

Infectious Complications of Post-Sleeve Surgery and Other Related Abdominal Infections Caused by *Streptococcus anginosus*

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Abstract: Invasive *Streptococcus anginosus* group (SAG) infection is associated with severe infection and poor outcome particularly among malignancy and post-surgical patients. We aimed to study the clinical details and outcomes of invasive SAG infection in post-sleeve surgery and malignancy related and non-malignancy related abdominal infections. (SAG) isolates from invasive infections between January 2015 and February 2018 were collected. Clinical data from the medical records of the infected patients were obtained retrospectively and analyzed. Fourteen invasive infections caused by SAG were identified. The mean age of the patients was 40.9 (minimum; 18 years, maximum; 80 years, SD; 21.03), five females (35.7 %) and nine (64.3 %) males. The peritoneal fluid was the most common specimen (8/15; 53.3%), followed by pleural fluid (3/15; 20%), deep abscesses (2/15; 13.3%), blood (1/15; 6.7%) and ascetic fluid (1/15; 6.7 %). The most predominant specimens (73.3%) were intra-abdominal involving commonly *anaerobes* and *Enterobacteriaceae*. Six patients (6/14; 42.9 %), had SAG abdominal or pleural infection as a complication of sleeve surgery. Each four of the remaining eight patients were categorized as patients with abdominal malignancy (4/14; 28.6 %) or non-malignancy related abdominal infections (4/14; 28.6%). Ten of the cases had polymicrobial infection. All patients had eventual recovery except of two malignancy patients who died because of severe sepsis with empyema or abdominal infection. Further studies are required to delineate post-operative sleeve surgery infectious complications and malignancy related abdominal infections to provide early treatment and better outcome.

Keywords: Invasive *Streptococcus anginosus*, post-sleeve surgery infection, abdominal and malignancy associated infections.

INTRODUCTION

Streptococcus anginosus is part of the *Streptococcus milleri* group which is anaerobic gram positive cocci in pairs or chains and contains three members, *Streptococcus intermedius*, *Streptococcus anginosus*, and *Streptococcus constellatus intermedius*. They are commensal flora of the human oropharynx and gastrointestinal tract and female genital tract. In addition, they also can cause severe infections. They can cause respiratory illnesses such as abscesses, empyema and pneumonia. The initiative to conduct this study was the observation of an increasing number of *Streptococcus anginosus* isolation from sterile specimens obtained from post-sleeve surgery patients. This has led to the initiation of a retrospective review of all SAG isolates recovered from sterile specimens (blood, CSF, pus and body fluid). In addition, we reviewed the literature searching for the infectious complication of post sleeve surgery and other abdominal conditions. Review of the literature using

different terms revealed inadequate data. Most reported studies and case series [1-4] were focused on the surgical complications of sleeve surgery with minimal information and attention to the infectious complications and their related microbial etiology. Moreover, infections related to sleeve surgery caused by these organisms, or other gram-negative bacteria and anaerobes can be serious. Polymicrobial infections are common and they range from simple infections such as abscess collection or peritonitis to septic shock or even death. During the 12 months of our prospective study, fourteen patients having clinically significant suppurative infections caused by *streptococcus milleri* were detected.

METHODS

Data collection

This is a retrospective chart review study reviewing patient's files to obtain the clinical details. Patients with invasive infections caused by SAG were

identified retrospectively from January 2015 to February 2018, using the microbiology computerized data base. An invasive SAG infection was defined as a case where SAG bacteria were cultured from sterile specimen(s) such as pleural fluid, blood, peritoneal fluid, ascetic fluid and pus samples. Cultures of upper respiratory tract swabs, wound swabs, urine, and sputum were excluded. This study was approved by the Research Ethics Review Committee of our institution (Research project number E-17-2775).

Microbiological diagnosis

- The isolated bacterial species were identified using a VITEK 2 system (bio-Mérieux).
- This work has been reported in line with the relevant guideline which should be named and cited.

