# Treatment of supragastric belching with cognitive behavioral therapy improves quality of life and reduces acid gastroesophageal reflux

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OBJECTIVES: **Excessive supragastric belching (SGB) manifests as troublesome belching, and can be associated with reflux and significant impact on quality of life (QOL). In some GERD patients, SGB-associated reflux contributes to up to 1/3 of the total esophageal acid exposure. We hypothesized that a cognitive-behavioral intervention (CBT) might reduce SGB, improve QOL, and reduce acid gastroesophageal reflux (GOR). We aimed to assess the effectiveness of CBT in patients with pathological SGB.**

METHODS: **Patients with SGB were recruited at the Royal London Hospital. Patients attended CBT sessions focused on recognition of warning signals and preventative exercises. Objective outcomes were the number of SGBs, esophageal acid exposure time (AET), and proportion of AET related to SGBs. Subjective evaluation was by patient-reported questionnaires.**

RESULTS: **Of 51 patients who started treatment, 39 completed the protocol, of whom 31 had a follow-up MII-pH study. The mean number of SGBs decreased significantly after CBT (before: 116 (47–323) vs. after 45 (22–139), *P*<0.0003). Sixteen of 31 patients were shown to have a reduction in SGB by >50%. In patients with increased AET at baseline, AET after CBT was decreased: 9.0–6.1% (*P*=0.005). Mean visual analog scale severity scores decreased after CBT (before: 260 (210–320) mm vs. after: 140 (80–210) mm, *P*<0.0001).**

CONCLUSIONS: **Cognitive behavioral therapy reduced the number of SGB and improved social and daily activities. Careful analysis of MII-pH allows identification of a subgroup of GERD patients with acid reflux predominantly driven by SGB. In these patients, CBT can reduce esophageal acid exposure.**

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## INTRODUCTION

Excessive belching is a frequently reported symptom in patients with dyspepsia, gastro-esophageal reflux disease, and other upper gasterointestinal disorders (1,2).

Esophageal impedance monitoring enables clinicians to identify two distinct types of belching: (a) gastric belching, which involves gastric venting of swallowed air via transient relaxation of the lower esophageal sphincter (TLESR), and (b) supragastric belching (SGB), when air enters and leaves the esophagus rapidly without reaching the stomach (3).

Both gastric and SGBs occur in asymptomatic healthy subjects. Whereas increased gastric belching is considered to be a consequence of pathological aerophagia, and/ or incompetent antireflux barrier in reflux disease, increased SGB is considered to be the expression of a distinct behavioral disorder (4,5).

The prevalence of pathological SGB has recently been estimated at 3.4% among a tertiary referral population for investigation of upper gastrointestinal complaints (5).

Patients with pathological SGB can present with excessive belching as a main symptom but can also be associated with heartburn

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and regurgitation, rumination syndrome or globus, and after antireflux surgery (5–7).

Patients with SGB often report reduced social functioning (2). In addition to the psychosocial concerns, SGB can be associated with increased gastroesophageal reflux. A temporal association between SGBs and acid reflux has been identified (5,8). In a recent study, 95% of patients identified as having pathological SGB suffered from typical reflux symptoms. Furthermore, in the subgroup of patients with pathological acid exposure, up to a third of the acid burden was due to acid reflux episodes temporally associated with SGBs (5).

Treatments for pathological SGB include the use of Baclofen alone or in combination with pregabalin (9,10). However, these treatments can be hampered by excessive sedation.

It has been hypothesized that SGB may initially develop as a voluntary response to unpleasant thoracic or epigastric sensations, where the patient performs a SGB to relieve the discomfort (8). However, as the SGB response is performed repeatedly over time it may, according to this hypothesis, gradually become an automatic mechanism, with the individual losing conscious control over the belching response (11). There are some indications that psychological factors may play a role in SGB. These include the absence of SGB during sleep, the reduction in symptoms when the patient is speaking or distracted, and exacerbation during stressful events (11–13).

Encouraging results using cognitive behavioral interventions (CBTs) have been reported to reduce the occurrence of excessive SGB (14–16). Those studies included a small number of patients, have mainly provided subjective measures of outcomes focusing on belching but less information on the effect of treatment on acid gastro-esophageal reflux.

The aim of this study was to assess the effectiveness of a standardized protocol of CBT in patients with pathological SGB, and to investigate whether CBT-induced reduction in SGB can decrease acid gastro esophageal reflux in those with pathological GOR.

