

# Review article: abdominal bloating and distension in functional gastrointestinal disorders – epidemiology and exploration of possible mechanisms

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## SUMMARY

### Background

A sensation of abdominal bloating, sometimes accompanied by an increase in girth (distension), is one of the most common and most intrusive features of functional bowel disorders.

### Aim

To conduct a systematic, evidence-based review of the epidemiology and pathophysiology of abdominal bloating and its relationship to distension.

### Methods

The terms bloating, distension, functional bowel, irritable bowel syndrome, constipation and diarrhoea were searched on MEDLINE up to 2006. References from selected articles and relevant abstracts were also included.

### Results

Approximately 50% of irritable bowel syndrome patients with bloating also experience an increase in abdominal girth and this is more pronounced with constipation than diarrhoea. Bloating appears to be more frequently associated with visceral hypersensitivity, whereas distension is more often related to hyposensitivity and delayed transit. Although there is little evidence for excessive gas as a cause of bloating, gas infusion studies suggest that handling of gas may be impaired in irritable bowel syndrome and there may also be abnormal relaxation of the anterior abdominal musculature in these patients.

### Conclusions

There is unlikely to be a single cause for bloating and distension, which probably have different, but overlapping, pathophysiological mechanisms. Relieving constipation might help distension, but the treatment of bloating may need more complex approaches involving sensory modulation.

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## INTRODUCTION

Abdominal bloating and distension occur extremely commonly in the functional gastrointestinal disorders with many patients ranking them as particularly intrusive symptoms. Characteristically, the problem is exacerbated by meals, fluctuates in intensity, is worse at the end of the day and settles overnight. When these symptoms follow this pattern, they are almost pathognomonic of a functional gastrointestinal disorder and it is somewhat surprising that their diagnostic utility has not been harnessed more often. This is in part because these features do not appear to be so common in men, but to some extent, this is because men describe the problem differently often referring to it as a 'hardness' or 'tightness' of the abdomen. Probably the best way to view these features is that when they are present, they make the possibility of a functional bowel disorder almost certain but when absent, they don't exclude the diagnosis.

Until recently, research into bloating and distension has been sparse and largely empirical as well as being based on the assumption that the two descriptors were describing the same phenomenon. Thus, interpreting the data from older studies is difficult and even today, patients and their physicians often use the terms synonymously. However, with the development of more objective ways of assessing it such as the gas challenge technique<sup>1, 2</sup> or abdominal inductance plethysmography (AIP),<sup>3, 4</sup> there is increasing evidence that bloating and distension may have different pathophysiological mechanisms.

## EPIDEMIOLOGY AND CLINICAL FEATURES OF BLOATING/DISTENSION IN THE HEALTHY POPULATION AND IRRITABLE BOWEL SYNDROME

Population based studies have estimated that the prevalence of bloating varies between approximately 16% and 30%<sup>5-7</sup> and this is similar to that observed in non-western populations such as Mexico and Vietnam.<sup>8, 9</sup> A householder survey published from the USA that included 2510 subjects suggested that 16% suffered with this symptom when the ROME II definition of bloating was applied.<sup>6</sup> Furthermore, 43% had taken medication for this symptom and 16% had sought medical advice with more than a quarter reporting a significant reduction in daily activity because of the problem. This latter observation suggests that it may

therefore be wrong to conclude that bloating is relatively common in truly healthy individuals.

In irritable bowel syndrome (IBS), up to 90% of patients report that they suffer from bloating with apparent differences in terms of gender, bowel habit and symptom severity.<sup>10</sup> It appears to be more common in women<sup>10-12</sup> with a reported female to male ratio of 2:1, but this may be because men describe the symptom differently.

Irritable bowel syndrome patients can present with diarrhoea (IBS-D), constipation (IBS-C) or they may fluctuate between the two subtypes (IBS-M).<sup>13</sup> In studies which have assessed bloating in patients with IBS-C and IBS-D, it has been shown to have a higher prevalence in those with IBS-C compared to IBS-D. For instance, in 714 patients satisfying ROME II criteria, compared with IBS-D, IBS-C patients had significantly more upper and lower abdominal bloating, which also had a higher severity rating.<sup>14</sup> This trend was confirmed in another study where the prevalence of bloating in IBS-C was reported to be 75% compared with 40.9% in IBS-D.<sup>15</sup>

