



Terry Bolin

Wind

Problems with intestinal gas

Background

Problems with intestinal gas and its transit through the gut are common, although the mechanisms causing the most common problems of belching (eructation), bloating, and passing flatus from the anus are reasonably complex.

Objective

This article outlines the role of intestinal gas in the genesis of the common symptoms of wind, the importance of gas transit, and considers new information about our understanding of small bowel motility.

Discussion

Healthcare providers often underestimate the severity of a patient's symptoms relating to the oesophagus, stomach, small bowel, and colon, especially the loose relationship between bloating and abdominal distension. Medications and diet modification play a key role in management, particularly in terms of fibre, resistant starch and fat intake.

Keywords

eructation; flatulence; irritable bowel syndrome; diet



The symptoms of belching (eructation), bloating and passing flatus from the anus are a consequence of the interaction of gas production and gastrointestinal motility. Symptoms are greatly affected by food, particularly high fibre foods, and medications that impact on gastrointestinal motility, especially in the oesophagus and stomach. The majority of patients with these symptoms are female. Belching is perhaps more common in the older age groups and is consequent on oesophago-gastric dysmotility. Passing flatus from the anus is universal, although the exact nature and quantity of emissions vary greatly between individuals.

Gases

Twenty-five litres of gas is produced in the intestine every day (Table 1), so it is little wonder that bloating will be common if there is any disturbance of gut motility.

Despite the enormous production of gases, there is an equally enormous re-absorption and utilisation of gas within the gut, such that the average net output per day in terms of flatus is only 1–2 L.

Gases that play an important role in the symptoms of belching, bloating and passing flatulence include:

- oxygen (O₂)
- nitrogen (N)
- carbon dioxide (CO₂)
- hydrogen (H)
- methane (CH₄)
- hydrogen sulphide (H₂S).

All of these gases are produced, absorbed or consumed in various parts of the gut.

Oxygen and nitrogen

As there is no gas production in the oesophagus or stomach, the only gases found there are those that are swallowed, essentially oxygen and nitrogen. Almost all the oxygen is absorbed from the stomach and duodenum leaving less than 1% in rectal gas. Seventy percent of nitrogen is similarly re-absorbed, leaving 30% within the lumen. Air swallowing has long been blamed for excess gas from the bowel, although that remains unlikely except in a minority of patients. Ultra-fast computed tomography (CT) has shown that swallowing is accompanied by 15–20 mL of air; hence over the course of the day, the average person could swallow 2.5 L of air.

**Table 1. Gases found in the gut***

| Type | Quantity (litres) |
|--|-------------------|
| Swallowed air | 3 |
| Nitrogen | 1 |
| Carbon dioxide (small intestine) | 3 |
| Hydrogen (colon)* Carbon dioxide (colon)* Methane/hydrogen sulphide (colon)* | 18 |
| Total | 25 |
| * Individual amounts vary with diet | |

Carbon dioxide

The next important event that takes place is the interaction between acid, produced in great amounts by the stomach, and bicarbonate from the pancreas. This chemical reaction is part of the process of the digestion of fat, carbohydrate and protein, and generates large amounts of carbon dioxide gas. This may be as much as 3 L, but most of this is re-absorbed before the small bowel contents reach the colon. The interaction between acid and bicarbonate occurs almost immediately after eating, as the first swallow is often in the duodenum within a few minutes. This may account for the immediacy of the bloating experienced by many women.

Hydrogen

Hydrogen production is confined to the colon. After passing the ileocecal valve and entering the colon, there is an enormous fermentation factory involving 400 species of bacteria, weighing 1–2 kg. The first event in this fermentation process is the production of hydrogen in amounts that may exceed 12 L/day. While up to 2 L or so of the resulting gas will ultimately be passed as flatus, some is re-absorbed from the colon before travelling via circulation through to the lungs and then expired in the breath. The remainder is consumed by the other bacteria in the colon and used as a source of energy to stimulate growth of bacteria. Up to 90% of the total production of hydrogen may be consumed in this way, with another type of bacteria utilising carbon dioxide and hydrogen to produce acetic acid.

