

## Original Article

# Sarcina Ventriculi of Gastrointestinal Tract: A Clinicopathologic Study

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### ABSTRACT

**Background:** *Sarcina ventriculi*, a gram-positive coccus, are occasionally found in gastric biopsies. Although *Sarcina* had been described more than 150 years ago, little is known about its pathogenicity in humans.

**Method:** This retrospective case series included patients who were identified with *Sarcina* infection. We report clinicopathologic characteristics of 13 patients with *Sarcina* in gastric or duodenal biopsies.

**Result:** The presenting symptoms included: epigastric discomfort (n=6), epigastric pain (n=4), anorexia (n=6), nausea and vomiting (n=5), constipation (n=2), diarrhoea (n=2) and weight loss (n=3). All patients had evidence of mucosal injury. *Sarcina* was found on mucosal surface. 12 patients had food residue on oesophagogastroduodenoscopy (OGD). 10 patients had gastric outlet obstruction (GOO), antral narrowing in 7 and duodenal obstruction in 3. 6 patients had malignant GOO. Causes of benign GOO included *Helicobacter Pylorigastritis* (n=1), eosinophilic gastritis (n=1) and duodenal ulcers (n=2, 1 NSAIDs). Of the 5 patients that had follow-up OGD, 2 had gastric residue. One patient had recurrence of symptoms with the persistence of *sarcina* on biopsy at 3 months. Symptoms improved at 6 months and no evidence of *sarcina* on biopsy at 6 months.

**Conclusion:** Our findings suggest GOO can be considered as a predisposing factor for *Sarcina* infection. *Sarcina* infection may not be the aetiology for GOO but may complicate recovery and may lead to life-threatening complications. Clinicians and pathologists must be aware of such microorganisms and must be documented in the histology report for further investigation and therapeutic consideration.

**KEYWORDS:** *Sarcina ventriculi*, Gastrointestinal tract, Gastritis, Gastric outlet obstruction.

### Introduction

*Sarcina ventriculi* is a gram-positive, non-motile, chemo-organotrophic, obligate anaerobic microorganism that grows in the acidic environment with carbohydrate

fermentative metabolism.<sup>1</sup> Characteristic morphology includes spherical shape, 1.8-3 µm individual size, occurs in tetrads or octet (cell division in two or more planes

of growth) and refractile nature that can mimic vegetable matter due to birefringent cellulose coating. Numerous cases of fatal disease in animals have been attributed to this organism in the veterinary literature. In humans, it was first observed and described by John Goodsir in 1842. Only a few cases of human infections are reported since then.<sup>1</sup>

Most cases have dyspepsia, abdominal pain, nausea, vomiting and food residue on endoscopy.<sup>2</sup> Few cases were associated with life-threatening complications such as emphysematous gastritis, peritonitis and gastric perforation.<sup>2</sup> This association draws attention towards microbial pathogenicity in humans. Hence, in this case series, we review clinical and pathologic characteristics of *Sarcina* infected patients.

## Methods

This retrospective case series included patients who were identified with *Sarcina* infection. We reviewed the pathology database of our tertiary care centre to identify patients with *Sarcina ventriculi* on endoscopic mucosal biopsies between December 2015 and December 2019. Total 13 cases of *Sarcina ventriculi* were identified and included in the case series. Medical records of thirteen patients with *Sarcina ventriculi* organism were reviewed for demographic details, clinical features, imaging results, diagnostic process, and management

