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ORIGINAL CONTRIBUTIONS

The Clinical Outcome of Postoperative Invasive Fungal Infections Complicating Laparoscopic Sleeve Gastrectomy

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Abstract

Purpose Peritonitis is a major complication of bariatric surgery due to direct damage to the natural barriers to infection. Most such secondary peritoneal infections are caused by Gram-negative microorganisms; however, under certain conditions, *Candida* species can infect the peritoneal cavity following bariatric surgery.

Materials and Methods We retrospectively analyzed the clinical and microbiological data of morbidly obese patients who suffered infectious complications following laparoscopic sleeve gastrectomy (LSG) at the Soroka Medical Center between January 2010 and June 2015.

Results Out of 800 patients who underwent LSG, 43 (5.3%(developed secondary peritonitis and were admitted to our General Intensive Care Unit during the study period**.** Intraperitoneal leaks, intraabdominal abscesses and pleural effusions were significantly more common in patients with fungal infection than in those with non-fungal infections (p values 0.027, < 0.001, and < 0.014, respectively). Leaks situated at the suture line of gastro-esophageal area occurred much more frequently in the fungal infection group than in the non-fungal infection group (94.7 vs 41.7%, $p < 0.001$). Microbiological analysis of the abdominal and pleural fluids of patients with invasive fungal infectious complications showed the presence of commensal polymicrobial bacterial infections—mainly *Streptoccocus constellatus* and coagulase negative *Staphylococcus* spp. Leakage at the suture line of gastro-esophageal area (upper suture part) and administration of parenteral nutrition were found to be independent predictors for invasive fungal infections after LSG.

Conclusion Our study demonstrates that invasive fungal infection is a significant postoperative infectious complication of bariatric LSG surgery in morbidly obese patients.

Keywords Sleeve gastrectomy · Invasive fungal infection · Obesity · Critical care

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Background

Longitudinal laparoscopic sleeve gastrectomy (LSG) is one of the most frequently performed surgical procedures for treating morbid obesity [1, 2]. It is regarded as a relatively easy procedure with a low complication rate [3, 4]. Only a few studies describing postoperative infectious complications following bariatric surgery have been published in the last decade [5]. These have shown that complications such as postoperative peritonitis following bariatric surgery generally occur in patients who are younger, less immunocompromised, and freer of underlying medical conditions than patients who have a complicated postoperative course following other gastrointestinal (GI) surgical procedures [5, 6]. Furthermore, and not unexpectedly, bariatric surgery patients who suffer postoperative peritonitis appear to have better clinical outcomes and

lower mortality rates compared to patients with postoperative peritonitis after conventional surgery [5, 6].

In general, GI surgical interventions, because they directly damage the natural barriers to infection, are not infrequently complicated by secondary peritonitis [6, 7], predominantly due to infection by Gram-negative invasive bacteria [6, 7]. However, under certain conditions, and especially after upper GI surgery, *Candida* species can also colonize the peritoneal cavity [8], although the prevalence of such fungal infections after bariatric procedures is unknown.

The aims of this study were to review and analyze the clinical and microbiological data of a series of morbidly obese patients who underwent LSG at the Soroka University Medical Center (SUMC) between January 2010 and June 2015 and who experienced postoperative infectious complications.

Patients and Methods

SUMC is a 1069-bed tertiary care university teaching hospital located in the city of Beer-Sheva in Israel's southern Negev region. We retrospectively collected the clinical and laboratory data of 800 patients who underwent LSG at SUMC between January 2010 and June 2015. All data were extracted from the operating room and General Intensive Care Unit (GICU) electronic patient records. The study was reviewed and approved by the SUMC Human Research and Ethics Committee (RN 0334-15-SOR).

Inclusion Criteria

All patients aged ≥ 18 who underwent any type of LSG procedure for morbid obesity at SUMC between January 2010 and June 2015 were eligible for inclusion in the study.

Exclusion Criteria

The following patients were excluded from the study: patients aged < 18; immunocompromised patients (including patients who had undergone chemo- and/or radiotherapy during the 3 months prior to the LSG procedure); patients with a previous history of documented chronic fungal infection; patients with a record of recurrent prior hospital admissions; and patients who had received antibiotic therapy during the month preceding the LSG procedure.

