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ORIGINAL CONTRIBUTIONS

# Should We Abandon Routine Microscopic Examination in Bariatric Sleeve Gastrectomy Specimens?

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**Abstract**
*Background* Laparoscopic sleeve gastrectomy (LSG) is a relatively new bariatric surgical procedure to reduce weight in morbidly obese patients, with an overall low rate of complications and thus gaining a worldwide popularity. It provides an opportunity to study the pathology of the stomach in obese patients. Most studies, however, focused on clinical aspects, surgical techniques, and postoperative complications. Few authors studied the histopathologic findings. Whether routine histopathologic examination is warranted in patients with grossly unremarkable LSG specimens and nonsignificant clinical history was not previously studied.
*Methods* We conducted a prospective study over 8 years to compare the prevalence, the morphologic spectrum and importance of histopathologic findings, and the frequency of incidental neoplasms in LSG specimens with other studies. We also proposed a protocol for the gross handling and sectioning of LSG specimens.
*Results* We found 546 LSG specimens. Five patients developed iatrogenic postoperative complications, two of which pursued a medicolegal case. There was no association between the histopathologic findings and the complications. Less than 1 % of incidental benign lesions were found. No malignancies were identified. All of the patients without postoperative complications had uneventful outcome after 5 months to 6 years follow-up.
*Conclusions* Routine microscopic examination of all LSG specimens is not necessary. Selective microscopic examination guided by relevant clinical history and macroscopic examination is a better option. This protocol will save money, time, and workload without compromising patient's safety and future management. However, a careful gross description is still necessary in certain cases for potential future medicolegal implications.

**Keywords** Stomach · Sleeve gastrectomy · Morbid obesity · Microscopic examination · Macroscopic examination

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## Introduction/Purpose

There are several techniques of bariatric surgery to reduce body weight and treat morbid obesity [1, 2]. Laparoscopic sleeve gastrectomy (LSG) is gaining popularity because of its relatively low morbidity and mortality [1, 3, 4]. LSG provides an opportunity for the pathologists to examine the partially resected gastrectomy specimens. Several studies demonstrated a high prevalence of gastritis and *Helicobacter pylori* (Hp) infection in LSG specimens [5–8]. Few studies and case reports described rare incidental findings of mostly benign neoplasms in LSG specimens [5, 9–11]. Special gross handling and meticulous macroscopic examination should facilitate discovery of incidental findings, documentation of iatrogenic surgical shortcomings with potential future complications, and selection of certain cases for routine histologic examination. In our institution, we aimed to design a protocol for the gross handling and macroscopic examination of LSG specimens and correlate that with the histologic findings. We carried a prospective study to decide whether a routine or selective microscopic examination is necessary in LSG specimens.

## Materials and Methods

In our institution, a vertical LSG without omentectomy was started in 2007 to introduce this relatively new surgical technique for the treatment of morbid obesity in our population. All resected specimens were routinely received in our pathology laboratory. We conducted a prospective study of LSG specimens over 8 years from 2007 to 2014. LSG specimens that were removed for surgical treatment of morbid obesity were collected. Partial gastrectomies performed for other reasons, for example, peptic ulcer disease, trauma, and neoplasms, were excluded from the study.

For each case, the gross dimensions were measured in centimeter. The outer surface of each LSG specimen was inspected for completeness of the wall and the presence of hemorrhage, defects, and serosal lesions or lymph nodes was noted. Any possibility of loose staples or gaps of the stapled area (staple line) was documented. The stapled edges were cut away with a thin rim. The content of the stomach was examined for hemorrhage. The stomach was opened flat and the mucosa was gently cleansed for a better inspection. The mucosal rugae were inspected carefully for hemorrhage, edema, defects, and polyps and for flattening. We ignored gross hemorrhages that are more likely to be artifacts related to the surgical procedure, for example, adjacent to the stapled line, around wall defects. We focused on gross hemorrhage in intact gastric wall and attempted to correlate that with the histologic findings. The stomach was not pinned out on a wax board so to maintain its original curved anatomy and to prevent distortion. The specimen was fixed overnight in 10 % buffered formalin. The stomach wall was serially sectioned at 3-mm intervals starting from the proximal end to the distal end (Fig. 1). Each strip was carefully inspected and palpated for polyps or nodules. Each strip was meticulously examined starting from the mucosa, submucosa, muscle layer, and serosa, looking for any small lesions. We took four routine random sections if no lesions were grossly detected. We took one section from the proximal end and one from the distal end, and two sections from the lesser and greater curvatures. We took extra representative sections from flattened or polypoid mucosa, hemorrhagic areas, or grossly detected lesions. Histologic sections of 4–6-μm thickness were stained with routine hematoxylin and eosin (H&E) stain. For each case, the following special stains (Giemsa for *H. pylori* organisms and Alcian blue for intestinal metaplasia) were performed. Each case was independently examined by two pathologists. Immunohistochemistry study for SMA, desmin, S-100 protein, CD117, and CD34 was performed as indicated for any discovered lesions.

