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Pathologic findings of the removed stomach during sleeve gastrectomy

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Abstract

Background Laparoscopic sleeve gastrectomy (LSG) is the preferred surgical intervention to treat morbid obesity. Despite the rising popularity of LSG, little is known on the histopathologic findings of the resected partial stomach specimens. Our study aims to identify prevalent pathologic findings of the removed stomach and explore the association between patient characteristics and abnormal findings.

Methods A retrospective analysis was conducted using a prospectively maintained database of 649 patients who underwent LSG between November 1, 2013 and December 31, 2015 at our institution. Patient characteristics included age, body mass index, gender, and preoperative comorbidities (diabetes, hyperlipidemia, depression, gastroesophageal reflux, hypertension, and sleep apnea). Statistical analysis was performed using descriptive analysis and logistic regression models.

Results Abnormal pathologic findings were identified in approximately one-fifth ($n = 142$, 21.9%) of the patients. The most common find is non-specific chronic gastritis (9.7%), followed by *Helicobacter pylori* gastritis (4.9%). Approximately 15% of patients had significant histopathological alterations that might require further investigation, treatment, or follow-up, including non-specific chronic gastritis, *H. pylori* gastritis, autoimmune atrophic gastritis, and gastrointestinal stromal tumor. The odds of abnormal findings in patients without hyperlipidemia was 0.09 times the corresponding odds in those with hyperlipidemia (95% CI 0.03–0.29), controlling for factors including age, body mass index, gender, and other preoperative comorbidities.

Conclusion Patients with gastroesophageal reflux and hyperlipidemia might suggest higher incidence rate of gastric histopathologic abnormalities. Routine preoperative screening may not be beneficial for patients undergoing sleeve gastrectomy.

Keywords Sleeve gastrectomy · Pathology · Stomach

Obesity has been rapidly increasing in incidence over the past decades. According to the World Health Organization (WHO), there are more than one-seventh of the world population overweight, of which more than 300 million are obese (body mass index, BMI ≥ 30 kg/m^2) [1]. In the United States, approximately one-third of American adults are obese as of 2012 [2]. Together with lifestyle modification and other non-surgical methods, several techniques of bariatric surgery have been developed to treat morbid obesity. Laparoscopic vertical sleeve gastrectomy, Roux-en-Y gastric bypass, and laparoscopic adjustable gastric banding are the most frequent procedures [3]. Among those three, laparoscopic sleeve gastrectomy (LSG) is preferably chosen thanks to its relatively low morbidity and mortality [4–6]. Also, it is the only procedure allows for histopathologic analysis from the resected specimens [7, 8].

Despite the rising popularity of LSG, only several studies world-wide investigate the unexpected microscopic findings in sleeve gastrectomy specimens with mixed results [3, 9–15]. There is even less documented observation on stomach histopathologies of patients undergoing LSG in the United States. The present study aims at prevalent pathologic findings of the removed stomach and analyzes the association between patient characteristics and abnormal findings.

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Materials and methods

After institutional review board approval and following the Health Insurance Portability and Accountability Act guidelines, the authors performed a retrospective chart review of a prospectively maintained database of 649 patients who underwent LSG between November 1, 2013 and December 31, 2015.

LSG was performed by two surgeons according to the National Institutes of Health criteria for the surgical management of morbid obesity. Patients were followed up at our office clinic at 1, 3, 6, 12 months postoperatively and yearly thereafter. Follow-up visits included weight measurement, clinical history and examination, and laboratory tests for blood glucose as well as nutrition deficiency. Patients were discouraged from LSG when they reported reflux symptoms, but reflux symptom was not an absolute contraindication because we observed reflux symptoms can decrease after LSG [16].

LSG specimens were sent to the pathology department and examined by either a pathology resident or a pathology assistant. Random samples along with any lesions were submitted in cassettes and fixed in formalin. After tissue processing, the samples were then embedded in paraffin, subsequently sectioned, and stained with hematoxylin and eosin. Immunohistochemical staining was sometimes used to detect the presence of *Helicobacter pylori*. The pathologic evaluation and final diagnosis were made by pathologists.

Patient characteristics included age, BMI, gender, and preoperative comorbidities (diabetes, hyperlipidemia, gastroesophageal reflux, hypertension, and sleep apnea). Diabetes, hyperlipidemia, and hypertension were considered present when the patient had a history of previous diagnosis or was taking medications for the condition. Gastroesophageal reflux was considered present when the patient complained of reflux symptoms or had been taking proton-pump inhibitors longer than 3 months. Routine upper gastrointestinal imaging was performed preoperatively, and the presence of gastroesophageal reflux was assessed using this method as well. Sleep apnea was considered present when the patient was using continuous positive airway pressure or biphasic positive airway pressure machines.

Preoperatively, *H. pylori* was tested using a blood sample as part of a routine preoperative laboratory testing few months prior to LSG. When the test was positive, the patient was treated with triple therapy prior to the operation. Eradication of *H. pylori* after the triple therapy was not assessed. All patients including those undergoing triple therapy were put on proton-pump inhibitors after LSG. We did not routinely perform intraoperative endoscopy during LSG. All data for age and BMI are demonstrated as mean ± standard deviation, unless otherwise noted. Statistical analysis was performed using descriptive analysis, and unconditional logistic regression models.