It has been estimated that patients with IBS suffer from bloating approximately 28% of the time, whereas the pain experience is somewhat higher at about 33%.<sup>16</sup> However, in contrast, nearly two thirds of patients seen in tertiary care centres rate bloating as their most severe symptom, compared with only one third who feel that pain is their worst symptom.<sup>17</sup> In the more severe cases, patients often have to loosen their clothes and it is not uncommon for women to liken their appearance to that of pregnancy. The common clinical characteristics of bloating in IBS have been assessed and are listed in Table 1.<sup>18</sup>

Although healthy women may report changes in bowel function at the time of menstruation, this effect is far more pronounced in women with IBS with approximately 40-75% claiming that bowel habit and bloating are exacerbated perimenstrually.<sup>10, 19, 20</sup> This might initially suggest that bloating may be strongly influenced by hormonal status although it should be noted that it can occur at any time during the menstrual cycle and is also equally prevalent in postmenopausal females.

The role of psychological factors in the pathogenesis of bloating is somewhat controversial. It was originally thought that this symptom was an entirely self-induced problem resulting from the patient intentionally protruding their abdomen as a result of increasing their lumbar lordosis and pushing down their

**Table 1.** Clinical features of abdominal bloating and distension in irritable bowel syndrome (IBS) patients<sup>18</sup>

Clinical characteristic	Frequency (%)
Abdomen flat in the morning	69
Worse in evening	73
Improves overnight	80
Better lying down	67
Worse with eating	82
Worse with stress	34
Not related to defecation or flatus	82
More than once a week	86
Rapid onset <10 min	61

diaphragm.<sup>21</sup> This hypothesis has been disproved by CT scanning<sup>18</sup> and although some studies report a relationship between psychopathology and bloating,<sup>5, 10</sup> this has not been confirmed by others.<sup>22, 23</sup> Certainly, the patients themselves do not seem to relate bloating to stress frequently.<sup>18</sup>

Although obesity is an established risk factor for some gastrointestinal conditions such as gastro-oesophageal reflux disease and dyspepsia, it might be anticipated that it could mask the symptom of bloating. However, even overweight individuals experience this problem and there have been studies examining this issue. In a questionnaire investigation undertaken in the USA of subjects with a BMI > 30 kg/m<sup>2</sup> obesity was significantly associated with bloating ( $P < 0.002$ )<sup>24</sup> and this was confirmed by another group who looked at an Australian cohort. In this latter study, obesity (BMI > 30 kg/m<sup>2</sup>) was associated with bloating even after adjustment for age, gender, education, alcohol consumption and smoking status [OR 1.32 (1.07, 1.63),  $P = 0.009$ ].<sup>25</sup>

### BLOATING AND DISTENSION: ARE THEY ONE AND THE SAME?

In the past, it was always considered that the terms bloating and distension both describe the same phenomenon. However, more recently, it has become apparent that not all individuals who feel bloated necessarily exhibit an increase in abdominal girth. This has led to the proposal that the term bloating should be used to describe the sensation of increased abdominal pressure and the descriptor distension should only be used when there is an actual change in abdominal circumference.

It is common for patients to claim that either bloating or distension appears to get worse during the course of the day and this was originally confirmed with tape measure studies<sup>19</sup> and subsequently with tape measures combined with CT scanning.<sup>18</sup> Tape measure studies could be subject to bias and have the major disadvantage that they cannot be used in an ambulatory fashion to record girth over long periods of time during which the subject is unable to pursue normal activities. To overcome this problem, we have recently devised and validated a technique called ambulatory AIP, which allows unobtrusive, accurate, automated and ambulatory measurement of abdominal girth over relatively prolonged periods of time, e.g. 24 h or more. The device works on the principle that a loop of wire forms an inductor, the inductance of which is dependent on the cross-sectional area of the loop.<sup>3, 4, 26, 27</sup> The wire is stitched into a soft belt (Figure 1) and consequently changes shape with any



**Figure 1.** Ambulatory abdominal inductance plethysmography (AIP) equipment *in situ*.<sup>3, 4</sup> TS, Tilt switch; DL, Data Logger.

change in abdominal girth. This results in a change in inductance, which can then be converted to a measurement accurate to 1 mm.