## Results

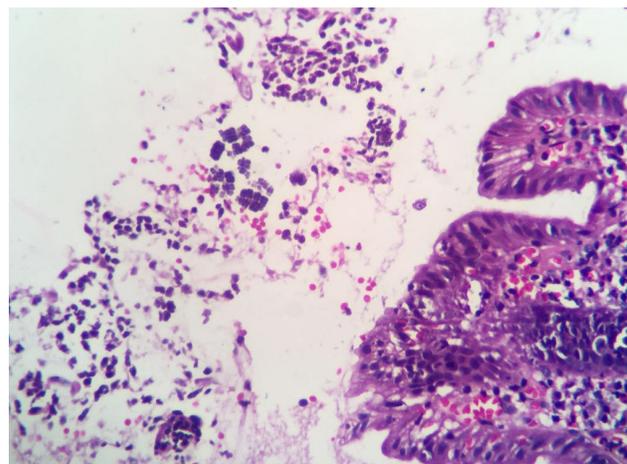
### Clinical characteristics

The clinical features of all patients are elucidated in **Table 1**. Of the 13 patients, 11 were male and 2 were female. The age of the included patients ranged from 24 years to 73 years. Presenting symptoms included: epigastric discomfort (n=6), epigastric pain (n=4), anorexia (n=6), nausea and vomiting (n=5), constipation (n=2), diarrhoea (n=2) and weight loss (n=3).

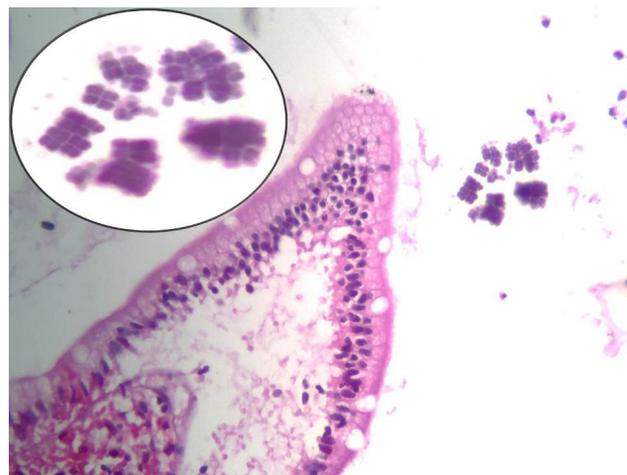
Of these 13 patients, 10 had GOO and 2 of the remaining 3 also had food residue on OGD suggestive of delayed gastric emptying. The location of GOO was the antrum in 7 and duodenum in 3 patients. Six patients had malignant GOO (4- Carcinoma stomach, 2- carcinoma duodenum). Causes of benign GOO included Hpylori gastritis (n=1), eosinophilic gastritis (n=1) and duodenal ulcers (n=2). One patient with duodenal ulcers

had a history of prolonged NSAID use. 4 Patients had underlying comorbidities. None of the patients had past gastric surgery or procedure. (**Table 1**)

All patients showed the presence of *Sarcina ventriculi* on the luminal mucosal surface of epithelium with their characteristic morphology on H and E staining. One patient had concomitant *H. pylori* infection. There was no common pathological finding of the gastric and duodenal mucosa that could be attributed to *Sarcina* (**Figure 1 and 2**).



**Figure 1: *Sarcina ventriculi* arranged in tetrad & octet packets with characteristic molding at places of contact with each other located on the luminal aspect of the gastric mucosal surface. (Hematoxylin and eosin stain; 40x).**



**Figure 2: *Sarcina ventriculi* in a duodenal biopsy, cocci arranged in tetrads & octets (40x magnification,) (inset image; 100x oil objective) H&E stain.**

**Table 1: Clinical Features, Endoscopic Findings, Histopathology, Treatment, and Follow-Up of 13 Cases of *Sarcina ventriculi* reported at our Tertiary Centre.**