RESULTS

Fourteen cases of SAG were reported. The clinical presentation, diagnostic and therapeutic managements and outcome were obtained for all cases. Fifteen specimens were obtained from the patients. SAG was isolated from pus and blood specimens of one patient. The peritoneal fluid was the most common specimen (8/15; 53.3%), followed by pleural fluid ((3/15; 20%),), deep abscesses (2/15; 13.3%), (liver and iliopsoas abscess), blood (1/15; 6.7%) (one patient had bacteremia associated with deep seated abscess), ascetic fluid (1/15; 6.7%). All patients had eventual complete recovery except two malignancy patient who died because of severe infections and serious underlying disease. The first one was a metastatic esophageal carcinoma patient who died because of severe sepsis and empyema and the other case underwent surgery (Whipple's procedure) for cancer head of pancreas complicated with bowel perforation. Most cases showed association with some underlying diseases and were related to certain clinical conditions. Six patients (6/14; 42.9%), had SAG infection as a complication of sleeve surgery. Each four of the remaining eight patients were categorized as abdominal malignancy (4/14; 28.6%) or patients with non-malignancy related abdominal infections (4/14; 28.6%). Ten out of the 14 cases have at least one organism in addition to *S. anginosus*. The mean age of the patients was 40.9 (minimum; 18 years, maximum; 80 years, SD; 21.03), five females (35.7 %) and nine (64.3 %) males.

Post-sleeve surgery infectious complications

Out of the fourteen patients, six were considered infectious post-operative complications of sleeve surgery. The clinical and laboratory characteristics of the six cases are summarized in Table-1. The detailed history of the patients is as followed: Case 1; a 28-year-old female, post sleeve gastrectomy (Wight, 135kg) and cholecystectomy complicated by leaking and endoscopy of stent for two and a half months. She presented to the clinic for follow up

complaining of vomiting for 4 months and back pain, mainly over the left side radiated to the left shoulder for one month. She also gave a history of productive cough of yellow sputum, chest pain and fever with chills for 2 weeks. Chest-X ray showed left lung empyema. Pleural fluid grew *Streptococcus anginosus*. The patient received tazocin for 15 days and tigecycline (50 mg 5ml, IV, q12h) and discharged home in good condition. Case-2; 30 years-old female diagnosed with hypothyroidism presented to the emergency room with severe abdominal pain and fever. She is a known case of morbid obesity; regain weight post laparotomy and insertion of gastric band (2009) which was removed 5 years later. She was seen in a private clinic and underwent sleeve gastrectomy (2015). Ten days later, she presented to the emergency department complaining of signs of leak (severe abdominal pain and fever). Abdominal CT- scan showed free leak, multiple collections and moderate plural effusion. She was hospitalized for 14 days. She underwent multiple CT scan guided drain insertion, aspiration of the pleural fluid and stent insertion. The pleural fluid grew *Streptococcus anginosus*. After drainage the patient showed improvement and discharged home. Case-3; a 50-year-old female, known to have diabetes mellitus, hypertension, hypothyroidism, underwent laparotomy (sleeve gastrectomy) 14 days before presentation. She presented to the emergency complaining of left upper quadrant pain and vomiting with difficulty in breathing and fever for one week post-surgery. The peritoneal fluid grew *Streptococcus anginosus* and *Prevotella buccae*. She was started on Tazocin and caspofungin. She was hospitalized for 5 days and was discharged home in good condition. Case-4; a 61-year-old male known to have diabetes and hypertension, had post laparoscopic gastric sleeve surgery (2015). He was complaining of continuous vomiting for 3 days and abdominal pain aggravated by eating. He had polymicrobial infection growing *Streptococcus anginosus* and *Klebsiella pneumonia* from the peritoneal fluid. He recovered after 3 days of hospitalization and discharged home on Augmentin (625 mg, Oral, q12hr). Case-5; a 31 years old male, post sleeve surgery, day 7 (weight; 180 kg, height; 181 cm and BMI 55.56). He was admitted as a case of gastric anastomotic leak presented with severe progressive diffuse abdominal pain for 5 days associated with shortness of breath, fever (38.5°C) and palpitation reaching HR 145 beat/min. He had polymicrobial infection of *Streptococcus anginosus* and *Streptococcus mitis* group. Ultrasound (US) abdomen and pelvis showed mildly enlarged liver (17 cm). CT-abdomen with contrast showed leakage and collection at the gastro-esophageal, left mild pleural effusion and free pelvic abscess collection. He was given caspofungin, clindamycin and fluconazole (200mg oral, daily). He underwent CT-guided drainage of the abscess that was to the microbiology laboratory for culture. The peritoneal fluid and collected abscess from the abdomen grew *Streptococcus anginosus*. He was hospitalized for

10 days and was discharged home. Case-6; a 32 year old male medically free admitted for elective gastric sleeve surgery. He had gastric band operation in 2006, complicated with upper abdominal pain and vomiting and removal of the band. One day post-operatively (gastric sleeve surgery), the patient developed abdominal pain and stomach leak. The peritoneal fluid grew *Streptococcus anginosus*. Accordingly, he received intravenous ceftriaxone and clindamycin without surgical intervention. He was hospitalized for 2 months and discharged home after complete recover.