Results

Demographics of the patients are shown in Table 1. Abnormality was identified in 142 (21.9%) patients. The details of pathologic abnormality are listed in Table 2. Most patients ($n = 63$, 9.7%) had chronic and/or follicular gastritis without *H. pylori*, followed by chronic and/or follicular

Table 1 Demographics of patients undergoing LSG

	Characteristic ($n = 649$)
Female (%)	468 (72.2%)
Mean age (years)	46.2 ± 11.7 (range 21–71)
Preoperative BMI (kg/m^2)	45.2 ± 7.0 (range 30.5–103.9)
Comorbidities	
Hypertension	308 (47.5%)
Diabetes mellitus	159 (24.5%)
Sleep apnea	161 (24.8%)
Hyperlipidemia	77 (11.9%)
Gastroesophageal reflux disease	138 (21.3%)

Table 2 Description of pathologic abnormalities in patients undergoing LSG

Abnormality	Number of patients (%)
Chronic and/or follicular gastritis, without *H. pylori*	63 (9.7)
Chronic and/or follicular gastritis, with *H. pylori*	32 (4.9)
Fundic gland polyp	28 (4.3)
Glandular dilatation	4 (0.6)
Autoimmune atrophic gastritis	1 (0.2)
GIST	3 (0.5)
Leiomyoma	1 (0.2)
Others	10 (1.5)
Segment of stomach with submucosal hemorrhage	
Minimal chronic inflammation	
Benign follicular lymphoid hyperplasia	
Minimal non-specific chronic inflammation	
Few foci of congestion and minimal superficial erosion	
Congestion	
Few microscopic foci of slight benign reactive gastropathy	
Focal submucosal vascular ectasia	
Mild, patchy, chronic inflammation, and congestion	
Mild chronic inflammation	

gastritis with *H. pylori* ($n = 32$, 4.9%). Other findings from most common to least common included fundic gland polyp ($n = 28$, 4.3%), glandular dilatation ($n = 4$, 0.6%), gastrointestinal stromal tumor (GIST) ($n = 3$, 0.5%), autoimmune atrophic gastritis ($n = 1$, 0.2%), leiomyoma ($n = 1$, 0.2%), and other benign changes ($n = 10$, 1.5%). No examples of dysplasia or malignancy were seen.

The odds of abnormal findings did not differ by age, BMI, or gender, controlling for preoperative comorbidities (diabetes, hyperlipidemia, depression, gastroesophageal reflux, hypertension, and sleep apnea). Among preoperative comorbidities, hyperlipidemia and hypertension were associated with abnormal findings, controlling for age, BMI, gender, and other preoperative comorbidities (Table 3).

The odds of abnormal findings in patients without reflux symptoms was not significantly different from the corresponding odds in patients with reflux symptoms (OR 0.61, 95% CI 0.36–1.03), regardless of other factors mentioned above. This suggests that patients with reflux symptoms did not have higher odds of abnormal findings. A total of 98 (15.1%) patients underwent hiatal hernia repair at the time of LSG, but hiatal hernia repair was not significantly related to the presence of pathologic histology ($p = 0.09$). The odds of abnormal findings in patients without hyperlipidemia was 0.09 times the corresponding odds in patients with hyperlipidemia (95% CI 0.03–0.29), controlling for other factors. This suggests that patients with hyperlipidemia had higher odds of abnormal findings. The odds of abnormal findings in patients without hypertension was 1.66 times the corresponding odds in patients with hypertension (95% CI 1.10–2.52), regardless of other factors. This suggests that patients without hypertension had higher odds of abnormal findings.

Table 3 The odds of abnormal findings in the resected stomach among patients undergoing sleeve gastrectomy

	Odds ratio	95% CI	*p* Value
Age	0.90	0.98–1.12	0.94
Gender	1.04	0.68–1.61	0.85
Hypertension	1.66	1.10–2.52	0.02
Hyperlipidemia	0.09	0.03–0.29	< 0.01
Diabetes mellitus	1.14	0.70–1.84	0.60
Gastroesophageal reflux	0.61	0.36–1.03	0.06
Sleep apnea	1.45	0.91–2.30	0.12
BMI			
< 40 kg/m^2	0.66	0.19–2.25	0.14
40 kg/m$^2 \leq$ BMI < 50 kg/m^2	1.41	0.45–4.47	0.39
50 kg/m$^2 \leq$ BMI < 60 kg/m^2	0.89	0.26–2.98	0.74

Reference category for BMI (BMI ≥ 60 kg/m^2)