More recent work using AIP has suggested that although there is an overall correlation between the symptom of bloating with change in girth (distension) in IBS, more IBS-C patients (72%) show this correlation ( $r > 0.5$ ,  $P < 0.05$ ) than IBS-D patients (30%).<sup>27</sup>

Several other studies also suggest that there are distinct differences between the subjective perception of bloating and objective abdominal distension in patients with IBS. Experiments based on jejunal gas perfusion have revealed that although this leads to an increase in abdominal girth, it is associated with a sensation of bloating and pain when the gut is contracted, whereas it is well tolerated when the gut is relaxed.<sup>1</sup> In addition, jejunal but not rectal gas infusions induce abdominal symptoms despite a similar increase in abdominal girth.<sup>2</sup> Colonic lactulose fermentation induces bloating and abdominal distension, but the time of the maximum increase in abdominal girth does not correlate with the time of peak bloating, and the magnitude of the increase in abdominal girth does not correlate with the concomitant bloating score.<sup>28</sup> Finally, our own work suggests that based on the 90% reference range for healthy volunteers, only half of all IBS patients who suffer from bloating have associated distension.<sup>27</sup>

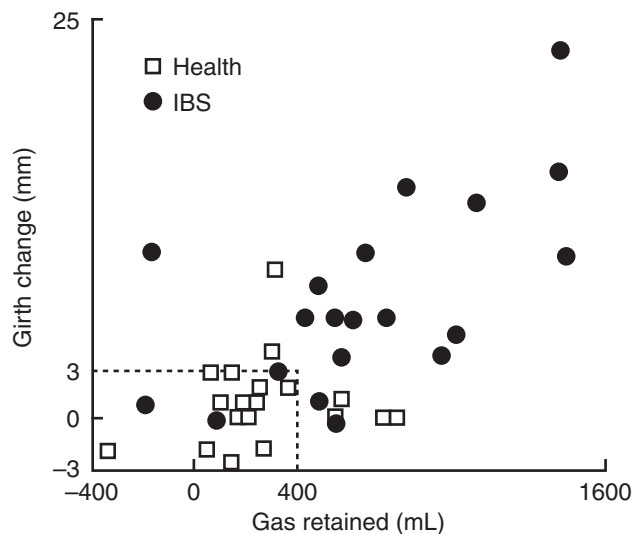
## PATHOPHYSIOLOGY: PUTATIVE MECHANISMS

### The role of gas in bloating and distension

**Gas excess.** There has been much debate as to whether IBS patients produce excessive quantities of gas, which might account for their symptom of bloating. The various techniques that have been used to measure intestinal gas content in IBS patients have included washout techniques, radiography and breath tests. In an investigation using an Argon washout technique, Lasser *et al.* showed that the overall gas content of the gut appeared to be no different between a group of IBS subjects and healthy controls.<sup>29</sup> Using 0.5% sulphurhexafluoride in a similar experimental paradigm, the Barcelona group came to the same conclusion.<sup>1</sup> Radiological

evaluation of intestinal gas, using plain radiography<sup>30, 31</sup> and CT volumetry<sup>18</sup> undertaken on patients with and without IBS, has shown somewhat inconsistent results with some studies suggesting higher gas concentration in IBS patients, whereas others did not find any differences. However, the methodology in these patients may not lead to comparable results and even when the overall presence of gas was greater in IBS patients, this did not correlate with the symptom of bloating. In addition, earlier studies by Levitt *et al.* showed that supplementing the diet with lactulose, psyllium and methylcellulose all lead to a sensation of bloating, although only lactulose resulted in excessive gas production suggesting that bloating may be unrelated to gas production.<sup>32</sup> Furthermore, the infusion of a large volume of a physiological mixture of gases in the jejunum results in an increase in abdominal girth of less than 2 cm., whereas studies using AIP suggest that at least half of all IBS patients demonstrate a change in girth of 6 cm or more.<sup>3, 4, 27</sup> Thus, it seems reasonable to assume that although excessive gas production can occasionally cause the symptom of bloating, it is unlikely to account for this symptom in the majority of patients with IBS.