S. No.	Age/S	Clinical Features	Endoscopic findings	Histopathologic findings	Treatment	Clinical Follow-up
1	47/M	Epigastric pain	Oesophageal candidiasis, gastric residue with deformity, D1 D2 stricture with ulcerations	Chronic active duodenitis with ulceration and colonization by <i>Sarcina</i> and oesophageal candidiasis	Metronidazole, PPI, domperidone, fluconazole	1 m: Symptom improvement
2	50/M	Epigastric discomfort, anorexia	Esophagitis, pyloric ulcerated mass with GOO	Infiltrative adenocarcinoma and <i>Sarcina</i>	Metronidazole, PPI, domperidone	Symptom improvement at 2 wk, succumbed to malignancy at 3 m
3	65/M	Epigastric discomfort, Anorexia, Nausea and vomiting	Antral growth involving the pylorus with GOO	Adenocarcinoma and <i>Sarcina</i>	Metronidazole, PPI, domperidone	succumbed to malignancy at 2 m
4	33/M	Epigastric discomfort, Epigastric pain, Constipation	Moderate gastritis, duodenal erosions	Chronic duodenitis with the colonization of <i>Sarcina</i>	Metronidazole, PPI, domperidone	1 wk: Symptom improvement Repeat OGD at 1 m: normal
5	53/M	Epigastric discomfort, anorexia, nausea, vomiting	Antral growth, GOO, severe reflux esophagitis	Infiltrative adenocarcinoma and <i>Sarcina</i>	Metronidazole, PPI, dicyclomine domperidone	succumbed to malignancy at 2 m
6	45/M	Epigastric discomfort, epigastric pain, anorexia	Pyloric ulcer with healed duodenal ulcer and GOO	Severe acute ulcers with chronic gastritis, duodenitis and <i>Sarcina</i>	Metronidazole, PPI, domperidone	2 wk: Symptom improvement. Recurrence of symptom at 3m. OGD at 3m: gastric residue, sarcina present, OGD at 6m: normal, no sarcina
7	24/M	Epigastric discomfort, constipation, nausea, vomiting	Moderate gastritis, GOO due to pyloric narrowing	Severe chronic active gastritis, <i>H-pylori</i> and <i>Sarcina</i>	Metronidazole, Clarithromycin, PPI, Amoxicillin	2 wk: Symptom improvement Repeat OGD at 6 m: normal, no sarcina
8	44/F	Vomiting and diarrhoea	Pyloric stricture with ulcers with GOO	Gastric ulcers with eosinophilic gastritis and <i>Sarcina</i>	Metronidazole, PPI, domperidone, albendazole	2 wk: Symptom improvement OGD at 1 m: gastric residue, no sarcina
9	57/F	Diarrhoea	Esophagitis, dilated stomach with gastric residue. ? Distal obstruction? Gastroparesis	Duodenitis, with focal mild increase in lamina propria eosinophils, normal villous crypt architecture, <i>Sarcina</i>	Metronidazole, PPI, domperidone	2 wk: Symptom improvement
10	48/M	Weight loss	Ulcerated nodular D1 and pyloric mass with GOO	Acute gastritis and submucosal eosinophils, adenocarcinoma, <i>Sarcina</i>	Metronidazole, PPI, domperidone	3 wk: Symptom improvement succumbed to malignancy at 6 m
11	54/M	Epigastric discomfort, anorexia, weight loss	Duodenal ulcer with nodularity and GOO	Infiltration by signet ring carcinoma-duodenal ulcers with nodularity, <i>Sarcina</i>	Metronidazole, PPI, domperidone	2 wk: Symptom improvement succumbed to malignancy at 6 m
12	27/M	Epigastric discomfort, nausea	Gastritis with food residue	Severe chronic active gastritis, <i>Sarcina</i>	Ofloxacin, Metronidazole, PPI	2 wk: Symptom improvement Repeat OGD at 1 m: normal, no sarcina
13	73/M	Epigastric pain, anorexia, weight loss	Perforated duodenal ulcer with gastric residue	Ulceration, acute inflammatory exudates, moderate lymphoplasmacytic infiltrates in lamina propria and submucosa. <i>Sarcina</i>	Ofloxacin, Metronidazole, Domperidone, PPI	Repeat OGD at 1m: non-healing ulcer, biopsy same findings, diagnosed metastatic adenocarcinoma at 4m and succumbed to malignancy at 5m

GOO: Gastric outlet obstruction; IBD: Inflammatory bowel disease; H-pylori: Helicobacter Pylori; PPI: Proton pump inhibitor; wk: week; m: Month; OGD: Oesophagogastrroduodenoscopy