Discussion

Abnormal pathologic findings were seen in approximately one-fifth (21.9%) of the patients. The most common abnormality was non-specific chronic gastritis and/or follicular gastritis seen among 9.7% of the patients, followed by *H. pylori* gastritis seen among 4.9% of the patients. This is surprising to see as we preoperatively test for *H. pylori* using blood samples. When the test was positive, we treated the patient with triple therapy prior to the operation. However, serologic testing of *H. pylori* has a sensitivity of 85% and specificity of 79%, and it is possible that we had many false-negatives by utilizing this test [17, 18]. This is supported by the fact that we were not able to associate positive *H. pylori* testing with positive histology. Also, serologic testing of *H. pylori* cannot confirm a current infection and resolution of the infection [17, 18]. In contrast, urea breath test can confirm a current infection and has a sensitivity of 99% and a specificity of 98% [18, 19]. Although the urea breath test is superior in detecting *H. pylori* infection, we opted for serologic testing because not all testing centers were equipped with the urea breath test specialized equipment. We did not expect all of our patients with positive *H. pylori* serology to have successful eradiation of the bacteria since the eradication rates for triple therapy are below 80% in the U.S [20]. The gold standard of *H. pylori* is obtaining histology using endoscopy [18]. However, due to insurance reasons, we did not perform a routine preoperative endoscopy and only did when patients complained of abdominal pain or dysphagia. Even with these symptomatic complaints, we did not find abnormal findings in most patients. Rare findings included fundic gland polyp (4.3%), glandular dilatation (0.6%), GIST (0.5%), autoimmune atrophic gastritis (0.2%), and leiomyoma (0.2%). No dysplasia or malignancy was identified, and the resection margins for GIST were negative. Although previously published studies [9, 12, 21–27] show variable results on the incidence rates of abnormal findings ranging from 19.8 to over 50%, most of them revealed the most common abnormality to be non-specific chronic gastritis (7.2–44%), followed by *H. pylori* gastritis (2.7–18%).

No previous study has examined the association between hyperlipidemia and abnormal pathologic finding in the stomach. However, previous studies suggested that elevated asymmetric dimethylarginine (ADMA) levels are associated with hyperlipidemia and hypercholesterolemia. Kwiecien et al. [28] reported that ADMA could be implicated in the mechanism of 3.5 h of water immersion and restraint stress (WRS)-induced ulcerogenesis, and that ADMA exacerbates WRS-induced gastric lesions. Our study suggests that patients with hyperlipidemia had higher odds of presenting with abnormal findings in their stomachs than those without hyperlipidemia.

Interestingly enough, patients with hypertension exhibited a different outcome. Patients with hypertension had

lower odds of presenting with abnormal findings in their stomach than those without hypertension. To our knowledge, this is a novel finding and it is difficult to explain the mechanism behind the association.

Overall, approximately 15% of patients in our study had significant histopathological alterations that might require further investigation, treatment, or follow-up, including nonspecific chronic gastritis, *H. pylori* gastritis, autoimmune atrophic gastritis, and GIST. The 2009 SAGES guideline of LSG [29] regarding preoperative medical evaluation states "upper endoscopy may be used if suspicion of gastric pathology exists." However, many studies have reported a lack of correlation between patient symptoms and endoscopic findings, suggesting that a systemic preoperative endoscopic screening may be beneficial [29–32]. Preoperative endoscopy is also useful for detecting and diagnosing esophageal abnormalities such as Barrett's esophagus, hiatal hernia, dysplasia, and esophageal cancer [28, 29, 33]. Finding such as Barrett's esophagus may raise the need for a gastric bypass instead of sleeve gastrectomy. Findings of hiatal hernia may be helpful in preoperative planning of hiatal hernia repair at the time of sleeve gastrectomy. On the contrary, other studies have advocated a non-endoscopic approach for asymptomatic patients, considering the relatively weak clinical relevance of most lesions found during routine endoscopy and the cost and invasiveness of the procedure [34–36]. Our findings corroborate this argument given the fact that most of our pathologic findings had weak clinical relevance. We also do not believe the procedure of choice would have changed had we known about our pathologic findings prior to the procedure. This further supports the perspective that a systemic preoperative endoscopic screening is not necessary.

One of the limitations of this study is defining the comorbidities using patient report and medical history of the patient. This may underestimate the true incidence of the comorbidities and possibly underestimate the association between comorbidities and pathologic findings.

To our knowledge, this study is the first study to describe gastroesophageal reflux and hyperlipidemia might suggest higher incidence rate of gastric histopathologic abnormalities, independent of age, BMI, gender, and other preoperative comorbidities including diabetes, depression, hypertension, and sleep apnea.

Conclusion

Patients with gastroesophageal reflux and hyperlipidemia might suggest higher incidence rate of gastric histopathologic abnormalities. Routine preoperative screening may not be beneficial for patients undergoing sleeve gastrectomy.

Compliance with ethical standards

Disclosures Dr. Andre Teixeira is a consultant for Intuitive Surgical and Ethicon Endo-Surgery. Dr. Muhammad Jawad is a consultant for Ethicon Endo-Surgery. Dr. Li Ge, Dr. Rena Moon, Dr. Ha Nguyen, and Dr. Gustavo Quadros have no conflicts of interest or financial ties to disclose.

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