Variables and Measures

We recorded the following parameters: demographic data; the presence or absence of co-morbid conditions; the patients' chronic medications; the type of primary surgery; and information regarding reoperations, postoperative interventional procedures, and imaging studies. We also recorded the results of laboratory and microbiological studies; the patients' admission diagnoses; and their Acute Physiology and Chronic Health Evaluate-II (APACHE-II) and Therapeutic Intervention Scoring System (TISS) scores. Other recorded parameters included the rate of success in weaning the patients from mechanical ventilation (the number of ventilator-free days); the therapeutic management of the patients; the patients' nutritional state during their stay in the GICU; the development of infectious complications; and the intra-GICU and intra-hospital mortality rates among the study patients.

Microbiology

The microbiological results of blood, peritoneal fluid, and pleural fluid cultures sampled during the patients' hospital and GICU admissions were recorded. Intraabdominal infection (peritonitis), bacteremia (non-central line-associated blood stream infection), and empyema were diagnosed according to the criteria specified in the international surveillance guidelines of the Centers for Disease Control [9]. An invasive fungal infection [9] was defined as a new event of fungemia, fungal peritonitis, or fungal empyema during or after LSG.

Pus and infected fluid cultures were processed using the BACTEC 9240 blood culture system (Becton Dickinson, Franklin Lakes, NJ, USA). Isolates were identified according to routine bacteriological procedures. Testing of bacterial susceptibility to antibiotics was performed by the disk diffusion methods of Bauer and Kirby and ESBL production was determined using E-test ESBL strips (AB Biodisk, Solna, Sweden).

Definitions

The severity of illness and the presence or absence of multiorgan failure were evaluated using the patients' APACHE II and TISS scores as recorded within 24 h of admission to the GICU.

Study Groups

The patients were divided into two groups. Group 1 comprised morbidly obese surgical patients who underwent LSG and had an uneventful postoperative course. Group 2 comprised morbidly obese surgical patients who underwent LSG and developed new documented postoperative intraabdominal infectious complications, both fungal and non-fungal.

Statistical Analysis

Data analysis was performed with SPSS software (version 18.0 or higher). Data collected in the study was summarized using frequency tables, summary statistics, confidence

intervals, and p values as appropriate. Continuous variables were compared by t tests or analyses of variance. For continuous variables with non-normal distribution, comparisons were evaluated for significance using the Wilcoxon rank-sum test. For categorical variables, the 95% confidence interval was analyzed using binomial distribution. For continuous variables, the 95% confidence interval was calculated using means and standard errors from Student's t test statistical method.

Results

A total of 800 morbidly obese patients underwent LSG between January 2010 and June 2015 at SUMC.

Of the 800 patients, 43 (5.3%) developed secondary peritonitis and were admitted to our GICU during the study period (group 2). Out of the remaining 757 patients who had an uneventful postoperative course, we collected the clinical and laboratory data of a further 100 patients who constituted a control group (group 1).

The demographic and clinical data of the study patients are presented in Table 1. Both patient groups were similar for age, gender, and past medical history. The mean weight of the group 2 patients was significantly higher than that of the group 1 patients; however, there was no significant difference in the BMI between the two groups (p values < 0.001 and 0.38, respectively, Table 1). Most of the patients in group 2 were on maintenance drug therapy compared to only a minority in group 1 (Table 1); however, many more patients in group 1 were on chronic ACE (angiotensin converting enzyme inhibitor) therapy compared to the group 2 patients (17 vs 2.3%, respectively; Table 1). None of the patients in either of the study groups had received long-term antibiotic therapy prior to the LSG procedure. There were no patients who suffer from gastritis before the surgery in both study groups. There was no need for screening and eradication of *H. pylori* pre-surgery. None of the patients in both study groups received anti-acid therapy pre-operatively. The overwhelming majority of the patients in group 2 (83.7%) received postoperative parenteral nutrition compared to none in group 1 (Table 1). The hospital stay of the group 2 patients was significantly longer than that of the group 1 patients ($p < 0.001$, Table 1).

Table 2 shows the demographic data of the group 2 patients, the nature of their postoperative infectious complications, and their clinical outcomes. As noted above, all the patients in group 2 had documented postoperative secondary peritonitis. Of the 43 group 2 patients, 19 (44.1%) had invasive fungal *Candida* spp. infection (*Candida* peritonitis, $n = 10$; *Candida* empyema, $n = 6$; and candidemia, $n = 3$) on admission to the GICU (Table 2). The patients with non-fungal infectious complications had higher pre-operative weights and BMIs compared to the patients with invasive fungal infections. There were no differences in age, gender, past medical history, and chronic medication treatment between the fungal and non-fungal subgroups (Table 2).