All patients with benign underlying disease (n=7) responded well to antibiotics (metronidazole alone in 10, ofloxacin + metronidazole in 2, Anti *H. pylori* regimen in 1) and proton pump inhibitors (PPI) with symptomatic improvement in all by 3 weeks. The clinical follow-up duration ranged from 2 to 12 months. Follow up OGD was available in 5 of 7 patients with benign aetiology. Two of these patients had evidence of food residue in the stomach on follow up OGD. One patient had recurrence of symptoms at 3 months. OGD at 3 months showed mild antral gastritis with gastric residue. Biopsy showed *Sarcina ventriculi* and the antibiotic course was repeated. OGD at 6 months showed no evidence of *Sarcina ventriculi*. The patient with perforated duodenal ulcer was managed conservatively with nasojejunal feeding as the patient was unwilling for surgery. Repeat OGD at 1 month showed persistence of the perforated ulcer. Biopsy revealed the presence of *Sarcina* and no evidence of malignancy. The patient was later diagnosed with metastatic adenocarcinoma on follow up at 4 months and succumbed to the same. All other patients with malignant GOO had unresectable disease at diagnosis. 1 patient had partial improvement in GOO at 2 weeks with antibiotics. Repeat OGD was not done in patients with malignant GOO. Histology on follow up OGD was available in 4 of the 5 patients. Only one patient showed the presence of *sarcina* on follow up biopsy. Repeat antibiotic course cleared *sarcina*.

## Discussion

Despite the first description in 1842, only 33 cases of human infections have been documented prior to this study (Table 2). The research on this organism has flourished in recent years as evident by the recent publication surge. If the pathologist is aware of *Sarcina*, the likelihood of mistaking it for vegetable matter decreases.

*Sarcina* has its natural habitat in the soil, stagnant water, on the surface of cereal seeds and interestingly as one of the major bacterial contaminants isolated from commercially available children's soap bubbles. *Sarcina* reaches the gastrointestinal tract by the ingestion of contaminated food.<sup>2,3</sup> Moreover, it has been identified in the faeces of healthy adults.<sup>1</sup> *Sarcina* can be identified

in any age group ranging from 3 years to 87 years. While previous reports showed female preponderance, our study had male preponderance. *Sarcina* has been identified from the stomach (85%), oesophagus (10%) and duodenum (5%) and can lead to complications like emphysematous gastritis or perforation.<sup>3</sup> In our case series, *Sarcina* was found in the stomach and duodenum and not in the oesophagus. Mucosal inflammation and ulceration were seen in all patients. Previous case reports have shown the presence of *Sarcina* in gastric biopsy even in asymptomatic patients. Histology however showed acute and chronic gastritis.<sup>4</sup> This suggests the presence of mucosal inflammation might cause more symptomatic disease by worsening underlying disease. *Sarcina* as the cause of this mucosal injury seems less likely as no specific histologic characteristics could be attributed to *sarcina*. 12 of the 13 patients had food residue on OGD suggesting an association with delayed gastric emptying. Of the 33 cases in prior literature, 8 had GOO and an additional 9 had food residue on OGD (gastroparesis confirmed in 2 by gastric emptying studies). In patients with food residue on OGD, 3 patients had diabetes mellitus and 1 patient had narcotic bowel syndrome. 12 had altered anatomy of which 8 had food residue on OGD and one had an oesophageal stricture. This might suggest a predisposition to *sarcina* colonization by probable delayed gastric emptying and altered gastric anatomy. Delayed gastric emptying provides carbohydrate and other fermentative substrates from food to grow *Sarcina*. They can survive in the low pH of the stomach that provides an ideal environment for *Sarcina* over growth and subsequent passage of organism from the stomach to duodenum as the duodenum does not have a highly acidic environment.<sup>5,6</sup>

Meij *et al.* reported *Sarcina* in oesophageal biopsy in patients with an oesophageal stricture. Severe stenosis provides an optimal anaerobic condition for *Sarcina* growth.<sup>6</sup> Occasionally, *Sarcina* coinfects with *H. Pylori* and *Candida*. The coinfections with *H. Pylori* are due to existing environmental conditions and coinfection with *candida* is associated with GOO.<sup>6</sup> None of the patients in our series presented with emphysematous gastritis or gastric perforation. 3 patients presenting with emphysematous gastritis and 2 with gastric perforation

**Table 2: Clinical Features, Endoscopic Findings, Histopathology, Treatment and Follow-Up of total 33 Cases of *Sarcina Ventriculi* Reported in previous literature.**

