Obesity Surgery (2019) 29:1805–1809
https://doi.org/10.1007/s11695-019-03740-8

ORIGINAL CONTRIBUTIONS

Gastric Lipohyperplasia Presenting as Gastric Polyposis: the First Case Report and Morphometric Study of Additional 127 Bariatric Specimens with a Proposal for Diagnostic Criteria

Vaibhav Chumbalkar[1] · Zhiyan Fu[1] · Ann Boguniewicz[1] · Tejinder P. Singh[2] · Hwajeong Lee[1]

Published online: 9 February 2019

Abstract

Introduction Excessive fat accumulation in the gastrointestinal tract is pathologic. Gastric mucosal polyposis due to excessive submucosal fat infiltration in a bariatric partial gastrectomy specimen was encountered, which has not been described in the literature. This observation prompted us to assess the extent of fat in gastric submucosa and study the incidence of mucosal polyposis due to submucosal fat accumulation in morbidly obese patients.

Materials and Methods Archived pathology slides of 128 bariatric partial gastrectomy specimens including the index case and 89 control cases obtained from Whipple's procedure were examined. The amount of submucosal fat was categorized as 0 (no fat), 1 (up to 70% fat), and 2 (> 70% fat). The maximum submucosal fat thickness was measured with the interval cutoff of 5 mm and 10 mm.

Results Of the 128 cases, 90 (70.3%) were category 1 and 31 (24.2%) were category 2. Maximum submucosal fat thickness was > 10 mm in 3 (2.3%) cases including the index case. The extent of submucosal fat accumulation correlated with the body mass index. The frequencies of category 2 and > 10 mm of fat thickness were higher in the bariatric patient group compared with the control group.

Conclusion We propose a submucosal fat thickness of > 10 mm and diffuse (> 70%) fat accumulation as diagnostic criteria for gastric lipohyperplasia. Using these criteria, the prevalence of gastric lipohyperplasia in the morbidly obese population is 2.3%. A subset of these may present as gastric mucosal polyps.

Keywords Obesity · Bariatric · Lipomatosis · Lipohyperplasia · Polyposis

Introduction

Obesity and associated conditions such as metabolic syndrome and type 2 diabetes mellitus are a worldwide epidemic and contribute to significant mortality and morbidity [1]. Pathologically, obesity manifests as excessive accumulation of fat not only in its normal anatomic locations but also in ectopic locations [2]. Increased hepatic and visceral fat are well-known ectopic fat depots and are associated with insulin resistance and poor health outcome [2, 3]. Excessive accumulation of fat in the gastrointestinal tract has been studied in detail as part of inflammatory bowel diseases, particularly in Crohn's disease [4]. In patients without inflammatory bowel disease, submucosal fat accumulation in colon correlates with body weight and is related to obesity [5]. Submucosal excessive fat accumulation in the ileocecal valve is reported to cause local mechanical symptoms [6, 7] and correlates with body mass index (BMI) [8], suggesting that abnormal submucosal

✉ Hwajeong Lee
LeeH5@amc.edu

Vaibhav Chumbalkar
Chumbav@amc.edu

Zhiyan Fu
Fuz@amc.edu

Ann Boguniewicz
BoguniA@amc.edu

Tejinder P. Singh
SinghT@amc.edu

[1] Department of Pathology and Laboratory Medicine, Albany Medical Center, Albany, NY 12208, USA

[2] Department of Surgery, Minimally Invasive and Bariatric Surgery, Albany Medical Center, Albany, NY 12208, USA

fat accumulation at the ileocecal valve is a part of pathological process of obesity.

We encountered a case of bariatric surgery specimen wherein a portion of stomach exhibited multiple mucosal polyps. The polyps were due to excessive and diffuse accumulation of fat in the gastric submucosa. Although excessive fat accumulation in the gastric submucosa has been described and referred as gastric lipomatosis or lipohyperplasia [9, 10], this is not a usual location of fat accumulation and is considered ectopic. Gastric lipohyperplasia may represent a pathology associated with obesity.

We evaluated whether the degree of gastric submucosal fat accumulation correlates with BMI similar to ileocecal lipohyperplasia. Further, we studied the incidence of gastric mucosal "polyposis" due to excessive accumulation of submucosal fat in patients that underwent bariatric surgery.

Materials and Methods

The study was approved by an institutional review board.