The age, gender, and pre-LSG endoscopic gastric biopsies for each case were collected. A previous or family history of malignancy was recorded. Patients were followed up for a period of 5 months to 6 years to investigate for postoperative complications. Post-LSG endoscopic biopsies to investigate for upper gastrointestinal tract complaints were collected, reviewed, and correlated with the histopathologic findings of their corresponding LSG specimens.

A preoperative testing for Hp status was only performed in symptomatic patients. A routine preoperative endoscopy and Hp testing is not a protocol procedure in our institution.

## Results

A total of 546 LSG specimens were received and processed as per our grossing and sectioning protocol. The age range was from 16 to 62 with a mean age of 33 years. Two thirds of the patients were between 21 and 40 years (Table 1). The male to female ratio was 1:1.8 (195 males to 351 females). Sixty-three (11.5 %) symptomatic patients had a preoperative endoscopy

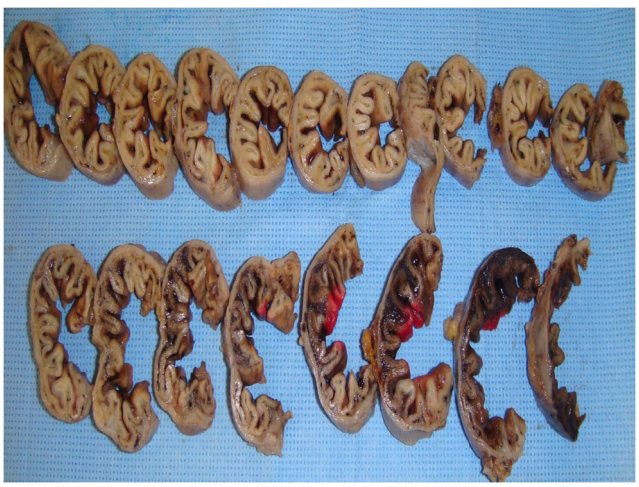

**Fig. 1** Serial sections of the sleeve gastrectomy specimen with parallel strips

**Table 1** Clinical features of the patients who underwent LSG procedures

| Feature | Patients, *n* (%) | Male/female |
|---|---|---|
| Age (years) ≤20 | 34 (6.2 %) | 1:1.4 (14:20) |
| 21–30 | 192 (35.2 %) | 1:1.7 (72:120) |
| 31–40 | 210 (38.5 %) | 1:1.7 (79:131) |
| 41–50 | 91 (16.7 %) | 1:2.4 (27:64) |
| ≥51 | 20 (3.7 %) | 1:4 (4:16) |
| Preop gastric biopsy | 63 (11.5 %) | 1:2 (21:42) |
| Postop gastric biopsy | 11 (2.0 %) | 1:1.7 (4:7) |
| Previous or family history of malignancy | 8 (1.6 %) | 1:3 (2:6) |
| Postop complications | 5 (0.9 %) | 1:1.5 (2:3) |
| Medicolegal cases | 2 (0.4 %) | 2:0 |