Patients with non-fungal and invasive fungal infectious complications had similar APACHE and TISS scores within 24 h of GICU admission and similar lengths of GICU stay (Table 2). The average length of hospital stay was longer in the subgroup of patients with invasive fungal infections (Table 2) compared to the patients with non-fungal infections. The prevalence of documented intraperitoneal leak was also higher in the patients with fungal infection ($p = 0.027$, Table 2).

Table 1 The demographics, underlying conditions, and length of hospital stay of the study patients (group 1-control group, uneventful postoperative period; group 2-patients who developed documented intraabdominal infections)

	Group 1 ($n = 100$)	Group 2 ($n = 43$)	P value*odds ratio
Age, years (mean ± SD)	41.4 ± 12.9	45 ± 13.9	0.48
Weight, kg (mean ± SD)	98.08 ± 5.7	120.37 ± 26.6	< 0.001
BMI (mean ± SD)	42.74 ± 6.4	42.8 ± 7.02	0.38
Gender (male)	27/100 (27%)	16/43 (35.6%)	0.21
Underlying condition (%):			
Unknown	75/100 (75%)	26/43 (60.4%)	0.4
Diabetes mellitus	13/100 (13%)	8/43 (18.6%)	0.49
Hypertension	22/100 (22%)	9/43 (20.9%)	0.55
Chronic therapy(*) (%):			
No therapy	67/100 (67%)	39/43 (90.7%)	0.003 0.208 (0.07–0.6)
Statins	8/100 (8%)	1/43 (2.3%)	0.2
ACE	17/100 (17%)	1/43 (2.3%)	0.001 8.6 (1.10–66.8)
TPN (n, %)[a]	0 (0%)	36/43 (83.7%)	< 0.001
Hospital length of stay (day, mean ± SD)	4.3 ± 1.2	38.4 ± 3.6	< 0.001 0.07 (0.01–0.2)

*$p < 0.05$ is considered to be significant

ACE angiotensin-converting enzyme inhibitors

[a] Percent total parenteral nutrition after laparoscopic sleeve gastrectomy

Table 2 Demographic data, postoperative infectious complication data, and clinical outcome endpoints of the group 2 patients (*n*, %, mean ± SD)

	Invasive fungal[a] (*n* = 19)	Non-fungal (*n* = 24)	*P* value* odds ratio
Age, years (mean ± SD)	44.42 ± 15.4	45.45 ± 12.9	0.32
Weight, kg (mean ± SD)	109.6 ± 15.6	128.83 ± 13.6	< 0.001 0.1 (0.01–0.7)
BMI (mean ± SD)	40.21 ± 4.6	45 ± 7.9	0.06
Gender (male)	5/19 (26.3%)	11/24 (45.8%)	0.24
Underlying condition (%):			
Without chronic disease (*)	13/19 (68.4%)	13/24 (54.1%)	0.48
Diabetes mellitus	3/19 (15.7%)	5/24 (20.8%)	0.7
Hypertension	3/19 (15.7%)	6/24 (25%)	0.7
Chronic therapy (%):			
Without chronic therapy	18/19 (94.7%)	21/24 (87.5%)	0.08
Statins	0	1/24 (4.2%)	NA
ACE	1/19 (5.6%)	2/24 (8.3%)	0.11
Previous upper gastric banding surgery (*n*, %)	6/19 (31.5%)	7/24 (29.1%)	0.2
Postoperative complications data:			
Intraperitoneal leak (*n*, %) (documented)	19/19 (100%)	18/24 (75%)	0.02
Leak location (n, %):			
Suture line of gastro-esophageal area (EGJ)	18/19 (94.7%)	10/24 (41.7%)	0.001 0.039 (0.004–0.348)
Gastric suture line (GC)	1/19 (5.3%)	9/24 (37.5%)	< 0.001 32.4 (3.2–320)
Intraabdominal abscesses (*n*, %)	17/19 (89.5%)	13/24 (54.2%)	0.01 0.139 (0.026–0.74)
Presence of pleural effusion (*n*, %)	14/19 (73.7%)	3/24 (12.5%)	0.014 0.05 (0.01–0.248)
Sepsis with MOF (*n*, %)	7/19 (36.8%)	7/24 (29.1%)	0.1
Clinical outcome endpoint:			
APACHE 24 (units, mean ± SD)	23.04 ± 4.3	26.2 ± 5.02	0.16
TISS score 24 (units, mean ± SD)	20.91 ± 4.2	24.2 ± 4.9	0.14
ICU stay (day, mean ± SD)	19.3 ± 3.8	26.2 ± 2.9	0.9
Hospital stay (day, mean ± SD)	28.8 ± 3.8	50.4 ± 4.2	0.04 0.5 (0.3–0.6)