Study (Bariatric Patients) and Control Groups

In the study group, 127 consecutive patients and the index case (a total of 128 patients) that had undergone partial gastrectomy as a part of bariatric surgery were included. Patients' characteristics such as age, gender, and BMI and any relevant information including previous gastric biopsy results were noted from electronic medical records.

For the control group, we included 89 consecutive patients who had undergone Whipple's procedure (pancreaticoduodenectomy) for pancreatic, bile duct, ampullary, and duodenal neoplasm/disease where a portion of the stomach was removed as part of the surgery but was not involved with the disease.

Assessment of Submucosal Fat Accumulation

Archived hematoxylin and eosin (H&E)–stained slides from the stomach were evaluated, and the extent of submucosal fat and the maximum thickness of submucosal fat were assessed. The extent of fat accumulation was categorized based on the percentage of fat tissue in the submucosa in the given sample as follows: 0, no excessive fat accumulation; 1, up to 70% fat accumulation; and 2, more than 70% fat accumulation. The thickness was measured with an interval cutoff of 5 mm, upper normal limit of submucosal thickness on imaging [11], and 10 mm and reported in three tiers as up to 5 mm, 5 to 10 mm, and > 10 mm in thickness.

Correlation Between Submucosal Fat Accumulation and BMI

We assessed correlation in the study group firstly between the BMI and the extent of submucosal fat and secondly between the BMI and maximum fat thickness in the submucosa.

Statistical Analysis

An unpaired *t* test was employed to analyze the difference between the two groups. The significance was analyzed using the Mann-Whitney test using Graph Pad Prism software (Version 7.04, La Jolla, CA, USA). *p* value of 0.05 or less was considered statistically significant.

Results

Case Report

The index case was a 46-year-old obese male with BMI of 38.5 kg/m^2, who underwent preoperative endoscopy followed by bariatric partial gastrectomy. Multiple gastric polyps were noted endoscopically (Fig. 1a). A few polyps were biopsied and histological examination revealed no obvious epithelial lesion, while submucosa was not available for assessment. Subsequent partial gastrectomy specimen showed gross multiple polyps (Fig. 1b). Histological evaluation revealed excessive accumulation of fat (more than 70%) with polypoid thickening of the submucosa (Fig. 1c). The maximum thickness of fat was 12 mm when measured from the submucosal tip of the polyp to the upper layer of the muscularis propria. The mucosa was unremarkable.

Demographics

The mean age of the patients from the study group was 46.1 years (range 19 to 69 years) with 29 males and 99 females. The mean BMI was 43.75 kg/m^2 (range 33.63–73.19 kg/m^2). The mean age of the patients from the control group was 61.8 years with 51 males and 38 females. The mean BMI was 26.33 kg/m^2 (range 17.16–42.43 kg/m^2) in the control group (Table 1).

Gastric Submucosal Fat Accumulation in the Study and Control Groups

Histopathological analysis of 128 cases and 89 control cases revealed that 76% of the study group and 93% of the control group showed ≤ 70% of submucosal fat accumulation (category 0 and 1). Twenty-four percent (31 of 128) of bariatric patients showed > 70% fat accumulation in the submucosa (category 2) compared with only 7% of the control group.

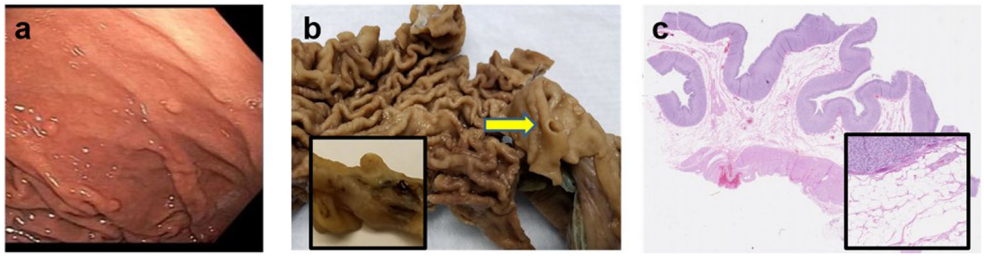

Fig. 1 Gastric lipohyperplasia. **a** Endoscopy showing multiple polypoid lesions, predominantly in the fundus. **b** Gross examination confirmed the endoscopic finding of multiple mucosal polyps (inset: closer view of the arrow depicting a polyp). **c** On histological examination, diffuse submucosal fat infiltration leading to polypoid projection of the mucosa was noted. The mucosa is unremarkable (hematoxylin and eosin, scanning view, inset: higher magnification view of submucosal adipose tissue)

The difference was statistically significant ($p < 0.001$) (Table 2).