Author year	Age	Symptoms	Underlying condition	Endoscopy/CT	Histology	Gastroparesis/GOO/Food residue	Follow up	Treatment
Heidinger M 2020 <sup>7</sup>	67/F	GERD	S/P HiatoPlasty with gastropepy	Reflux esophagitis	ulcerative reflux esophagitis with sarcina	gastroparesis on barium swallow	OGD at 12m: food residue, sarcina in oxyntic mucosa	PPI, D
Sergi C 2020 <sup>4</sup>	13/F	Asymptomatic, gastrocutaneous fistula (PEG) closure	Phenylketonuria	No	acute and chronic gastritis with sarcina	No	NA	
Dumitru A 2020 <sup>8</sup>	76/M	Acute abdomen (Gastric Perforation)	No	No	marked acute inflammation, hemorrhagic areas and extensive necrosis of the fatty tissue. Sarcina in lumen and blood capillaries	no e/o GOO or mass intraoperatively	NA	
Hillman L 2020 <sup>9</sup>	70/M	GERD	S/P fundoplication for reflux	sloughing gastric ulcers, gastric residue, Barrett's oesophagus	acute gastritis with sarcina	gastroparesis on gastric emptying study	no symptom improvement and no eradication of sarcina with antibiotics. Surgical revision of hiatus hernia led to symptom improvement and eradication of sarcina	C+M
Zare SY 2019 <sup>10</sup>	69/M	Diarrhoea, bloating, weight loss	DM, SIBO, chronic pancreatitis	esophagitis, pyloric obstruction with inflammatory thickening, food residue	acute and chronic gastritis with sarcina with marked increase in eosinophils	GOO	OGD at 1, 3, 5m: persistent GOO, no sarcina. GJ at 1 yr for GOO	C+M
Rohr J 2019 <sup>11</sup>	38/M	Nausea, early satiety, hematemesis	Hodgkin's disease in remission	Pyloric and duodenal ulcer	gastric adenocarcinoma, sarcina in brushings	GOO	NA	NA
Singh K 2019 <sup>12</sup>	86/F	abdominal pain, nausea, vomiting, anorexia, diarrhoea	HT, DM	-	emphysematous gastritis with sarcina on postmortem	-	Expired	vancomycin, piperacillin-tazobactam
Aggarwal S 2018 <sup>13</sup>	45/F	abdominal discomfort and vomiting	No	edematous distal antrum causing luminal narrowing	mild, nonspecific chronic gastritis, sarcina, candida. H pylori absent	GOO	Clinical improvement at 7 days. No follow up OGD	C+M, no antifungal
Shetty 2018 <sup>14</sup>	48/F	abdominal pain, nausea, vomiting	DM, HT, COPD, polysubstance abuse	Esophagitis Previous OGD: esophagitis with food residue	Cytology: benign and reactive squamous epithelial cells and reactive glandular cells, sarcina. Sarcina in gastric biopsy 4m prior	Food residue	NA	No treatment
Alvin M 2018 <sup>15</sup>	87/M	Hematemesis, abdominal pain	Dementia, IHD	diffuse severe erosive and necrotic gastritis CT: portal venous gas, gastric emphysema	acute phlegmonous gastritis, sarcina	follow up OGD no features suggestive of GOO	CT at 24 hrs: resolution of portal venous gas and gastric emphysema; OGD at 5d: resolution of necrosis, no ulceration	antibiotics managed conservatively
Behzadi J 2017 <sup>16</sup>	65/F	Dysphagia	Carcinoma Breast, Schatzki ring	stenosis with a nodule at GE junction, gastric ulcers, food residue	Acute and chronic gastritis, sarcina Acute and chronic esophagitis, sarcina	GOO	Succumbed to other complications	C+M, oesophageal stent
Meij T 2017 <sup>5</sup>	12/F	Hematemesis	West syndrome, PEG	Erosive esophagitis & gastritis, food residue	severe ulcerative esophagitis and gastritis, sarcina	Food residue	Clinical improvement	C+M