Abdominal infections

Summary of the cases is shown in Table-2. Detailed history is as follow: Case-1; a 27-year-old male diagnosed as acute pancreatitis managed by conservative therapy. He presented with two weeks history of severe lower abdominal pain associated with increased urination and tea colored urine. He also had weight loss of almost 6 kg in the last 2-3 weeks associated with increased sweating but no fever. No history of alcohol intake. Ultrasound pelvis showed: large collection at the posterior aspect of the urinary bladder (15 x 7.5 cm) with thick echogenic contents and edematous mesentery at the right iliac fossa. CT-abdomen showed a large pelvic cystic mass lesion causing bilateral moderate hydronephrosis and hydroureter. He was diagnosed as acute pancreatitis and was treated with piperacillin-tazobactam (4.5 gm. 22.5 mL, IV, q6hr). He stayed for 29 days in the hospital, repeated CT-scan revealed resolution of the pelvic mass. He showed complete recovery and discharged home. Peritoneal fluid from the abdomen grew *Streptococcus anginosus*. Case-2; an 18 years old male, medically free, presented with right lower quadrant pain for one week. CT-abdomen showed inflamed appendix with abscess collection (3x4x5 cm) and mesenteric lymph node enlargement. He underwent a percutaneous drainage of the abscess. The Peritoneal fluid grew *Streptococcus anginosus* and *Escherichia coli*. He was hospitalized for 3 days, received ciprofloxacin (400 mg, 200 mL, IV, q12hr, 1000 mL and IV metronidazole, 500 mg, 100 mL, IV, q8hr) and discharged home. Case-3: an 80 year old male, known case of uncontrolled diabetes mellitus (DM) type II, morbid obesity (130 kg) and gallstone disease, presented to the emergency room with one week history of fever, right upper quadrant pain (RUQ), nausea, vomiting, jaundice, confusion and changes in stool color (clay appearance). On presentation, he was hypotensive; (112/53), respiratory rate; 91 breath/minute, metabolic acidosis and high lactate level. The abdomen was distended and tender on the RUQ. Abdominal ultrasound showed thickened gall bladder wall and report on gallbladder stones was not conclusive. A preliminary diagnosis of ascending cholangitis with septic shock, multi organ failure, respiratory failure, acute kidney injury and cardiovascular failure was made. He was admitted to the ICU and intubated due to respiratory failure. He was on high dose norepinephrine, vasopressin infusions and

was not responding well to shock management. He had high troponin level secondary to multiple factors, septic shock and worsening kidney function. The patient was planned for an urgent ERCP after clinical stabilization. Tazocin, Vancomycin were commenced and central lines were inserted. Two days after admission, he developed fever (39.5 °C). His blood culture grew gram-positive bacilli. Therefore, intravenous metronidazole, (500 mg, IV), imipenem-cilastatin and vancomycin were started. His clinical condition became critical and worsened over time. He underwent percutaneous abscess drainage under ultrasound guidance. Three days after admission, CT-abdomen showed multiple common bile ducts (CBD) stones and multiple liver abscesses (Figure-1). Percutaneous liver abscess drainage and percutaneous tube (PTC) insertion were done. There were no gall stones in the CBD and gall bladder (GB) was thick. Percutaneous and biliary drainage of two liver abscesses revealed, 80 cc of purulent bilious fluid. The blood culture grew *Streptococcus anginosus* and *Clostridium perfringes*. The drained abscess grew *Streptococcus anginosus*. Over one month of hospitalization, the patient improved gradually and discharged home. Case-4; A 32-year-old female, case of ileocecal crohn's disease presented with abdominal and right hip pain and perianal fistula complicated with entero-enteric, colo-muscular and multiple abscess collections. She improved after pus drainage and antibiotic treatment (Tazocin, 4.5 q8hrs IV). There was tenderness in the right inferior quadrant at the site of the drained abscess. CT scan abdomen revealed active crohn's disease involving the terminal ileum and cecum with a skip lesion seen in the lower third of the rectum, entero-enteric, colo-muscular, and peri-anal fistulous tracts. Multi-focal abscesses in the right psoas major, iliacus, and iliopsoas muscle were also noted (Figure-2). Pus from iliopsoas muscles abscess gram-stain showed many pus cells, gram-positive bacilli, gram negative bacilli and gram-positive cocci. The culture grew heavy growth of *Escherichia coli* (pan-sensitive), *Streptococcus anginosus* and *Enterococcus faecalis*. Anaerobic culture grew *clostridium species*. She was discharged home after completing 10 days of antibiotic treatment in good condition.