The great majority of cases in both study and control groups (81% in the study group and 97% in the control group) showed submucosal fat thickness of < 5 mm. In contrast, only 3 (2.3%) cases showed submucosal fat thickness of > 10 mm, all in the bariatric group (Table 3). The three cases also had more than 70% of fat in the submucosa. The number of cases in which the maximum submucosal fat thickness was between 5 to 10 mm was significantly higher in the bariatric group (21 of 128, 16.4%) as compared with the control group (3 of 89, 3.4%) ($p = 0.002$). Likewise, the median of the maximum submucosal fat thickness in the study group was higher (4 mm) compared with that in the control group (1 mm) and the difference was statistically significant ($p < 0.0001$) (Fig. 2).

In the study group, there was a significant difference in BMI between the cases with submucosal fat extent of up to 70% and greater than 70% ($p = 0.02$) (Fig. 3). No statistically significant correlation was noted between the BMI and maximum submucosal fat thickness in the study group.

Preoperative Endoscopy and Biopsy

One hundred six patients in the study group had preoperative endoscopy, and 48 of these had preoperative biopsy. In total, 13 patients including the index patient showed polyps or polypoid lesions on endoscopic examination. Upon microscopic examination, 7 were fundic gland polyps, 2 were hyperplastic polyps, 1 showed intestinal metaplasia, and 1 showed *Helicobacter pylori* gastritis. The biopsy of the polyp from the index patient and another patient did not show significant pathology in the mucosa on microscopic examination. Including the 11 patients with endoscopically observed polyp/polypoid lesions that were pathologic, in total, 15 patients showed pathologic changes in gastric biopsies. Additional pathologic changes identified in non-polypoid gastric mucosa included reactive gastropathy in 3 and non-polypoid *Helicobacter pylori* gastritis in one. Neither fat tissue nor submucosal tissue was present in preoperative biopsies. Corresponding gastrectomy specimens from these 15 patients did not show polypoid projection of submucosal fat.

Incidence of Gastric Mucosal Polyposis Secondary to Submucosal Fat Infiltration

In the study group, 1 of 128 (0.8%) patients presented with gastric mucosal polyposis secondary to excessive submucosal fat infiltration. When only the cases with category 2 and the submucosal fat thickness of > 10 mm were considered, the incidence of gastric mucosal polyposis due to submucosal fat infiltration was 33% (1 of 3).

Conclusion

Fat accumulation in the stomach, so-called gastric lipomatosis, has been described in the literature since the 1950s [9, 10, 12–14]. We report a first case where fat

Table 1 Patient characteristics in the study group and control group

	Bariatric patients	Control group
Age, mean (range)	46.1 (19–69)	61.8 (18–85)
Male:female	29:99	51:38
BMI (kg/m^2), mean (range)	43.75 (33.63–73.19)	26.33 (17.16–42.43)

Table 2 Extent of gastric submucosal fat infiltration in the study (bariatric) group and control group

Submucosal fat extent category	Bariatric patients	Control group
0	7 (5.4%)	16 (17.9%)
1	90 (70.3%)	67 (75.3%)
2	31 (24.2%)	6 (6.7%)

Table 3 Maximum thickness of submucosal fat in the study (bariatric) group and control group

Maximum thickness of submucosa fat (mm)	Bariatric patients	Control group
≤ 5	104 (81.3%)	86 (96.6%)
> 5– ≤ 10	21 (16.4%)	3 (3.4%)
> 10	3 (2.3%)	0 (0%)

accumulation in the gastric submucosa presented as multiple "mucosal polyps." The mucosal polypoid projections were secondary to diffuse fat infiltration in the submucosa rather than discrete submucosal lesion or mucosal abnormality. Upon evaluation of larger number of cases, we found that diffuse infiltration of fat in the submucosa is more evident in obese patients as compared with controls and the degree of obesity represented by BMI indeed is associated with the presence of excessive submucosal fat infiltration in the stomach. We believe that this represents another site for ectopic fat deposition in addition to well-known ectopic depots such as liver and muscle [2, 3].

