REVIEW ARTICLE

Intestinal Gas - Its Syndromes

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Introduction

Not only the ancient man was tormented by the whirlwinds in his bowel but even today belching, bloating and flatulence remain all too common to the modern man. Although the syndromes related to intestinal gas were recognised since time of Hippocrates, the treatment of these syndromes had been far from satisfactory (1). The advent of space exploration, and with it the recognition, that gaseous distention of the intestinal tract is a troublesome problem for those who venture into the outer space, aroused scientific interest in gastrointestinal gas. Bloating and excessive flatulence are one of the commonest gastrointestinal symptoms with which a patient presents to a physician. We, in the present article, will review the genesis of and the problems related to gastrointestinal gases.

Physiology of gastrointestinal gas

There is a regular turnover of gas in the gastrointestinal tract in normal human adults, and it moves within the lumen of the stomach and then to both small and large intestines. The volume of gas has been measured using a body plethysemograph or a rapid intestinal infusion of argon to wash out the bowel gases(2,3). The normal small and large bowel usually contain less than 200 ml of gas, both in the fasting state and after a meal (4-6). Even in those patients complaining of abdominal distension due to excessive gas, the volume of intestinal gas is similar to those observed without symptom (4-7)

Composition of bowel gas

Approximately 99% of the gas present in the gastrointestinal tract of normal adults is composed of 5 gases, nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), hydrogen (H_2) and methane (CH_4) Table 1 (5-9). Present as well, but in trace amounts are other gases and substances that are odoriferous and probably responsible for unpleasant odor imparted by flatus.

Table 1

Composition of Bowel Gas

Gas	Stomach %	Intestine %	Flatus %
Nitrogen	79	23-80	11-92
Oxygen	17	0.1-2.3	0-11
Carbon dioxide	4	5.1-29	3-54
Hydrogen	–	0.06-47	0-69
Methane	–	0-26	0-56

Genesis of gastrointestinal gas

Of the 5 principal gases found in the gastrointestinal tract, only nitrogen and oxygen are derived from atmospheric air swallowing. They may also gain entrance in the bowel through charged beverages, aerated drinks and food that contains air (e. g. an apple contains 20%

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gas by volume). On the other hand carbon dioxide, hydrogen and methane are produced predominantly by intraluminal metabolism. Some of the intraluminal air also diffuses from blood (5,6,8).

Disposition of bowel gas

The intestinal gas escapes or is removed from the gastrointestinal tract by (a) expulsion by belching or passage of flatus from rectum ; (b) consumption by intestinal bacteria ; and (c) diffusion into blood, transportation to lungs and finally excretion in the expired air.

Clinical significance of bowel gas

Although bowel gas is inert, however, it can lead to number of clinical syndromes, which are described below.

BELCHING

Belching (eructation) is a normal event that is experienced by everyone at sometime, especially after a large meal or after a meal eaten rapidly. The act becomes abnormal when its frequency exceeds that experienced by an average healthy person. There is no quantitative definition to differentiate between a natural, infrequent (benign) belching and repetitive, exorbitant (malignant) belching. It is upto the clinician to decide about the kind of belching the patient is suffering from depending upon the severity of symptoms and subsequent line of the management (5,6).

In the patients with repetitive belching, *aerophagia* (swallowing of air) almost invariably plays a vital role. If such a patient is watched closely, it is noted that each act of eructation is proceeded often surreptitiously by aspiration and air swallowing. If such a patient is observed fluoroscopically, during the act of belching, it is noted that air is swallowed immediately before each belch.

Swallowing of atmospheric air is a common occuring, however, aerophagia becomes more prominent in patients with malignant belching. One can swallow air through other ways also, such as :

swallowing of liquids or solid foods rapidly ;

talking while eating ;

sucking of an object such as cigarette, cigar or pipe ;

sipping of liquid through a straw ;

chewing gum or sucking a candy ;

impaired swallowing, such as that arising from bulbar or pseudobulbar palsy ; and

ingestion of gas containing liquids or solids in large.

Pathophysiology of belching

In normal belching, the intragastric gas refluxes into the esophagus during transient relaxations of the lower esophageal sphincter. The refluxed gas causes an abrupt rise in intra-esophageal pressure which in turn triggers upper esophageal relaxation thus the intraesophageal air is expelled out by an act of eructation. If the air is not eructated, then through secondary peristaltic activity in the esophagus, it returns back in the stomach. The sequence of events that transpire when belching is induced purposely differs from that occuring naturally. In such belching, the initial change is slow relaxation of the upper esophageal sphincter (UES) followed by contraction of the abdominal muscles. This produces an abrupt rise in intra-abdominal pressure and also in the esophagus, which propels gas upward through the relaxed UES (10-11).