Table-1: Clinical characteristics of six post-sleeve surgery patients presenting with gastric leak and infectious complications.

Case	Age	Gender	Source/Site	Post-operative day of presentation	Diagnosis	Clinical presentation	Isolated organism	Management	Outcome
1	28	Female	Pleural fluid	1 and a half months	left lung empyema	Vomiting, back pain and productive cough for 1 months. Chest pain and fever for 2 weeks.	<i>Streptococcus anginosus</i>	Tigecycline 50 mg 5 mL, IV, q12hr	Recovered
2	30	Female	Pleural fluid	10 days	Pleural effusion	Severe abdominal pain and fever	<i>Streptococcus anginosus</i>	Surgical drainage and antibiotic aspiration and stent removal	Recovered
3	50	Female	Peritoneal fluid	14 days	DM, Post sleeve gastrectomy leakage	LUQ pain and vomiting with difficulty in breathing and fever for one-week post-surgery	<i>Streptococcus anginosus</i> and <i>Prevotella buccae</i>	Tazocin, caspofungin. drainage and stent removal	Recovered
4	61	Male	Peritoneal fluid	3 weeks	DM, Post sleeve gastrectomy leakage	Abdominal pain	<i>Streptococcus anginosus</i> and <i>Klebsiella pneumonia</i>	Augmentin ES-600 SUSP, 625 mg, Oral, q12hr post stent and drain insertion	Recovered
5	31	Male	Peritoneal fluid	7 days	Gastric anastomotic leak, left mild pleural effusion and free mild pelvic collection.	Severe progressive diffuse abdominal pain associated with shortness of breath, fever (38.5 ⁰ C) and palpitation	<i>Streptococcus anginosus</i> and <i>Streptococcus mitis</i> group	Caspofungin, clindamycin, fluconazole, 200 mg, Oral, Daily post stent, drain, TPN	Recovered
6	32	Male	Peritoneal fluid	16 days	Gastric anastomotic leak	Abdominal pain	<i>Streptococcus anginosus</i>	Ceftriaxone, clindamycin drainage and stenting	Recovered

† LUQ; left upper quadrant, DM; diabetes mellitus, TPN; total parenteral nutrition.

Table-2: Clinical characteristics and outcome of four patients presented with abdominal infection caused by *Streptococcus anginosus*.

Case	Age	Gender	Source/site	Underlying diseases	Diagnosis	Clinical presentation	Isolated organism	Management	Outcome
1	27	Male	Peritoneal fluid	Acute pancreatitis	Abdominal abscess	Severe lower abdominal pain	<i>Streptococcus anginosus</i> .	Metronidazole + Tazocin	Recovered
2	18	Male	Peritoneal fluid	Perforated acute appendicitis with abscess collection.	inflamed appendix with abscess collection	right lower quadrant pain for one week	<i>Streptococcus anginosus</i> and <i>Escharchia coli</i>	Ciprofloxacin + metronidazole + cefuroxime percutaneous abscess drainage.	Recovered
3	80	Male	Liver abscess drainage, blood	Uncontrolled DM, morbid obesity gallstones hypertension chronic kidney disease	Ascending cholangitis. Septic shock with biliary dilatation and the multiple liver abscesses.	Hemodynamically unstable presented with ascending cholangitis with septic shock, multi organ failure, respiratory failure , AKI and cardiovascular and immunity failure	Blood culture grew <i>Streptococcus anginoses</i> and <i>Clostridium perfringes</i> . Abscess grew <i>Streptococcus anginoses</i>	left-sided percutaneous internal-external biliary drainage \ percutaneous liver abscess drainage	Recovered
4	32	Female	Pus from illiopsoas muscle abscess	Ileocecal crohn's disease	Multi-focal abscesses in the right psoas muscle, (Illiopsoas abscess)	Abdominal, right hip pain and perianal fistula.	psoas abscess grew <i>Escherichia coli</i> , <i>Streptococcus anginosus</i> and <i>Enterococcus faecalis</i> . and <i>clostridium species</i> .	Tazocin, 4.5 q8hrs IV	Recovered

† AKI; acute kidney injury, DM; diabetes mellitus

Table-3: Clinical characteristics of four malignancy patients infected with *Streptococcus anginosus*