**Gas handling.** The Barcelona group has undertaken a series of elegant studies, which have helped our understanding of how gas might cause symptoms in IBS. They have suggested that while gas volumes may be normal in these patients, the intestinal handling of gas by these individuals is abnormal. In studies involving gas infusion in the jejunum in fasting healthy volunteers and IBS patients, Serra *et al.*<sup>1</sup> found that, whereas 18 of 20 IBS patients retained gas, had distension, or developed abdominal symptoms, 16 of 20 healthy volunteers failed to do so (Figure 2). These changes could be enhanced by enteral infusion of lipid, providing one possible mechanism of postprandial bloating.<sup>33, 34</sup> Another study by the same investigators suggested that the physical component of a meal (simulated by an intragastric balloon) may induce bloating, but the chemical component (simulated with an enteral lipid infusion) causes distension.<sup>35</sup> This idea was also supported by another study showing that bloating could be induced by voluntary inhibition of gas passage, while gut relaxation (induced using glucagon) caused asymptomatic distension.<sup>36</sup>



**Figure 2.** Change in abdominal girth following infusion of a physiological gas mixture (Nitrogen, Oxygen and CO<sub>2</sub>) in irritable bowel syndrome (IBS) patients and healthy volunteers. Note IBS patients retained significantly more gas compared with healthy volunteers with higher symptom score of pain and bloating.<sup>1</sup>

## Other mechanisms

**Sensory dysfunction.** It is well recognized that a large proportion of patients with IBS exhibit visceral hypersensitivity<sup>37, 38</sup> and it is tempting to speculate that this process might be involved in the sensation of bloating. Visceral hypersensitivity can be demonstrated throughout the gastrointestinal tract in patients with IBS<sup>39</sup> and can even occur in some patients with functional dyspepsia,<sup>40</sup> a condition which is frequently accompanied by bloating. It has also been suggested in the past that there is heightened visceral sensation premenstrually in women with IBS and this in turn is associated with increased bloating but not distension.<sup>41, 42</sup> We have recently investigated the role of visceral sensation in the pathogenesis of bloating and distension with the aid of AIP.<sup>43</sup> Patients exhibiting visceral hyposensitivity were much more likely to exhibit distension, whereas those with visceral hypersensitivity experienced bloating without necessarily experiencing distension.

**Motor dysfunction.** The motility of the gut involves the phenomena of myoelectrical activity, contractility, tone, compliance and transit. A whole variety of

motility patterns have been described in patients with IBS but none has been sufficiently consistent to be of any diagnostic utility in the condition.<sup>44</sup> It is, therefore, not surprising the search for an association between bloating or distension and any particular motility pattern has been far from conclusive with studies investigating the role of tone, compliance, small and large intestinal phasic activity not giving any clear cut answers.<sup>43, 45, 46</sup> The relationship between transit and bloating is also uncertain, as bloating is seen in both patients with IBS-D and IBS-C, conditions arguably associated with rapid and slow transit respectively. Studies which have assessed transit and bloating have shown conflicting results with a study by Cann *et al.* suggesting an association between delayed transit and bloating<sup>47</sup> whereas in another study by Hebden *et al.*, the authors demonstrated that accelerated ileo-caecal transit was associated with bloating.<sup>48</sup> In a pharmacological study undertaken in healthy volunteers, bloating was induced by using loperamide, an agent known to slow transit and it was even suggested that this approach could be an experimental model for IBS.<sup>49</sup> Using AIP, we have recently assessed the role of transit in abdominal distension rather than bloating and our study showed that a delayed colonic transit does correlate with abdominal distension in IBS-C patients.<sup>50</sup>

**Abnormal anterior wall muscular activity.** It seems reasonable to assume that there is likely to be some form of innate reflex of the anterior abdominal musculature to accommodate normal events such as the ingestion of a meal or the development of a pregnant uterus as well as maintaining appropriate anterior abdominal tone when standing or sitting. Consequently, it is possible that such a reflex might be disordered or exaggerated in patients suffering from abdominal distension in particular. This question has been addressed using EMG in two studies the first of which did not find any difference between patients and controls in relation to activity in response to lying, standing or producing voluntary contractions of the abdominal wall.<sup>51</sup> In a more recent study, the Barcelona group tried to mimic what might be happening in the patients by infusing gas into the rectum and colon. Compared to controls this resulted in a failed contraction of the abdominal wall accompanied by a paradoxical relaxation of the internal oblique.<sup>52</sup> More data in favour of abdominal wall dysfunction come from a very old study where anterior abdominal muscle

weakness was detected by the inability of IBS patients to complete 'sit ups' as effectively as controls.<sup>19</sup>

*Carbohydrate intolerance and altered gut flora.* Intolerance to lactose, fructose and sorbitol are relatively common in patients with IBS but this is no more than in the general population.<sup>53</sup> However, excluding this from the diet is somewhat beneficial in patients in whom the bloating or distension is particularly troublesome. However, bloating is equally common in IBS subjects without carbohydrate intolerance and is therefore probably only contributing in a small subgroup of individuals.