Methane and hydrogen sulphide

The population of bacteria is roughly divided into those producing methane gas (methanogens) and other, mainly sulphate reducing, bacteria producing volatile sulphide gases. The two important groups of bacteria that consume hydrogen are methanogens, and the sulphate reducing bacteria producing hydrogen sulphide. Methanogens are found throughout the colon, although they are particularly plentiful in the right colon. They compete for the hydrogen produced in the right colon and unless there is a lot of sulphur in the diet, the methanogens usually win. The odour of flatus comes primarily from three volatile gases that rapidly spread into the surrounding space: hydrogen sulphide, methanethiol and dimethyl

sulphide; all other gases in the gut are odourless. Other non-volatile agents causing odour in stools include indole and skatole. During the process of metabolism of hydrogen by methanogens, one volume of methane is produced from 5 volumes of hydrogen, thereby providing a very efficient reduction in the volume of gases. There is a similar, although smaller, reduction in volume with the production of hydrogen sulphide. As occurs with hydrogen, both methane and hydrogen sulphide gas are partly re-absorbed from the colon and may be expired on the breath.

All people have a dominant bacterial population: either a methane producer or a sulphate producer. Females are more likely to be 'methanogens' than males: 49% versus 33%,¹ which may explain why males have more aromatic flatus. Caucasian people and African people are more likely to be methane producers (48%) than Asian people (24%) and Indian people (32%); this may be associated with diet.¹

Belching (eructation)

One of the following conditions is almost always the cause of belching, although confirmation of the diagnosis may at times be elusive:

- oesophagitis, usually secondary to gastro-oesophageal reflux
- oesophago-gastric dysmotility
- gastroparesis
- rumination – cyclical vomiting
- scleroderma.

As pain and retrosternal discomfort may not necessarily be a feature of belching, oesophagitis needs to be confirmed endoscopically. This will also exclude other conditions, such as Barrett oesophagus and eosinophilic oesophagitis, and assess the degree of inflammation to help guide therapy.

Oesophago-gastric dysmotility is a relatively common problem that occurs particularly in the elderly, and more commonly in women. It is typically associated with epigastric bloating, discomfort, and the inability to eat a large, or sometimes even normal, sized meal. It is variably associated with oesophageal reflux. Endoscopy may disclose food residue or excessive mucous in the stomach, which is consistent with delayed gastric emptying. It may also be accompanied by intermittent dysphagia for solids and/or liquids.

Gastroparesis, whose symptoms include nausea, vomiting, early satiety and post-prandial fullness, is diagnosed with a gastric emptying study to exclude gastric outlet obstruction.

Rumination and cyclical vomiting are rare, and are likely to be accompanied by symptoms of anxiety and/or depression.

Scleroderma may have manifestations in other organs, as well as the classic skin changes seen in this condition.

Bloating

Bloating is a particularly common and difficult to manage complaint, with few patients having a formal identifiable disease. In a community survey² carried out by The Gut Foundation of 1295 women aged 18–49 years, two-thirds experienced bloating, and in a quarter of this group,



the bloating occurred frequently and had a significant impact on quality of life.

Specific causes include classic coeliac disease, which affects 1% of the population. There is now also recognition of wheat sensitivity in patients without coeliac disease,^{3,4} which may be due to a disturbance of the autonomic nervous function on the gut, rendering them more sensitive to gaseous distension. These patients may have evidence of other autonomic dysfunction, such as Reynaud disease.

It is important to recognise that the sensation of bloating may not necessarily be accompanied by visible distension. Historically, this has placed these patients at a significant disadvantage in their interactions with doctors and dieticians, as they have little to show for their symptoms. It is also important to recognise that bloating, and particularly its distribution, may be at variance with our preconceptions, with 60% of women complaining of either upper or middle abdominal bloating in contrast to the low and generalised bloating that is frequently linked with constipation.

Bloating may appear at the beginning of the day, although it is more common at the end of the day, which is most likely due to the production of gas within the colon from fibre and resistant starch being fermented. Bloating may also appear immediately on eating, presumably due to production of carbon dioxide gas in the small intestine by the interaction of gastric acid and pancreatic bicarbonate.

The Neurogastroenterology Unit at the University of Manchester⁵ has recently focused on the distinction between bloating and distension, and documented that hypersensitivity to gaseous distension in conjunction with impaired propulsion and delayed clearance of intra-luminal gas in the small intestine is a major source of symptom production.

Studies from Barcelona^{6–10} have emphasised that many symptoms emanate from the small intestine and not the colon. The interaction of gastric acid and pancreatic bicarbonate generates large amounts of carbon dioxide gas. The neutralisation of 1 mEq of hydrochloric acid by bicarbonate yields 22.4 mL of CO₂. During digestion, as much as 3 L of CO₂ can be generated, and virtually all of this is reabsorbed before the small bowel contents reach the colon. Using xenon and other gases they demonstrated that if motility is abnormal, gas may be trapped in the small bowel and that jejunal perfusion of both saline and lipid caused significant gas retention in patients with bloating, causing discomfort that was at times extreme. Importantly, the symptoms were located in the abdominal mid-line in three-quarters of the patients, a location that may be helpful in distinguishing gastric, small intestinal and colonic origins of bloating.