Author year	Age	Symptoms	Underlying condition	Endoscopy/CT	Histology	Gastroparesis/GOO/Food residue	Follow up	Treatment
Meij T 2017 <sup>5</sup>	15/F	Convulsions, inability to pass NG tube	Epilepsy, PEG	Erosive gastritis with gastric ulcer, oesophageal stricture, food residue	Active gastritis, sarcina	Food residue	Clinical improvement	C+M
Liu L 2018 <sup>17</sup>	43/F	Abdominal pain, tachycardia	Gastric banding	CT: Distended stomach pneumatosis of the gastric wall	ischemic pattern injury and transmural necrosis with a necro-inflammatory exudate	-	NA	NA
Haroon al Rasheed 2016 <sup>1</sup>	57/F	Asymptomatic	DM	Scarred and eroded prepyloric ulcer, food bezoar	Sarcina, ulcer bed, and reactive gastropathy	Food residue	NA	NA
Darch R 2016 <sup>18</sup>	78/M	Epigastric pain, dyspepsia, anemia	Surgery for hiatus hernia, h/o radio-chemotherapy for oesophageal adenocarcinoma	Ulcerated Barrett's oesophagus with significant dilatation of the distal oesophagus with stricture at GE junction	Adenocarcinoma with sarcina	GOO	NA	NA
Sopha 2015 <sup>1</sup>	32/F	Headache, dyspnea, melena	Aastric banding, H pylori gastritis	Ulcer at the gastric cardia,	Sarcina	No	f/up OGD: gastric ulcer with perforation, laparotomy and repair, biopsy not taken	C+M
Berry 2015 <sup>1</sup>	65/F	Melena, diarrhoea, weakness	Aastric banding	Pouch, restriction with ulcers	Sarcina	No	Clinical improvement	PPI
Medlicott 2015 <sup>1</sup>	53/F	Epigastric pain, regurgitation, vomiting	Gastric banding, gastric ulcer, GERD, DM, hiatus hernia	Food bezoar, polyps, healed ulcer	Mild, chronic gastritis with Sarcina	Food residue	F/up OGD: Persistent polyps and reactive gastropathy; no Sarcina	M+motilium
Bhagat 2015 <sup>1</sup>	55/F	Abdominal pain, vomiting	No	Deep ulcer in the pylorus. CT: diffuse thickening of the pyloric antrum	Gastric adenocarcinoma, ulcer and sarcina	GOO	NA	NA
Kumar 2014 <sup>1</sup>	3/M	Vomiting, chronic diarrhoea	No	Normal gastric mucosa, mild grooving in D2	Normal duodenal mucosa with Sarcina and giardia	No	NA	NA
DiMaio 2014 <sup>1</sup>	37/F	Epigastric pain, nausea, anorexia, abdominal distension	Cystic fibrosis	Severe erythema, linear erosions in the posterior wall of the gastric antrum	Moderate chronic gastritis and superficial mucosal haemorrhage with sarcina and candida	No	Clinical improvement	PPI
Kulkarni 2013 <sup>1</sup>	34/F	Epigastric pain, chronic diarrhoea	No	Normal oesophagus, stomach, and duodenum	Normal gastric mucosa with Sarcina, intraepithelial eosinophils in oesophagus, lymphocytes with villous blunting in the duodenum	No	F/up OGD: Identical histology but no Sarcina	C+M
Sauter 2013 <sup>1</sup>	12/M	Vomiting, epigastric pain	No	Erosive esophagitis, gastritis, edematous and tight pylorus	Active erosive esophagitis, chronic active H pylori gastritis, Sarcina	No	NA	NA
	16/F	Vomiting, epigastric pain	No	Erosive esophagitis, gastritis, edematous pylorus, food bezoar	Sarcina in oesophagus and stomach	Food residue	NA	NA
Ratuapli 2013 <sup>1</sup>	73/M	Chronic iron deficiency anaemia	Refractory gastric ulcers treated by Billroth II antrectomy and truncal vagotomy	Diffuse gastric erythema, 2 polyps at the anastomotic site, food bezoar	Diffuse gastritis, gastric ulcer, and sarcina, no H pylori	Food residue	Repeat endoscopy showed improvement of erythema, clearance of Sarcina, no food bezoar	C+M