*$p < 0.05$ is considered to be statistically significant

ACE angiotensin-converting enzyme inhibitors, *EGJ* esophago-gastric junction, *GC* greater curvature

[a] Invasive fungal (Candida) complications: Candida peritonitis, candidemia, and Candida empyema

Within 24 h of ICU admission

Regarding previous bariatric procedure(s) prior to LSG in group 2 patients with postoperative sepsis, there was no significant difference between patients with (19) or without (24) invasive fungal infection (31.5 vs 29.1%, Table 2). Suture line leakage was observed in all 19 patients (100%) with invasive fungal infection, as opposed to 18/24 patients (75%) in the non-fungal subgroup ($p = 0.02$) (Table 2).

In 28 patients (65%), the leakage was located at the esophago-gastric junction (EGJ); when in 10/43 patients (23%), the leakage was found at the greater curvature (GC) suture line level. Most patients with invasive fungal infection had an EGJ leak: 18/19 (94.7%), which is significantly different from the non-fungal infection patients EGJ leak rate (10/24–41.7%) ($p = 0.001$, Table 2). A GC suture line leak was found in 10 patients: 1/19 in the fungal infection sub-group and 9/24 in the non-fungal sub-group with a significance of $p < 0.001$ (Table 2).

Sepsis with Multiple Organ Failure (MOF) was observed in14 patients in Group 2: 7/19 in the invasive fungal infection sub-group (36.8%) and 7/24 (29/1%) in the non-fungal sub-group.

Furthermore, intraabdominal abscesses and pleural effusions occurred more frequently among the patients with invasive fungal infections than in the patients with non-fungal infections (p values < 0.001 and 0.014, respectively, Table 2).

All patients included in present study received only antibiotic prophylaxis by Cefazolin 2 g, intravenously, within 30 min before the surgery. Microbiological data analysis of the abdominal and pleural fluids of patients with invasive

Table 3 The microbial blood, intraabdominal fluid, and pleural effusion data and the chemical and hematological laboratory parameters of the group 2 patients during their GICU stay

	Non fungal ($n = 24$)	Fungal[a] ($n = 19$)	*P* value* odds ratio
Intraabdominal positive cultures (%):			
No growth	16/24 (66.7%)	5/19 (26.3%)	0.016
Candida spp.	0	10/19 (63%)	NA
E. coli	5/24 (20.8%)	2/19 (10.5%)	0.36
Klebsiella spp.	2/24 (8.3%)	2/19 (10.5%)	0.4
Enteroccocus spp.	1/24 (4.2%)	1/19 (5.3%)	0.3
Staph. aureus	0	1/19 (5.3%)	NA
Staph. coagulase negative	0	1/19 (5.3%)	NA
Streptoccocus constellatus[b]	0	7/19 (36.8%)	NA
Pleural effusion positive cultures (%):			
No growth	22/24 (91.7%)	13/19 (68.4%)	0.039
Candida spp.	0	6/19 (31%)	NA
Klebsiella spp.	1/24 (4.2%)	0	NA
Staph. Aureus	1/24 (4.2%)	1/19 (5.3%)	0.3
Staph. coagulase negative	0	4/19 (21.1%)	NA
Streptoccocus constellatus[b]	0	1/19 (5.3%)	NA
Blood cultures (%):			
No growth	8/24 (33.3%)	11/19 (57.9%)	0.46
Candida spp.	0	3/19 (7.6%)	NA
E. Coli	1/24 (4.2%)	1/19 (5.3%)	0.3
Klebsiella sp.	1/24 (4.2%)	0	NA
Staph. Aureus	4/24 (16.7%)	0	NA
Staph. coagulase negative	5/24 (20.8%)	3/19 (15.8%)	0.23
Streptoccocus constellatus	2/24 (8.3%)	3/19 (15.8%)	0.03
Laboratory data[b]*:*			
WBC (cells/μL, mean ± SD)	13,791.6 ± 6100.9	12,894.7 ± 8272.4	0.14
Neutrophils (%)	77.8 ± 11.4	74 ± 12.5	0.76
Creatinine (mg/dL)	0.98 ± 0.65	1.26 ± 0.7	0.19
pH arterial blood pH	7.29 ± 0.1	7.28 ± 0.12	0.8
Arterial blood lactate (mmol/L)	1.8 ± 0.7	3.3 ± 0.1	0.08 0.9 (0.1–1.2)

[a] Invasive fungal (Candida) complications: Candida peritonitis, candidemia, and Candida empyema

[b] All laboratory data are on admission to the GICU

fungal complications showed commensal polymicrobial culture growth, mainly *Streptoccocus constellatus* and coagulase negative *Staphyloccoci* spp. (Table 3). There were no other differences in the microbiological culture findings between the two study groups. There was also no difference in the laboratory data parameters between the groups (Table 3).

