	Single/unilocular	-	No
2	Genser et al. 2015 [12]	1	6 weeks	Single/unilocular	Leak	No
3	Nassour et al. 2017 [13]	1	18 months	Multiple	Leak	No
		2	3 months	Single/unilocular	-	No
		3	12 months	Single/unilocular	-	No
4	Abdelhady et al. 2017 [14]	1	45 days	Single/unilocular	Bleeding	No
		2	7 weeks	Multiple	Leak	No
5	Aoun et al. 2020 [15]	1	3 weeks	Single/unilocular	Pleural effusion	No
6	Singh et al. 2015 [16]	1	10 weeks	Single/unilocular	Bleeding	No
7	Cervera-Hernandez et al. 2017 [17]	1	6 weeks	Single/unilocular	-	No
8	Avallone et al. 2018 [18]	1	67 days	Single/unilocular	Leak, splenic vein thrombosis	No
9	Khuri et al. 2017 [19]	1	2 months	Single/unilocular	Splenic tear	No
		2	10 days	Single/unilocular	Leak, hemorrhagic, septic shock	No
10	Abbas et al. 2020 [20]	1	3 weeks	Single/unilocular	Leak, pleural effusion	No
11	Shanti et al. 2017 [21]	1	4 months	Single/unilocular	Leak	No
12	Schiavo et al. 2015 [22]	1	11 weeks	Multiple	-	No
13	Avulov et al. 2018 [23]	1	2 weeks	Multiple	-	No

**Fig. 4** Management algorithm for splenic abscess after Sleeve Gastrectomy. *Abbreviations:* NPO = nothing per os, IV = intravenous, TPN = total parenteral nutrition, PPI = proton pump inhibitor, CT = computed tomography, EGD = esophagoduodenogastroscopy, UGIS = upper gastrointestinal series



drainage is generally the preferred treatment modality in unilocular or bilocular abscesses and when the content appears less viscous. Splenectomy allows for definitive management of splenic abscesses but is not without its own short- and long-term morbidity. However, it remains the only viable treatment option for some patients, especially those with multilocular or multiple abscesses, those where percutaneous drainage has failed, and patients with recurrent abscesses.

This study further suggests that percutaneous drainage is a safe and effective alternative to surgery, especially in unilocular or bilocular abscesses, allowing preservation of the spleen and avoiding the need for immunization and lifelong prophylactic penicillin. It should be considered the first line of treatment. Splenectomy should be reserved for those where the percutaneous drainage has failed.

Further studies with a larger sample of SG patients should be conducted to elucidate the role of splenic ischemia or infarction in abscess formation.

## Conclusion

Splenic abscess formation after SG is an uncommon but highly morbid complication. It should be considered in the differential diagnosis of any post-SG patient presenting with the triad of fever, left upper quadrant abdominal pain, and raised inflammatory markers may herald a splenic abscess following sleeve gastrectomy. A CT scan will usually confirm the diagnosis. Patients should be initially treated conservatively with intravenous antibiotics and percutaneous drainage, where

possible. The decision to undergo a splenectomy will be based on clinical status and response to treatment.

**Author contribution** Initial idea: NS, SP

Literature search: NS, CP, SP

Data analysis: NS, RZ, BM, YG, CP, KM, CA, KS, NFG, SP

Writing the manuscript: NS, RZ, BM, YG, CP, KM, CA, KS, NFG, SP

Final approval: NS, RZ, BM, YG, CP, KM, CA, KS, NFG, SP

## Declarations

**Conflict of Interest** The authors declare no competing interests.

## References

1. Uhlaci N, Meteoglu I, Kacar F, et al. Abscess of the spleen. *Pathol Oncol Res.* 2004;10(4):234–6.
2. Smyrniotis V, Kehagias D, Voros D, et al. Splenic abscess. An old disease with new interest. *Dig Surg.* 2000;17(4):354–7.
3. Ng KK, Lee TY, Wan YL, et al. Splenic abscess: diagnosis and management. *Hepato-gastroenterology.* 2002;49(44):567–71.
4. Ooi LL, Leong SS. Splenic abscesses from 1987 to 1995. *Am J Surg.* 1997;174(1):87–93.
5. Ferraioli G, Brunetti E, Gulizia R, et al. Management of splenic abscess: report on 16 cases from a single center. *International journal of infectious diseases.* 2009;13(4):524–30.
6. Lotfollahzadeh S, Mathew G, Zemaitis MR Splenic abscess. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2020, LLC.
7. Chang KC, Chuah SK, Changchien CS, et al. Clinical characteristics and prognostic factors of splenic abscess: a review of 67 cases