*n* number of patients, *%* percentage, *op* operative

and pre-gastrectomy gastric biopsy. Thirty-six of which had Hp-associated active gastritis. Eight showed mild chronic gastritis, and two had ulcers. Three patients showed polyps (two hyperplastic and one fundic gland type). Ten patients had a normal histology. None had post-gastrectomy complications. Follow-up data were not available for 18 (3.3 %) patients. The remaining patients had a follow-up period that ranged from 5 months to 6 years. Eleven (2 %) patients had post-gastrectomy gastric biopsy as indicated by postoperative complaints. Six of which showed Hp-associated active gastritis, one had an ulcer and four showed normal gastric biopsies. None had complications on follow-up. Eight patients had a history of malignancy, of which three had a previous history of carcinomas (one breast, one colonic and one thyroid) and the other five patients had a family history of gastrointestinal and breast carcinomas. None demonstrated gastric malignancy. Four (0.8 %) patients developed post-gastrectomy complications. One had a staple line leak, two had a staple line stricture, and one had staple line gastric bleeding. The LSG specimens of these patients showed gross surgical shortcomings (two had loose stapled areas and two with irregular iatrogenic defects in the gastric wall near to the staple line rim). All of these patients who developed postoperative complications had normal histology. Two of the patients pursued a court case due to the complications.

Grossly, twenty patients showed hemorrhagic mucosa that histologically revealed marked chronic gastritis. None of these patients developed postoperative complications. Grossly visible lesions included a mucosal polyp and an intramuscular nodule. Four cases demonstrated loss of rugae pattern that histologically corresponded to atrophic mucosa with or without intestinal metaplasia. Two cases displayed a surgically defective wall with hemorrhage and two cases with a loose stapled rim (Table 2). The remaining cases (95 %) illustrated an intact, well-stapled LSG pouch with a grossly unremarkable gastric wall. One of these patents, however, developed a gastric ulcer on follow-up.

Histologically, more than half of the patients had normal histomorphology. Chronic gastritis without activity was present in 45 % of the patients. Six of these patients had a postoperative abdominal pain and a postoperative gastric biopsy that revealed *H. pylori*-associated active gastritis in five patients. Active gastritis was present in 8.4 % of the patient with 10 % demonstrated Hp organisms. Four of these patients had a post-operative gastric biopsy, three of which showed persistent Hp-associated active gastritis. A small percentage (<1 %) of miscellaneous benign lesions was detected histologically (Table 3). They included a fundic gland polyp, a benign serosal mesothelial cyst, and a pancreatic heterotopic tissue. Collectively, they were more common in females. The age range was between 18 and 46 with a mean age of 32 years. All had uneventful outcomes. No granulomas or malignancies were identified. We did not find a predilection of the findings to a specific topography of the stomach, for example, lesser versus greater curvature or proximal versus distal end.

The female patients showed more clinical and histologic findings than the male patients. The females had more previous and family history of cancer and postoperative complications than the males in ratios of 3:1 and 1.5:1 (Table 1). The females showed more prevalence of gastritis and Hp infection (60 to 65 %) than the males. The incidental histologic findings were more common in females than in males in a ratio of 5:1.

## Discussion

LSG specimens provide an opportunity for the pathologists to examine the gastric fundic wall in morbidly obese patients. Because morbid obesity is an increasing epidemic in developed and rapidly developing countries, the rate of LSGs is expected to rise. This might result in an increased workload on pathologists, cost, and time. However, the issue of whether all LSG specimens should be routinely examined histologically by pathologists was not raised. The argument is that since LSG is a bariatric procedure to reduce weight, that is unlike other diagnostic curative procedures in symptomatic patients such as in routine surgical specimens for the appendix and gallbladder, is it still necessary to routinely examine all LGS specimens in the pathology department. Some studies were conducted to investigate the benefit and necessity of routine histologic examination of common surgical specimens such as tonsillectomy, hernia sacs, and

**Table 2** Gross findings and macroscopically detected lesions of the collected LSG specimens

| Findings | Patients, *n* (%) | Females, *n* (%) | Males, *n* (%) | Follow-up |
|---|---|---|---|---|
| Unremarkable | 518 (95 %) | 337 (65 %) | 181 (35 %) | Uneventful |
| Wall defect | 2 (0.4 %) | 1 (50 %) | 1 (50 %) | Stricture (2) |
| Loose staples | 2 (0.4 %) | 1 (50 %) | 1 (50 %) | Leak (1) / bleeding (1) |
| Hemorrhagic mucosa | 20 (3.6 %) | 10 (50 %) | 10 (50 %) | Uneventful |
| Flat mucosa | 4 (0.7 %) | 3 (70 %) | 1 (30 %) | Uneventful |
| Mucosal polyp | 1 (0.2 %) | 1 | 0 | Uneventful |
| Mural nodule | 1 (0.2 %) | 1 | 0 | Uneventful |