The suture line leak was managed by combined surgical (controlled fistula creation, drainage, reoperations with lavage) and interventional radiology approach.

CT-guided abdominal and pleural fluid drainage was performed more frequently in the patients with fungal infections than in those with non-fungal infections (p values 0.001 and 0.002, respectively, Table 4). Furthermore, the patients with invasive fungal complications had received parenteral nutrition therapy for longer periods of time during their GICU stay than the patients with non-fungal infections ($p = 0.01$, Table 4). There were no other differences in therapeutic management between the non-fungal and invasive fungal subgroups (Table 4).

Table 5 shows the results of multivariate logistic regression analysis for postoperative secondary peritonitis (both fungal and non-fungal) following LSG in morbidly obese patients. Advanced age, higher body weight, and administration of parenteral nutrition were found to be independent predictors for secondary peritonitis after LSG (Table 5).

Table 6 shows a multivariate analysis of postoperative invasive fungal infections following LSG. Leakage from the suture line of gastro-esophageal area (upper suture part) and administration of parenteral nutrition were found to be independent predictors for invasive fungal infections following LSG (Table 6**).**

Table 4 Therapeutic management of the group 2 patients during their GICU stay (mean ± SD, %)

	Non-fungal ($n = 24$)	Invasive fungal[a] ($n = 19$)	P value* odds ratio
CT-guided drainage of pleural effusions			
(n, %)	2/24 (8.3%)	11/19 (57.9%)	0.001 0.06 (0.0012–0.365)
CT-guided drainage of intraabdominal abscesses			
(n, %)	2/24 (8.3%)	10/19 (52.6%)	0.002 0.08 (0.01–0.45)
TPN (n, %)	18/24 (75%)	18/19 (94.7%)	0.01
Steroid treatment (n, %)	5/24 (20.8%)	8/19 (42.1%)	0.12
Vasopressor therapy (n, %)	9/24 (37.5%)	7/19 (63.2%)	0.08
Re-surgery number			
(n, %)[b]	21/24 (87.5%)	16/19 (84.2%)	0.6
Proceed-to-total/subtotal gastrectomy			
(n, %)[c]	2/24 (8.3%)	3/19 (15.7%)	0.07

[a] Invasive fungal (Candida) complications: Candida peritonitis, candidemia, and Candida empyema

[b] Re-surgery number: more than two operations per patient

[c] Number of patient who initially underwent LSG, however, because surgical complications went to formal total or subtotal gastrectomy

Discussion

Within recent decades, LSG has become one of the most frequently performed bariatric surgical techniques due to its simple technique and efficacy in achieving weight loss [3, 10–12]. It is classified as a type of upper GI tract surgery [10] and it is credited with a relatively low rate of complications, ranging from 1 to 5% [3].

In common with other types of upper GI surgery, intraoperative complications during LSG (such as prolonged operative time or suturing or anastomosis to the small bowel) are major causes of secondary peritonitis [5, 11, 12]. Other established risk factors for postoperative infectious complications after any type of upper GI surgery include male gender, advanced age, and underlying cirrhosis [13]. In our study, we retrospectively analyzed 143 cases out of a total group of 800 morbidly obese patients who underwent LSG at SUMC during a five and a half year period. The study groups were made up of the 43 patients (5.3% of the overall 800 cases) whose postoperative course was complicated by secondary peritonitis and a further 100 patients who served as controls. Advanced age and higher pre-operative weight were found to independent risk factors for the development of postoperative peritonitis. Of the 43 patients with postoperative intraabdominal infection, 19 (44%) developed invasive fungal *Candida* infections including *Candida* spp. peritonitis, candidemia, and *Candida* spp. empyema.

In general, *Candida* colonization in the abdominal fluid is relatively frequent after any upper GI surgery complicated by postoperative perforation, and in approximately 40% of such cases, this situation leads to secondary fungal peritonitis or intra-abdominal fungal abscess formation [14]. *Candida* peritonitis is associated with a very high mortality rate which can even reach 60–70% [1, 15, 16].