Case	Age	Gender	Source/site	Underlying diseases	Diagnosis	Clinical presentation	Isolated organisms	Treatment	Outcome
1	60	Male	Peritoneal fluid	Hodgkin's lymphoma, Abdominal TB	Peritonitis	Weight loss of > 20 kg in last 6 months along with lower abdominal pain, fever and night sweating.	<i>Streptococcus anginosus</i> and <i>Escharchia coli</i> .	Vancomycin	Recovered
2	56	Male	Pleural fluid	DM, HTN, and esophageal carcinoma	Lung empyema	back pain, shortness of breath and sweating for one day	<i>Streptococcus anginosus</i> , <i>Klebsiella Pneumonia</i> and <i>Aeromonas hydrophila</i> .	Meropenem and vancomycin	Died
3	75	Female	Ascetic fluid drainage	Disseminated ovarian cancer	Ascites (peritonitis)	Fever, abdominal distention, abdominal Pain, fatigue, and anorexia	<i>E coli</i> , <i>klebsiella pneumoniae</i> and <i>Streptococcus anginosus</i> .	Surgical drainage + Tazocin.	Recovered
4	52	Male	Peritoneal fluid	Cancer head of pancreas post-surgery (Whipple's procedure), complicated with bowel perforation.	Peritonitis + abscess collection	abdominal pain, fever (39.5 °C) and sweating.	(ESBL) <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , and <i>Streptococcus anginosus</i> .	exploratory laparotomy and wash out, and four drains were inserted as management of the perforation + Tazocin.	Died not recovered

† TB: tuberculosis, DM; diabetes mellitus, HTN; hypertension, ESBL; Extended spectrum beta lactamase.



Fig-1: Multiple hepatic abscesses largest one at segment II, VIII with air fluid level with concern of rupture of hepatic abscess at segment VIII



Fig-2: Multi-focal intra-muscular abscesses seen in the right psoas major, iliacus, and iliopsoas muscles, the largest abscess collection is seen in the right psoas major and extending to the right iliacus muscle. It measures 8 x 1.6 x 12 cm in AP, transverse, and craniocaudal dimensions respectively

Colorectal cancer and other malignancies

Cases are summarized in Table-3. Detailed history is as follows: Case-1; a 56-year old male, known to have diabetes mellitus, hypertension, and metastatic esophageal carcinoma. He presented with severe sepsis, metabolic acidosis and right pneumothorax with empyema. The pleural fluid grew polymicrobial infection of *Streptococcus anginosus*, *Klebsiella pneumoniae* and *Aeromonas hydrophila*. Blood culture was negative. He was admitted to the intensive care unit and was started on meropenem and vancomycin. During his hospitalization, he had poor response to management and eventually died. Case-2; a 60 year old male presented with abdominal pain and weight loss (>20 kg) for the last 6 months, fever and night sweating. CT scan abdomen and colonoscopy revealed abdominal mass; abdominal lymph node and ileocecal valve biopsy revealed Hodgkin's lymphoma with evidence of retroperitoneal perforation. He underwent post extended right hemicolectomy with end ileostomy. Tuberculosis culture was positive from abdominal lymph node. He was hospitalized for 1 month and 22 days and received anti-tuberculosis medication. The peritoneal fluid grew *Streptococcus anginosus* and *Escherichia coli*. He responded well to Tazocin for 10 days duration. Case-3;

a 75-year old female presented with fever, abdominal distention, abdominal pain, fatigue, and anorexia. Magnetic Resonance Imaging (MRI)-Abdomen showed large volume of ascites, peritoneal nodules and irregularity in the liver surface. Histopathology showed ovarian cancer (disseminated). Blood culture grew *fusobacterium nucleatum*, and ascitic fluid drainage culture grew *E coli*, *Klebsiella pneumoniae* and *Streptococcus anginosus*. She received Tazocin, responded well and discharged after two months. Case 4; A 52 year old diabetic male, admitted as a case of cancer (head of the pancreas), underwent surgery (Whipple's procedure) complicated with bowel perforation. He had exploratory laparotomy and wash out, and four drains were inserted as management of the perforation. Post-operatively, in the ICU, he developed abdominal pain, fever (39.5 °C) and sweating. The abdomen was distended and tender with fecal like discharge from the abdominal drain. He received Tazocin empirically. His white cell count; WBC 17.900 x10⁹/L. Intraoperative findings revealed fibrin and slough tissue on the proximal transverse colon and omentum representing sealed perforation or abscess. The colon was dilated but no gas, collapsed small bowel and right paracolic turbid fluid and fecal matter. The

peritoneal fluid grew heavy growth of Extended Spectrum Beta Lactamase producer (ESBL) *Escherichia coli* and *Klebsiella pneumoniae*, and moderate growth of *Streptococcus anginosus*. Intravenous imipenem was administered for 14 days; the patient responded moderately to treatment over time but eventually he died after 3 months during his hospitalization, possibly due to his underlying severe disease.