*n* number, *NA* not applicable

**Table 3** Histopathologic findings in the collected LSG specimens and follow-up of the patients

| Findings | Patients, *n* (%) | Females, *n* (%) | Males, *n* (%) | Follow-up |
|---|---|---|---|---|
| Unremarkable | 296 (54 %) | 191 (65 %) | 105 (35 %) | Uneventful |
| Chronic gastritis | 244 (45 %) | 156 (64 %) | 88 (36 %) | Uneventful |
| Active gastritis | 46 (8.4 %) | 30 (65 %) | 16 (35 %) | Uneventful |
| *Helicobacter pylori* | 55 (10 %) | 33 (60 %) | 22 (40 %) | Uneventful |
| Atrophy | 6 (1.1 %) | 1 (17 %) | 5 (83 %) | Uneventful |
| Intestinal metaplasia | 4 (0.7 %) | 3 (75 %) | 1 (25 %) | Uneventful |
| Granulomas | 0 | | | |
| Polyps | 2 (0.4 %) | 2 | 0 | Uneventful |
| Cysts | 1 (0.2 %) | 0 | 1 | Uneventful |
| Lymph node | 1 (0.2 %) | 1 | 0 | Uneventful |
| Heterotopic tissue | 1 (0.2 %) | 1 | 0 | Uneventful |
| Neoplasms | | | | |
| Benign | 1 (0.2 %) | 1 | 0 | Uneventful |
| Malignant | 0 | | | |

*n* number, *%* percentage

hemorrhoids. However, no previous similar studies specifically addressed this issue in LSG specimens.

Few retrospective studies demonstrated the rarity of clinically significant incidental histologic findings in LSG specimens. They included stromal neoplasms and granulomas that might have an impact on the patients' postoperative follow-up and management. However, the granulomas were noncaseating and none of the patients demonstrated tuberculosis or sarcoidosis on follow-up. They might have represented idiopathic gastric granulomas. The stromal lesions were mostly benign and of sizable volume that they could have been suspected intraoperatively or during gross pathologic examination [5, 12]. These patients had normal postoperative recovery. The postoperative complications that were reported in several studies were not related to the histologic findings such as gastritis and *H. pylori* organisms [7, 8, 12, 13, 14]. The estimated rate of different incidental pathologic findings during LSG ranged from 0.2 to 2 % [4, 5, 9, 12]. The incidence of gastrointestinal stromal tumor (GIST) and smooth muscle tumors that were found in LSG specimens ranged from 0.2 to 0.8 % [5, 9, 11]. The rate of reported chronic gastritis was between 15 and 74 % [5, 6, 8, 12]. The incidence of Hp infection was from 6 to 12 % [4, 8, 13, 14]. One study reported a high prevalence (44 %) of Hp [7, 15]. Most of the complications were related to surgical techniques and iatrogenic causes [16–19]. Even though the burden of gastritis and Hp-related gastritis in LSG was high, there was no significant correlation between these pathologic findings and the rate of postoperative complications. One study detected some postoperative histopathologic changes in the residual stomachs in obese rats after sleeve gastrectomy [20]. These changes were, however, nonsignificant.

Several studies demonstrated that either abandoning routine histologic evaluation in certain routine specimens, for example, hernia sacs, foreskins, prolapsed vertebral discs, teeth, vagus nerve, or adopting a more selective policy in other specimens such as hemorrhoids, tonsils, appendix, and gallbladder guided by clinical history and gross findings can be implemented in these common surgical specimens [21–27]. The rarity of incidental histopathologic findings relevant to patients' management especially in the absence of intraoperative or gross abnormalities suggests that routine histologic analysis may be omitted [23, 25, 27]. Certain clinical factors, for example, age and symptoms, should direct surgeons and pathologists to further histologic assessment. Therefore, a gross examination either by surgeons or pathologists is still recommended. This selective policy was found to be more cost-effective and did not compromise patients' outcome [21, 22]. Similar analogy could be applied to LSG specimens.