- in a single medical center of Taiwan. *World J Gastroenterol*. 2006;12(3):460–4.
8. Gadacz T, Way LW, Dunphy JE. Changing clinical spectrum of splenic abscess. *Am J Surg*. 1974;128(2):182–7.
  9. Riaz RM, Myers DT, Williams TR. Multidetector CT imaging of bariatric surgical complications: a pictorial review. *Abdominal radiology (New York)*. 2016;41(1):174–88.
  10. Akkary E, Duffy A, Bell R. Deciphering the sleeve: technique, indications, efficacy, and safety of sleeve gastrectomy. *Obes Surg*. 2008;18(10):1323–9.
  11. Gumbs AA, Gagner M, Dakin G, et al. Sleeve gastrectomy for morbid obesity. *Obes Surg*. 2007;17(7):962–9.
  12. Frezza EE, Reddy S, Gee LL, et al. Complications after sleeve gastrectomy for morbid obesity. *Obes Surg*. 2009;19(6):684–7.
  13. Pradarelli JC, Varban OA, Ghafari AA, et al. Hospital variation in perioperative complications for laparoscopic sleeve gastrectomy in Michigan. *Surgery*. 2016;159(4):1113–20.
  14. Dhanasopon AP, Lewis CE, Folek JM, et al. Splenic infarct as complication of sleeve gastrectomy. *J Am Soc Bariatric Surg*. 2009;5(5):626–9.
  15. Wilkinson NW, Edwards K, Adams ED. Splenic infarction following laparoscopic Nissen fundoplication: management strategies. *J Soc Laparoendoscopic Surgeons*. 2003;7(4):359–65.
  16. Green BT. Splenic abscess: report of six cases and review of the literature. *Am Surg*. 2001;67(1):80–5.
  17. Nelken N, Ignatius J, Skinner M, et al. Changing clinical spectrum of splenic abscess. A multicenter study and review of the literature. *Am J Surg*. 1987;154(1):27–34.
  18. Cavuoti D, Fogli M, Quinton R, et al. Splenic abscess with *Vibrio cholerae* masking pancreatic cancer. *Diagn Microbiol Infect Dis*. 2002;43(4):311–3.
  19. Farnsworth TA. *Enterococcus avium* splenic abscess: a rare bird. *Lancet Infect Dis*. 2002;2(12):765.
  20. Chou YH, Hsu CC, Tiu CM, et al. Splenic abscess: sonographic diagnosis and percutaneous drainage or aspiration. *Gastrointest Radiol*. 1992;17(3):262–6.
  21. Ralls PW, Quinn MF, Colletti P, et al. Sonography of pyogenic splenic abscess. *AJR Am J Roentgenol*. 1982;138(3):523–5.
  22. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ*. 2009;339:b2700.
  23. Sakran N, Ilivitzki A, Zeina AR, et al. Splenic abscess after sleeve gastrectomy: a report of two cases. *Obes Facts*. 2012;5(4):635–9.
  24. Genser L, Pattou F, Caiazzo R. Splenic abscess with portal venous gas caused by intrasplenic migration of an endoscopic double pig-tail drain as a treatment of post-sleeve gastrectomy fistula. *J Am Soc Bariatric Surg*. 2016;12(1):e1–3.
  25. Nassour F, Schoucair NM, Tranchart H, et al. Delayed intra splenic abscess: a specific complication following laparoscopic sleeve gastrectomy. *Obes Surg*. 2018;28(2):589–93.
  26. Abdelhady MH, Salama AF, Karam M, et al. Solid organ infections: rare complications after laparoscopic sleeve gastrectomy: a report of four cases. *Obes Surg*. 2017;27(5):1374–80.
  27. Aoun R, Gabriel M, El Haddad E, et al. Splenic abscess after sleeve gastrectomy. *Case Rep Med*. 2020;2020:4850675.