DISCUSSION

S. anginosus group bacteria are normal flora of the human oropharynx, gastrointestinal and genitourinary tract. They can cause minor infections or disseminated systemic infections resulting in polymicrobial infections and soft-tissue abscesses [5]. Patients at higher risk of infection by *S. anginosus* include those who had previous surgery or trauma or a history of diabetes or immunodeficiency [5]. Moreover, other comorbidities may play an additional role in infections caused by *S. anginosus* group such as liver cirrhosis, malignancy [6]. The risk factors for acquiring *S. anginosus* infection in the current study were like those mentioned in the literature. There were around 33% of patients having post-operative complication consequent to sleeve surgery, one post appendectomy patient and post Whipple's procedure. Four patients have diabetes and four were malignancy patients. Analysis of our patients as well as literature review reveals the ability of members of the *S. anginosus* group to cause disseminated invasive suppurative infections. One of our patients presented with multiple loculated liver abscesses which were drained by percutaneous liver abscess drainage. Like our case, Masood et al reported a case of a patient who presented with multiple liver abscesses non-amenable to nonsurgical drainage. Interestingly, blood cultures from this patient grew *S. anginosus* and colonoscopy revealed a rectal mass which was later confirmed to be rectal adenocarcinoma [7]. According to the author, this case presents an association between *S. anginosus* invasive infection and colorectal cancer and should raise the level of clinical physician to investigate for this possibility [7] literature review revealed only few reports of patients presenting with *S. anginosus* liver abscesses and were found to have adenocarcinoma of the colon [8-11]. In addition, esophageal and gastric cancer has also been implicated in systemic *S. anginosus* infections [12]. None of our patient was found to have colorectal carcinoma and only one patient had metastatic esophageal carcinoma. In our case series, ascending cholangitis and uncontrolled diabetes were documented in one patient who presented with septic shock and multiple liver abscesses. Laparoscopic sleeve gastrectomy (LSG) is currently one of the most commonly performed bariatric surgeries globally. Hemorrhage, leak, small bowel obstruction and infections (intra-abdominal abscess, peritonitis) are the most common perioperative complications [13]. Gastric leakage is the most serious complication that develops after LSG. The leak may result in peritonitis, sepsis or

septic shock and despite drainage of the leakage region, antibiotic therapy, parenteral feeding and intensive care, the mortality rate can be high [13]. Reviewing the current literature, we did not find reports that discuss in detail the microbiology etiological agents associated with infection related to gastric leakage after LSG [13-18]. We believe that, in the current study there were significant number (6/18; 33.3) of patients were having post sleeve complication (leakage), and developed *S. anginosus* infection in the form of peritonitis, abdominal collection or pleural effusion. Respiratory infections caused by the *S. anginosus* were mostly seen in male patients with comorbid diseases and were typically complicated with pleural effusion. In this study three patients (21 %) have pleural effusion and two of them have empyema. In one study pleural effusion was observed in 22 (73.3%) of patients. Empyema was observed in half of the 22 patients with pleural effusion. Six patients had mixed-infections [19].

Two of our malignancy patients in this series died due to lung and abdominal mixed infections involving *Enterobacteriaceae* species. The association between mortality and polymicrobial infection cannot be predicted from our cases, however, in a study reported by Junckerstorff *et al.*, a significant proportion of invasive SAG episodes were polymicrobial [20]. Additionally, Suzuki *et al.*, found that, the most common comorbidities in studied patients with SAG bacteremia were solid tumors (32.1%) [21].

This case series has few limitations; first: only little number of patients was found to have invasive infection caused by SAG over the study period. Second: many patients have associated comorbidities leading to more serious disease. Third: polymicrobial infection was common in most identified cases. This has led to difficulty in associating the outcome of infection to SAG.

CONCLUSION

We conclude that further studies are required to delineate post-operative infectious complications of sleeve surgeries in order to provide early treatment and better outcome. Our experience suggests that SAG is associated with serious suppurative infections of the abdomen related sleeve surgery and abdominal malignancy.

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