In our study, all the LSG specimens were macroscopically and microscopically examined in the pathology department since the introduction of LSG in our institution. We did not find a major impact of the histopathologic findings in LSG specimens and the postoperative follow-up and management of the obese patients. Some might argue that a sizable portion of the patients demonstrated gastritis and Hp infection. However, we did not find a relationship between the patients who had acute or chronic gastritis with or without Hp and the subsequent postoperative complaints or complications. In fact, some patients with LSG gastritis had normal postoperative gastric biopsies and vice versa. Since chronic gastritis and Hp-related gastritis are epidemic in obese patients, the postoperative management will be standard for these patients and a postoperative gastric biopsy is indicated only in symptomatic patients. Likewise, routine preoperative endoscopy is controversial and routine preoperative gastric biopsy is not supported by some authors since the status of Hp can be detected by other tests [13].

There are several benefits of a selective microscopic examination of LSG specimens. This approach will reduce cost. For example, it will save around 18,500 USD per year in our hospital. It will reduce the workload on technologists and pathologists. This will save time. It will save around 1440 working hours per year in our department. Since the prevalence of Hp infection in obese patients is relatively high, adopting an eradication treatment that costs 51 USD will be more cost-effective than performing a routine preoperative endoscopy and biopsy which cost 1400 to 2100 USD in our institution. The argument against stopping histologic examinations of LSG specimens is that important lesions could still be missed on macroscopic examination alone which can lead to medicolegal consequences. However, some might argue that macroscopically missed lesions are small and most likely benign, and therefore, these patients still receive an adequate treatment by the LSG procedure. Another argument is that the importance of omitting microscopic examination in LSG specimens might vary between different countries with high versus low prevalence of gastric cancer. Routine histologic examinations of LSG specimens in high-risk populations such as Japan might prove necessary. On the other hand, in countries with a low prevalence of gastric cancer, deleting histology is still a safe option. It will be of interest to learn the frequency of incidental preneoplastic lesions and malignancy in LSG specimens in high-risk countries. This selectivity might apply to certain patients as well. In our study, females showed more incidental findings, higher rate of Hp gastritis, and previous or family history of cancer than males. Therefore, selective histologic examination in female patients with a history of cancer is a wise option. Finally, the chance of conducting research on fundic gastric wall and correlating that with morbid obesity will be lost. However, this might apply to academic hospitals and not to service-based hospitals.

Our study has some limitations. Eighteen patients did not have a follow-up. This was a small percentage of the patients and had no major impact on our study. We used Giemsa stain to detect Hp organisms. This is not a particularly sensitive stain compared to immunostain which could have detected some more positive cases. Unfortunately, Hp immunostain is not available in our laboratory. Some might argue that the gross protocol that we have suggested is time-consuming and laborious and that a cursory gross examination followed by routine microscopic sections will be a faster option. We have designed this gross meticulous protocol to avoid missing hidden incidental findings and prove the value of our study of selectively eliminating routine microscopic examinations. Adopting this gross protocol is optional to pathologists depending on their workload of LSG specimens. The strength of the correlation of preoperative endoscopy and final pathologic analysis to include the endoscopy variable is low in our study. This is because only 11.5 % of symptomatic patients had preoperative endoscopy and a routine preoperative endoscopy is not a routine procedure in our institution. One of the strengths of our study compared to the previous retrospective studies is that it was a prospective study with adequate periods of follow-up with a focus on the importance of a careful gross inspection by surgeons or pathologists.

## Conclusion

Histopathologic evaluation of all gastrectomy specimens may not be necessary in patients undergoing routine LSGs. This is because of the rarity of incidental, predominantly benign, pathologic findings and the fact that there is no correlation between the histopathologic findings and the postoperative complications and management. A careful gross examination and description provide more information than random microscopic sections. A selective histologic analysis of grossly detected or suspected lesion is a better cost-effective and safe option.

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

**Statement of Informed Consent** Informed consents were obtained from all individual participants included in the study.

**Statement of Human and Animal Rights** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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