There are very few data in the literature relating to postoperative fungal infectious complications following LSG. Montravers et al. found [5] positive fungal cultures in 15% of morbidly obese patients whose postoperative course after bariatric surgery was complicated by secondary peritonitis. They also demonstrated that *Candida albicans* was the most frequent fungus (up to 50%) cultured from the abdominal fluid (5).

In the present study, we found that in patients with invasive fungal infections following LSG, intraabdominal abscesses and pleural effusions necessitating CT-guided drainage were extremely frequent complications (90 and 70%, respectively).

We also found that patients with invasive fungal infections frequently had leaks at the suture line of gastro-esophageal

Table 5 Multivariate logistic regression analysis of risk factors for postoperative secondary peritonitis after laparoscopic sleeve gastrectomy

	OR	95% CI	P value
Age	*1.2*	*1.07–1.29*	*0.04*
Weight	*1.16*	*1.05–1.2*	*0.003*
TPN	*1.1*	*1.03–1.2*	*0.001*

Table 6 Multivariate logistic regression analysis of risk factors for invasive fungal infection after laparoscopic sleeve gastrectomy

	OR	95% CI	P value
TPN	*1.17*	*1.14–1.21*	*0.01*
Leakage from the suture line of gastro-esophageal area (EGJ)[a]	*7.74*	*2.53- 21.1*	*0.005*

[a] Documented intraperitoneal leak location during first recurrent surgical procedure

area (upper suture part) and pleural effusions on admission to the GICU; however, there were no differences in the APACHE score between the fungal and non-fungal subgroups. Furthermore, we found that the patients with non-fungal infections had significantly longer hospital stays than the patients with invasive fungal infectious complications (28.8 ± 3.8 vs 50.4 ± 4.2 days, $p = 0.04$, Table 2). This difference might be explained by the fact that the patients with fungal infections were treated more aggressively and underwent invasive therapeutic procedures more frequently than the patients with non-fungal infections (see Table 4).

In addition, our microbiological data analysis demonstrated polymicrobial cultures—mainly *Streptococcus constellatus* and coagulase negative *Staphyloccoci* spp.—in the abdominal and pleural fluids of patients with invasive fungal infections compared to relatively less Gram-positive flora found in the non-fungal infection subgroup. These findings correlate well with the report of Montravers et al., who also found [5] a high percentage of Gram-positive flora in bariatric surgery patients with a postoperative course complicated by fungal peritonitis. Our findings as well as those of Montravers et al. [5] are not surprising given that Gram-positive bacteria and *Candida* fungi comprise the natural flora of the oral cavity [14]. These micro-organisms gain access to the abdomen via saliva that descends from the oral cavity to the stomach and in the presence of an anastomotic or suture line leaks finds their way into the abdominal cavity.

On multivariate analysis, we found that the presence of leakage from the suture line of gastro-esophageal area (upper suture part) and the administration of total parenteral nutrition (TPN) were independent predictors for invasive fungal infections after LSG. Despite the fact that the TPN was found to be an independent predictor of peritoneal invasive fungal infections, we believe that the patients admitted to the GICU have already been infected by fungi from the oral cavity prior to the initiation of TPN administration.

Our study has several limitations. Its main limitation is its retrospective design. Because of this, the previous data regarding HgA1C and glucose monitoring (including morbidly obese pre-diabetic patients) was not available. Furthermore, the significance of our results for long-term outcome is unclear because the study did not include post-discharge surveillance. We suggest that further prospective, well-designed studies of secondary peritonitis following LSG be performed.

Conclusion

Secondary peritonitis was found to be a significant postoperative infectious complication after bariatric LSG surgery in morbidly obese patients. Advanced age, higher body weight, and administration of postoperative parenteral nutrition were found to be independent risk factors for the development of both bacterial and fungal peritonitis after LSG. Specifically, the presence of leakage from the suture line of gastro-esophageal area (upper suture part) and the administration of postoperative parenteral nutrition were shown to be independent risk factors for the development of invasive fungal infection following LSG. We also consider that early antifungal treatment might be beneficial for such category of surgical patients. We feel that future studies are needed to better understand the clinical significance of the risk factors for invasive fungal infections after upper GI surgery.

Compliance with Ethical Standards

The study was reviewed and approved by the SUMC Human Research and Ethics Committee (RN 0334-15-SOR).

Conflict of Interests The authors declare that they have no competing interests.

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Statement of Informed Consent Informed consent was not needed to obtain because of retrospective design of the study.

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