Upper abdominal discomfort experienced on waking could be due to gases such as CO₂ and nitrogen trapped in the upper small bowel, a process that may also account for symptoms that occur after meals when motility is increased by eating and, if abnormal, causing gas trapping.

Studies from the Manchester group⁹ using the technique of abdominal inductance plethysmography to compare diurnal variation

in girth, revealed significantly more bloating both at the beginning and end of the day, and a greater severity of bloating in patients complaining of bloating when compared to the healthy volunteers. Bloating also correlated with distension in patients with constipation, but not for those with diarrhoea.

Treatment

A number of treatments are available, with variable effectiveness across the patient population. It is not unusual to have to try a range of approaches sequentially to find an effective therapy in an individual patient.

As constipation is an important contributor to the symptom of bloating, it requires treatment with either dietary advice or laxative use. Increasing fibre may worsen bloating and compromise treatment of the constipation. Fat, and perhaps coffee and chocolate, are important triggers for bloating of small intestinal origin in that it may induce abnormal motility. The effect of fat needs to be separated from lactose intolerance when dairy products are blamed. Women aged 30 years and over are more troubled by artificial flavouring, caffeine and shellfish, while chilli is progressively better tolerated in both men and women as age advances.

Antispasmodics such as mebeverine hydrochloride or hyoscine butylbromide (Buscopan®), and herbal solutions such as Iberogast®, may be helpful. Amitriptyline in small doses of 5–10 mg at night often reduces the sensitivity of the nervous system of the gut. Because fibre and resistant starch are important in fermentation in the colon, improvement in their absorption in the small intestine is achievable with use of a pancreatic supplement; this is an off-label indication. The use of a non-absorbable antibiotic such as rifaximin has been shown to be of value in patients considered to have underlying small bowel bacterial overgrowth. Probiotics have also been shown to affect bloating and discomfort although as they vary greatly in formulation there is little consistency in response.

The FODMAP diet (Fermentable, Oligo-, Di-, Mono-saccharides And Polyols) has achieved considerable recognition in recent times, and elimination of these 'FODMAPs' also eliminates a large majority of the foods containing fibre that may generate gas from fermentation within the colon.

Passing flatus from the anus

Flatulence can be defined through both volume and aroma; the volume will depend largely on diet, and the aroma on the type of bacteria that live in the colon. In 40% of the population, hydrogen sulphide is the predominant bacterium producing aromatic gas.

The average person produces 2400 mL of gas per day, usually passed in portions of 30–120 mL. The number of times someone passes gas varies, as does the time of day, with some passing more in the mornings, while others pass more in the evening. Most people produce more gas after meals and less while sleeping. Previous pregnancy, surgery, and general ageing may result in changes in pelvic muscle activity, which control the process of holding and passing gas.



A study of 60 men and 60 women found that the average number of passing flatus per day was seven for women and 12 for men, ranging from 3–40 depending largely on the amount of dietary fibre and resistant starch consumed.¹¹

Some people pass small volumes of gas more often, while others pass larger volumes less often. The sensitivity of the walls of the rectum will influence the pattern. The volume and aroma of the gas passed is of no diagnostic significance, except in cases of ulcerative colitis where a flare in the disease is often preceded by the passage of aromatic flatus.

Treatment involves dietary assessment aiming to reduce fibre, resistant starch and sulphur, the latter usually found in preservatives.

Key points

- Symptoms of intestinal gas are greatly affected by food, particularly high fibre foods, and medications that impact on gastrointestinal motility.
- Oesophagitis needs to be confirmed endoscopically.
- Gastroparesis is diagnosed with a gastric emptying study to exclude gastric outlet obstruction.
- Specific causes of bloating include coeliac disease and wheat sensitivity in patients without coeliac disease.
- Distribution of bloating to the upper and mid abdomen makes constipation less likely.
- Medications and diet modification play a key role in the management of bloating, particularly in terms of fibre, resistant starch and fat intake.
- Previous pregnancy, surgery and ageing may result in changes in pelvic muscle activity, which control the process of holding and passing gas.

Author

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