  28. Singh Y, Cawich S, Aziz I, et al. Delayed splenic abscess after laparoscopic sleeve gastrectomy. *BMJ*. 2015;2015:bcr2014208057.
  29. Cervera-Hernandez ME, Pohl D. Splenic abscess caused by *Streptococcus anginosus* following laparoscopic sleeve gastrectomy: a case report of a rare complication of bariatric surgery. *J Surg Case Reports*. 2017;2017(4):rjx072.
  30. Avallone M, Iossa A, Termine P, Silecchia G. Splenic and concomitant liver abscess after laparoscopic sleeve gastrectomy. *CRSLS*. 2018.
  31. Khuri S, Abboud W, Abofoul S, Kluger Y, Bishara B. Emergency presentation of spleen associated complication after laparoscopic sleeve gastrectomy. *J Surg Case Rep*. 2017.
  32. Abbas ARM, Al Quarshi TA, Mohamed SA. Splenic abscess: a rare complication of sleeve gastrectomy: a case report and literature review. *J Clinical Research and Reports*. 2019;2(3):019.
  33. Shanti H, Obeidat F. Splenic abscess secondary to sleeve gastrectomy leak. *Laparosc Endosc Surg Sci*. 2017;24(2).
  34. Schiavo L, Scalera G, De Sena G, et al. Nonsurgical management of multiple splenic abscesses in an obese patient that underwent laparoscopic sleeve gastrectomy: case report and review of literature. *Clinical case reports*. 2015;3(10):870–4.
  35. Avulov V, McQuillen DP, Mizusawa M, Brams D. Splenic abscess after sleeve gastrectomy. 2014.
  36. Choudhury SR, Rajiv C, Pitamber S, et al. Management of splenic abscess in children by percutaneous drainage. *J Pediatr Surg*. 2006;41(1):e53–6.
  37. Nores M, Phillips EH, Morgenstern L, et al. The clinical spectrum of splenic infarction. *Am Surg*. 1998;64(2):182–8.
  38. Salvi PF, Stagnitti F, Mongardini M, et al. Splenic infarction, rare cause of acute abdomen, only seldom requires splenectomy. Case report and literature review. *Ann Ital Chir*. 2007;78(6):529–32.
  39. Antopolsky M, Hiller N, Salameh S, et al. Splenic infarction: 10 years of experience. *Am J Emerg Med*. 2009;27(3):262–5.
  40. Sarr MG, Zuidema GD. Splenic abscess—presentation, diagnosis, and treatment. *Surgery*. 1982;92(3):480–5.
  41. de Bree E, Tsiftsis D, Christodoulakis M, et al. Splenic abscess: a diagnostic and therapeutic challenge. *Acta Chir Belg*. 1998;98(5):199–202.
  42. Stamou KM, Menenakos E, Gomatos IP, et al. Clinical implications of sleeve gastrectomy as a source of spleen infarction or ischemia. *Obes Surg*. 2011;21(10):1490–3.
  43. Alonso Cohen MA, Galera MJ, Ruiz M, Puig la Calle J, Jr., Ruis X, Artigas V, et al. Splenic abscess. *World J Surg*. 1990;14(4):513–6. discussion 6–7.
  44. Paris S, Weiss SM, Ayers Jr WH, et al. Splenic abscess. *Am Surg*. 1994;60(5):358–61.
  45. Zerem E, Bergsland J. Ultrasound guided percutaneous treatment for splenic abscesses: the significance in treatment of critically ill patients. *World J Gastroenterol*. 2006;12(45):7341–5.
  46. Thanos L, Dailiana T, Papaioannou G, et al. Percutaneous CT-guided drainage of splenic abscess. *AJR Am J Roentgenol*. 2002;179(3):629–32.