The natural act of belching is impeded when an individual is in supine position. In supine position,

intragastric gas rises above the posteriosuperiorly situated esophagogastric junction while the heavier intragastric fluid settles at the level of the origin and thus tends to occlude the lumen (10-11).

Chronic eructation is almost always a "functional" disorder. A telltale characteristic of the individual moved to seek medical advice for chronic repetitive belching is uninhibited public display of the act. They might proffer an apology in the presence of others, but uninhibited repetitive belching is the rule.

Most of the swallowed air manages to be expelled out, however, some of it enters from the stomach into the duodenum, subsequently it may be propelled with amazing speed through the gut and reach as far as colon. The splenic flexures, the highest segment of the colon, may become distended as the gas rises to fill it. This may induce abdominal discomfort – *splenic flexure syndrome* (5,6).

Treatment

The hallmark of treatment of belching is to make the patient understand the genesis of belching and then urging the patient to attempt to repress aerophagia. Sometimes excessive acrophagia-belching leads to anxiety of having a serious disease, which in turn exacerbate aerophagia, thus forming a vicious cycle. Anxiolytics and mild tranquillizers may be of some benefit in these patients. A variety of manouveres have been recommended in order to reduce air entry into the gastrointestinal tract. Patients should be instructed to chew food thoroughly, to eat slowly ; to avoid aerated drinks; to avoid talking during meals and to avoid also the acts which aggravate aerophagia such as gum chewing, sucking of cigar, and excessive smoking. Clenching a pencil between the teeth during periods of anxiety prevents air swallowing. Large meals should be avoided and in turn small and frequent meals are recommended (5-6).

Drugs have if at all little role to play in the management of repetitive belching. Agents that act to coalesce small bubbles of gas, such as simethicone, are of dubious value.

ABDOMINAL DISTENSION AND BLOATING

Abdominal distension and bloating especially after meals is also a common gastrointestinal symptom. and this distension is mostly attributed to 'too much gas'. Lacking objective measurements of intestinal gas volumes, physicians have accepted their patient's conviction that excessive intestinal gas is the cause of these symptoms. Contrary to the belief, a recent study using computed tomography scanning found no evidence of increased intestinal gas volume in patients complaining of abdominal distension(12). Similarly, measurements with the gas wash out techniques showed a mean intestinal gas volume of 176 ml in 18 patients with symptoms of abdominal distension due to excessive gas in comparison to 199 ml of gas volume in ten control subjects (7). The composition of intestinal gas was also similar in the gaseous patients and control subjects. Thus there is no evidence that excessive bowel gas is the primary cause of bloating and abdominal distension. It has been observed that intestinal infusion of gas caused much more discomfort in bloating subjects than in control and these subjects have been shown to have an enhanced pain response to balloon- induced bowel distension (13). Thus the basic problem underlying complaints of bloating and distension appears to be an unusual sensitivity to bowel distension.

Treatment

The initial and essential step is to convince the patient that the complaints, contrary to his or her belief, arise

neither from excessive amount of digestive tract gas nor any structural lesion. This task is often difficult. The treatment should focus on the disturbed intestinal motility and also change in dietary pattern. Antispasmodics and anticholinergics have not been found to be effective. In blinded controlled trials, prokinetic agents cisapride, domperidone and metoclopramide produced a significant reduction in complaints of distension when compared with placebo (14). There is no definitive evidence regarding the efficacy of activated charcoal in reducing symptoms related with abdominal gas. Some studies show a dramatic reduction, and other studies have shown that charcoal was ineffective (15,16).

Ingestion of beans and other gas forming foods should be reduced. Lactose restriction, substitution of yogurt for milk and ingestion of oral lactase enzyme may benefit patients with lactase enzyme deficiency. Excessive use of fiber in the diet should be avoided. If there is evidence of anxiety and depression, appropriate anxiolytics and antidepressants are to be added.

EXCESSIVE FLATUS

Expulsion of gas from the rectum similar to belching is a normal event. Excessive passage of gas per anus may be a source of social embarrassment. It may also cause the patient to suspect the existence of a serious digestive derangement. A major problem in treating the complaint of flatulence is the determination of whether the patient actually passes excessive gas or is unusually sensitive to the passage of normal volume of gas. Although not very precise, the frequency of gas passage may be used as a crude indicator of normality, one study suggested that more than 20 passages per day is abnormal (4).

Of the several sources of colonic gas, bacterial fermentation of incompletely digested and absorbed food residues and to a much lesser degree, swallowed air are the chief contributors. Gas chromatographic analysis of a gas sample collected via the rectal tube can rapidly differentiate air swallowing from intraluminal production as a source of gas (4-6). Out of 5 main gases, most patients having excessive flatus hydrogen, oxygen and methane are the main components and represent intraluminal production (4-6). None of the quantitatively important gases has an odor, and the smell of feces is attributable to gases present in trace quantities. Although indole and skatol were implicated in early studies, a carefully performed study showed that sulfer containing compounds such as hydrogen sulfide is responsible for noxious odor (5,6).