Author year	Age	Symptoms	Underlying condition	Endoscopy/CT	Histology	Gastroparesis/GOO/Food residue	Follow up	Treatment
Lam-Himlin 2011 <sup>1</sup>	58/F	Abdominal pain, vomiting	No	Gastritis, pyloric mass with obstruction and bezoar	Chronic, active gastritis and Sarcina	GOO	Treated for adenocarcinoma of Pylorus. Long term follow up NA	Partial gastrectomy (adenocarcinoma)
	44/F	Postprandial dyspepsia	DM-I, gastroplasty	Gastric ulcer, pyloric polyps, and food bezoar	Nonmalignant gastric ulcer with sarcina, hyperplastic polyp	Food residue	Clinical improvement	PPI, Metoclopramide
	36/M	Nausea, vomiting, epigastric pain	Narcotic-related gastroparesis	Food bezoar	Normal gastric mucosa and Sarcina	Food residue	No sarcina	FJ for malnutrition
	12/F	Dysphagia	Oesophageal atresia after gastric pull-through with anastomotic narrowing	Stricture at the anastomosis, food bezoar	Reflux esophagitis and Sarcina	GOO	NA	NA
	46/F	Painful epigastric spasms	h/o pylorus sparing pancreaticoduodenectomy for pancreatic adenocarcinoma	Bile, food bezoar	Chronic active duodenitis and Sarcina	Food residue	Symptomatic, continued spasms	NA
Laass 2010 <sup>1</sup>	3/F	Anorexia, vomiting, hematemesis, abdominal distension	No	Necrotic stomach distended by blood and air. x-ray: dilated stomach with intramural air	Chronic, active gastritis, Sarcina and intramural air	f/up ogd no e/o GOO	OGD day8, 3wk: healing ulcers OGD 6m: normal, no sarcina	Imipenem + fluconazole
Tolentino 2003 <sup>1</sup>	14/M	Abd pain, distension, gastric perforation, peritonitis	Bowel resection	Blackened gastric mucosa with a cobblestone appearance, indicating partial necrosis	Diffuse, acute, hemorrhagic gastritis with perforation, ulceration, necrosis, and Sarcina	-	Clinical improvement	M+ gentamycin
	50/M	Nausea, vomiting, hematemesis, melena, weight loss	No	Esophagitis, hiatal hernia, duodenal lesion	Chronic, superficial gastritis and ulcer with Sarcina	No	NA	NA

C: ciprofloxacin; M: metronidazole; FJ: feeding jejunostomy; PPI: proton pump inhibitor; NA: not available; f/up: follow up; e/o: evidence of

has been documented in previous literature. Follow up OGD in 2 patients showed no GOO or food residue on endoscopy. However gastric emptying studies were not done. All patients developing emphysematous gastritis were elderly except one with altered gastric anatomy. Whether mucosal injury predisposes to colonisation by sarcina and complications like emphysematous gastritis cannot be inferred convincingly but prompts towards a possible association. In our series *sarcina* was found on the mucosal surface and tissue invasion was not seen. However, *sarcina* has been found in capillaries of the gastric wall and gastric tissue in patients with emphysematous gastritis and gastric perforation. This association requires consideration as management of dysmotility and/ or antibiotic treatment can prevent likely

complications especially in elderly patients. All patients with benign aetiology in our study had symptomatic improvement with antibiotics, PPI and prokinetics. However, there was no comparative non-intervention group. The available literature is split regarding the use of antibiotics. Some patients have shown improvement only with the use of PPI and prokinetics even in the presence of ulcerated mucosa while one patient showed nonresponse even after treatment with antibiotics but responded after correction of gastric anatomy and physiology. Till further data is available it might be prudent to treat with prokinetics in non-ulcerated disease and add antibiotics in patients with ulcerations on OGD or inflammation on biopsy. If this fails, surgical correction of delayed gastric emptying (e.g. gastrojejunostomy in GOO) should be attempted.

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We did not confirm *Sarcina* by PCR sequencing of the 16s rRNA gene. However, histologic appearance is characteristic and cannot be confused with other causes.

## Conclusion

In conclusion, GOO and possibly gastroparesis is the predisposing factor for *Sarcina* infection. Though the microorganism is unlikely to cause any direct mucosal injury, GOO and the presence of mucosal injury might predispose to complications. The pathologist must be aware of it and if identified, it must be documented in the report to warrant further work-up and treatment.

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