Evidence for the role of bacterial flora in the clinical presentation of IBS and bloating is based on several observations. First, there are some preliminary data suggesting altered colonic bacterial flora in stool samples from patients with IBS compared with controls.<sup>54, 55</sup> Second, there are increasing number of reports of the potential benefit of treating IBS with probiotics such as bifidobacteria and lactobacilli<sup>56, 57</sup> and even antibiotics have been recommended as a treatment for bloating.<sup>58, 59</sup> Third, there are the studies from Lin's group reporting small-bowel bacterial overgrowth in some patients with IBS and bloating.<sup>60, 61</sup> In particular, there is interest in the potential role of methanogenic bacteria, which may slow gastrointestinal transit and could therefore potentially result in bloating or distension.<sup>62</sup> However, the data on small bowel bacterial overgrowth in IBS patients are not consistent, although they probably account for symptoms in a subgroup of patients.<sup>63</sup>

## DIFFERENTIAL DIAGNOSIS

In most cases, the diagnosis of bloating associated with a functional gastrointestinal disorder is not a major problem particularly if it fluctuates, is exacerbated by meals and follows a diurnal pattern. In more extreme cases, possible alternatives such as ascites or an ovarian tumour need to be considered and appropriately investigated, especially if there is no variation in the extent of the problem or if it is progressive. The possibility of intermittent small bowel obstruction may occasionally have to be entertained but the history usually suggests this diagnosis. On examination, there are no specific abnormalities but it is worth bearing in mind that large ventral hernias can give the appearance of distension.

## MANAGEMENT

Most patients with IBS recognize that eating makes their symptoms worse and the symptom of bloating is no exception to this rule. There is no doubt that a high fibre diet can make bloating worse<sup>64</sup> and limiting fibre intake is very effective in secondary care although not quite so rewarding in the primary care setting.<sup>64, 65</sup> Other measures worth trying are limiting fat intake, avoiding carbonated drinks, and taking care with sugar substitutes. The pharmacological management of bloating is very limited with preparations such as simethicone and charcoal often recommended with little evidence of efficacy.<sup>66, 67</sup> There is little evidence that antispasmodics are of any use but constipation is well worth treating with laxatives, especially as distension has been shown to correlate with this particular symptom.<sup>50</sup> However, lactulose should be avoided, as this nearly always exacerbates bloating. Probiotics are also worth trying as, although their effects in trials have been rather variable, bloating is a symptom that seems to be improved by these agents in some of the studies. Neomycin and more recently Rifaximin have been reported to be effective in reducing the symptoms of IBS including bloating.<sup>58, 68</sup> Although Rifaximin is not yet available in the UK, it is being used increasingly to treat IBS in the USA. This could be considered as somewhat premature in a condition where treatment often needs to be long-term. Before more widespread use of such antibiotics can be advocated, we need to know how long these agents should be given for, if repeated courses will be necessary and whether drug resistance will become a problem.

In 2002, the Barcelona group demonstrated that neostigmine could reverse gas retention following a gas challenge test.<sup>69</sup> This observation, coupled with the fact that constipation correlates with distension, suggests that the use of a prokinetic agent may have utility in reducing the symptom of bloating. The 5-HT<sub>4</sub> receptor partial agonist tegaserod has prokinetic activity and it is therefore of interest that it has been shown to reduce bloating consistently in a number of trials<sup>70-72</sup> and pooled data from a number of studies has confirmed this observation.<sup>73</sup> Thus pharmacologically improving transit either with a prokinetic or possibly with a laxative seems a logical way of trying to improve the problem.

## CONCLUSION

There is a growing body of evidence that bloating and distension are subtly different from each other and that a variety of probably overlapping mechanisms are involved in their pathogenesis. Sensory mechanisms appear to be more important in bloating and thus this symptom may be eased by drugs affecting this modality. It would therefore be of interest to assess whether something like a tricyclic antidepressant might be helpful as their specific effect on bloating or distension was not previously assessed. In contrast, distension seems to have a more mechanical basis suggesting that laxatives

and prokinetics should be helpful. However, it is likely that many patients will require a much more complex management strategy combining dietary, pharmacological, bacteriological and even behavioural approaches.

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