In most patients with complaints of excessive flatus, the heightened gas formation is traceable to the ingestion of greater than threshold quantities of lactose containing foods when there is lactase deficiency, or foods containing certain oligosaccharides (beans, cruciferous vegetables) which are poorly digestible and are flatugenic. There is a relative deficiency of enzyme 1,6-galactosidase (breaks down oligosaccharides) in human, thus these oligosaccharides are not digested and form a substrate for fermentation by colonic bacteria. Diseases of the small intestine that affect digestion and absorption (celiac disease, tropical sprue, giardiasis, pseudoobstruction, bacterial overgrowth) also give rise to excessive gas formation by colonic fermentation of undigested food. Still there are some patients, who do not have obvious digestive abnormality nor abnormal diet, who produce large volume of gases. The cause of excessive flatus in these patients is probably the imbalance between gas forming and gas consuming bacterial flora in the colon. Examination of such patient presenting with complaints of excessive flatus is mostly normal except for tympanitic abdomen, and palpable and audible borborygmi.

While approaching a patient with excessive flatulence, an inquiry regarding number of passages of flatus should be made. A daily passages of gas less than 25 is supposed to be normal and nothing needs to be done. More than 25 passages of gas per day, flatulence of recent onset and association with abdominal discomfort, impaired appetite and weight loss mandate a proper evaluation. It is wise to examine stool microscopically for undigested food, ova and cysts of parasites (especially, Giardia lamblia). Upper gastrointestinal endoscopy, barium studies and malabsorption tests including d-xylose excretion, fecal fat estimation, and jejunal histology are important to exclude any structural disease.

Flatulence, although unpleasant and socially distasteful, is not dangerous or life threatening in itself. However, the presence of combustible hydrogen and methane in colonic gas may lead to explosion if the gas is sparked, as during an electrosurgical procedure (surgical, endoscopic) performed on the lower bowel (5,6). Mannitol not being digested in the gut is fermented by colonic flora producing large volumes of hydrogen. Thus colonic purging by mannitol should be avoided prior to surgical or endoscopic procedures, where there is likelihood of use of electrosurgical devices.

Treatment

If organic digestive diseases are the cause of flatulence, specific treatment of these disorders abates flatulence. In other patients without a discernable digestive tract disease, the most important treatment of flatulence is dietary modification. Food items have various flatugenic potential (Table 2). Milk and milk products are most common offenders because of relative deficiency of lactase enzyme in the brush borders of the intestinal villi of persons older than 5 years of age. Beans and most cruciferous vegetables (cabbages), because they produce large volume of gases should be avoided. Avoidance of flatugenic food reduces excessive flatulence. Unfortunately truly effective results may require an intolerable starvation type diet. Therefore therapeutic programme should be designed in such a way to expect co-operation from the patient.

Table 2

Classification of food according to their flatugenic potential

Normoflatugenic foods (produce 10 or less passages of gas per 24 h)
Meat, fish
Vegetables – lettuce, cucumber, peppers, cauliflower, tomato, olives
Fruits – grapes, berries
Carbohydrates – rice, corn, potato
All nuts
Others – egg, chocholate
Moderately flatugenic foods (20 to 40 passages of gas per 24 h)
Pastries, citrus fruits, bread
Extremely flatugenic (> 40 passages of gas per 24 h)
Milk, milk products
Onions, carrots
Beans, bananas
Wheat germ

Simethicone is a defoaming agent that by changing their surface tension, enables small gas bubbles to coalesce and be passed more easily. This drug is effective in reducing belching, however experience with its use to treat excessive flatus has been disappointing (15-18). Activated charcoal because of its absorbent property has been tried in patients with gaseous syndromes. The evidences of usefulness of activated charcoal in patients with flatulence is inconclusive. Some studies found it effective, whereas others did not (15-18). However,

harmlessness and theoretic potential of activated charcoal might justify its clinical use. There are no convincing evidence for therapeutic usefulness of pancreatic enzymes, anticholinergics or antibiotics.

In those patients where excessive aerophagia is the cause of excessive flatulence, measures to reduce aerophagia should be instituted (described earlier).

Conclusion

Inspite of common occurrence of gas related syndromes, *eructations, flatulence* and *bloating* did not generate much scientific interest and their treatment more or less has been emperical and thus unsatisfactory. In recent time, although our knowledge of the pathophysiology of these syndromes has broadened considerably, however, therapeutic armamentarium remains limited. It is essential to be sympathetic and compassionate towards patients who are burdened with these otherwise non-fatal disorders.

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