Similar submucosal fat accumulation has been described in the ileocecal valve and termed as lipohyperplasia. The degree of ileocecal lipohyperplasia correlated with BMI and to some extent with fat infiltration of other organs [8]. We herein describe similar pathological findings in the stomach and report the positive correlation between BMI and the extent of submucosal fat accumulation at this site. Given the similarities between gastric vs. ileocecal submucosal fat infiltrations, the term gastric "lipohyperplasia" appears to be appropriate for usage to describe this phenomenon.

The two terms, lipomatosis and lipohyperplasia, are frequently used interchangeably [10]. The term lipomatosis has been used for multiple lipomas, excessive submucosal fat infiltration, and grossly obvious lipoma-like lesions [6, 10, 14]. It is also plausible that some of the earlier reports describing multiple lipomas might have had diffuse submucosal fat infiltration as found in our study group but may have been termed as multiple lipomas. Interestingly, some of the patients that were described to have multiple lipomas were obese; thus, it was suggested that the weight of patients should be taken into consideration when diagnosing lipoma-like lesion in the stomach [14].

Local fat accumulation in other organs is linked to an increased risk of developing malignancy through a procarcinogenic inflammatory process [15]. Similarly, there is known increased risk of gastric cancer in obese patients [16]. Therefore, submucosal fat accumulation in the stomach, as observed in this study, may be one of the risk factors and a key player in gastric carcinogenesis.

We believe the presence of gastric polyps in obese patients should prompt a biopsy not only to rule out epithelial lesions but also to assess fat accumulation. As seen in our index case, a subset of excessive gastric submucosal fat infiltration may present as mucosal polyps without epithelial abnormality. Likewise, surgical specimens from bariatric surgeries should be carefully evaluated not only for obvious gross lesions but also for submucosal fat infiltration. The extent of submucosal fat infiltration in this population may potentially be an indicator of the severity of obesity and prognosticator for associated conditions, such as insulin resistance [3]. In the future, the clear role of this evaluation for gastric carcinogenesis may likely emerge.

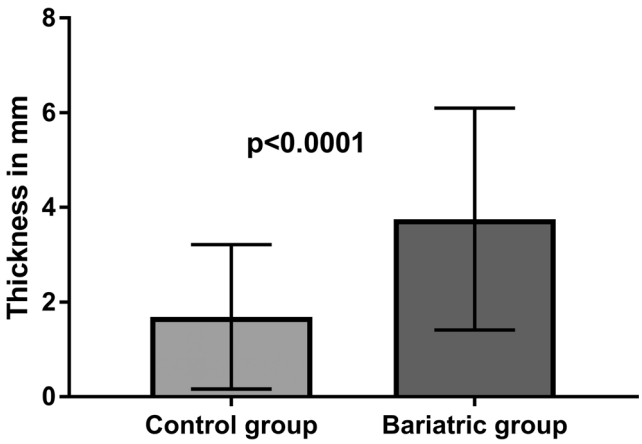

Fig. 2 Assessment of submucosal fat thickness. There was significant difference in the submucosal fat thickness between the control and bariatric groups ($p < 0.0001$)

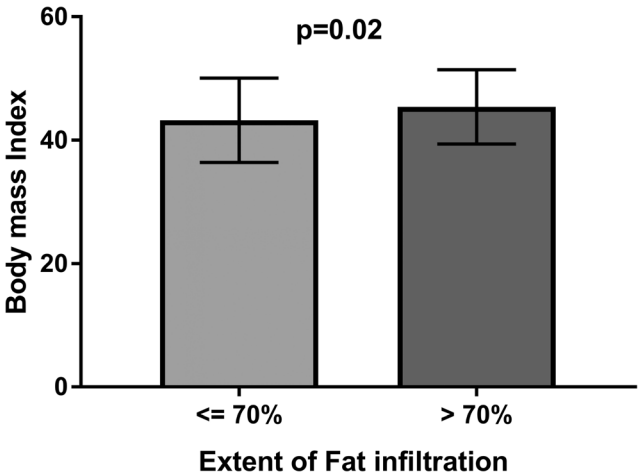

Fig. 3 When the bariatric patients were divided into two groups based on the extent of submucosal fat involvement of up to 70% and greater than 70%, their body mass indices (BMI) was significantly different ($p = 0.02$)

Based on our findings, we propose a submucosal thickness of a minimum 10 mm and diffuse (> 70%) fat accumulation in the stomach as diagnostic criteria for gastric lipohyperplasia. Using these criteria, the prevalence of gastric lipohyperplasia in the morbidly obese population is 2.3%. A subset of these (33% in our study) may present as mucosal polyps or polyposis. Gastric polyps secondary to gastric lipohyperplasia may be under-recognized.

The limitation of our study is the heterogeneous sampling of the control group. While the study group was mostly from the gastric body, different parts of the stomach were sampled in Whipple's procedure specimens. However, given the degree of statistical significance in the comparisons, we believe sampling would not have affected the results significantly. Also, we acknowledge that a classification cannot be devised based on a single study. However, we hope that our attempt to start the discussion herein would facilitate recognition of variable pathologic changes associated with obesity that had been overlooked, and help us better understand the pathogenesis of obesity and related conditions.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Statement -The manuscript has not been submitted to more than one journal for simultaneous consideration.

-No data, text, theories by others are presented as if they were the authors' own.

-Consent to submit has been received from all co-authors and responsible authorities at the institute/organization where the work has been carried out before the work is submitted.

-Authors whose names appear on the submission have contributed sufficiently to the scientific work and therefore share collective responsibility and accountability for the results.

Human/Animal Rights Statement Not applicable. The study was approved by an institutional review board.

References

1. Abdelaal M, le Roux CW, Docherty NG. Morbidity and mortality associated with obesity. Ann Transl Med. 2017;5(7):161.
2. Gustafson B, Smith U. Regulation of white adipogenesis and its relation to ectopic fat accumulation and cardiovascular risk. Atherosclerosis. 2015;241(1):27–35.
3. Shulman GI. Ectopic fat in insulin resistance, dyslipidemia, and cardiometabolic disease. N Engl J Med. 2014;371(12):1131–41.
4. Jones B, Fishman EK, Hamilton SR, et al. Submucosal accumulation of fat in inflammatory bowel disease: CT/pathologic correlation. J Comput Assist Tomogr. 1986;10(5):759–63.
5. Harisinghani MG, Wittenberg J, Lee W, et al. Bowel wall fat halo sign in patients without intestinal disease. Am J Roentgenol. 2003;181(3):781–4.
6. Eyselbergs M, Ceulemans LJ, De Bontridder S, et al. Ileocolic intussusception due to lipomatosis of the ileum: a common complication of a rare clinical entity. JBR-BTR. 2014;97(1):36–8.
7. Hamid HKS, Ahmed I, Mohamed A, et al. Ileocecal lipohyperplasia presenting as a chronic sideropenic anemia. BMC Case Rep. 2013;2013:bcr-2012-008052.
8. Tawfik OW, McGregor DH. Lipohyperplasia of the ileocecal valve. Am J Gastroenterol. 1992;87(1):82–7.
9. Djuric-Stefanovic A, Ebrahimi K, Sisevic J, et al. Gastroduodenal lipomatosis in familial multiple lipomatosis. Med Princ Pract. 2017;26(2):189–91.
10. Jeong IH, Maeng YH. Gastric lipomatosis. J Gastric Cancer. 2010;10(4):254–8.
11. Pickhardt PJ, Asher DB. Wall thickening of the gastric antrum as a normal finding: multidetector CT with cadaveric comparison. Am J Roentgenol. 2003;181(4):973–9.
12. Devlies F, Hoe LV, Leemans A-M, et al. Gastroduodenal lipomatosis. Eur Radiol. 1997;7(3):338–40.
13. Jayasundara J, Sellahewa C, Hall A, et al. A case of gastroduodenal lipomatosis. Ann R Coll Surg Engl. 2016;98(8):e203–5.
14. Peabody JW, Ziskind J. Lipomatosis of the stomach; a case report and a review of the literature. Ann Surg. 1953;138(5):784–90.
15. Renehan AG, Zwahlen M, Egger M. Adiposity and cancer risk: new mechanistic insights from epidemiology. Nat Rev Cancer. 2015;15(8):484–98.
16. Yang P, Zhou Y, Chen B, et al. Overweight, obesity and gastric cancer risk: results from a meta-analysis of cohort studies. Eur J Cancer. 2009;45(16):2867–73.