## METHODS

### Subjects

Fifty-one consecutive patients with pathological SGB (>13 SGBs per 24 h) were prospectively enrolled in this study. The definition of pathological SGB was based on our previous study showing that normal healthy subjects have a median of 3 (range 0–15) SGBs in 24 h. The 95th percentile value was taken as the upper limit of normal, and was calculated at 13 SGBs per 24 h (5). Eligible patients were identified at the Upper gasterointestinal Physiology Unit of the Royal London Hospital, UK after completion of a 24 MII-pH study performed at least one week off proton pump inhibitors. These patients had been referred to the gasterointestinal Physiology Unit to have high resolution manometry and MII-pH monitoring as part of their clinical or surgical management of esophageal/extra-esophageal reflux symptoms and/or increased belching. If pathological SGB was diagnosed, the patient was offered the possibility to undergo cognitive behavioral therapy provided by our team. Exclusion criteria included non-English speaking patients, a diagnosis of a current major psychiatric disorder, and cognitive or intellectual impairment. The CBT treatment was performed as part of the patient's clinical management.

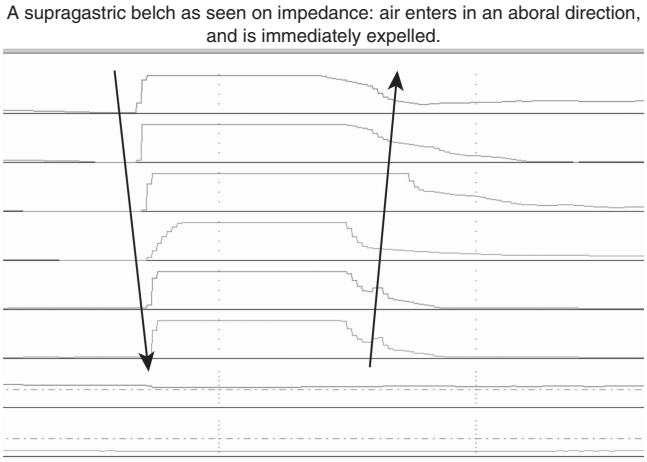


**Figure 1.** Example of supragastric belching in esophageal impedance recording. A rapid increase in impedance occurs when air moves along the esophagus. In this expanded tracing, the air initially moves in the aboral direction (arrow) and is eliminated by straining in the oral direction resulting in a supragastric belch.

### Diagnosis of SGB

We diagnosed SGB using 24 h MII-pH monitoring. A combined MII-pH catheter (Sandhill Scientific, Inc, Highlands Ranch, CO, USA) was placed transnasally such that the esophageal pH probe was situated 5 cm above the lower esophageal sphincter. The catheter also has eight electrode rings enabling impedance recording at six segments from 3 cm to 17 cm above the lower esophageal sphincter. Tracings were manually analyzed for presence of acid/non-acid reflux and SGBs. Meal periods were excluded from analysis. SGBs were identified using criteria described by Bredenoord *et al.* (3) (a rapid rise in impedance (≥1000 Ω) moving in an aboral direction, followed by a return to baseline moving in the opposite direction). Acid/non-acid liquid reflux episodes detected by MII-pH were considered to be associated with SGB if they began within 1 s after a SGB episode (**Figure 1**). The SGB-related percentages of total esophageal acid exposure time (AET) and total number of acid reflux events were calculated for each patient.

### Treatment with cognitive behavioral therapy

***Treatment protocol.*** Patients attended a total of five sessions, including an initial assessment with a gastroenterologist and psychologist, and four sessions of cognitive behavioral therapy. The treatment protocol was adapted from that described by Katzka *et al.* (14).

***Cognitive component.*** The intervention commenced with psychoeducation of SGB to help the patient understand the condition, the onset and triggering events, and the rationale for using the treatment exercises. A functional analysis of the belching

symptoms was discussed with the patient to identify antecedents and consequences to increase the patient's awareness of the factors contributing to or reinforcing the belching. The identification of a 'warning signal' preceding the SGB is considered an important stage to the behavioral treatment of SGB. Patients were asked to identify the physical sensations experienced prior to the belch occurring as a warning signal, with commonly reported sensations of "a feeling of pressure or tension in the foodpipe". The increased awareness of the warning signal allowed the patients to recognize this as a cue for using the treatment exercises to prevent the belch from occurring. Awareness training is a technique widely used in habit reversal training during interventions for behavioral disorders. In addition, the patient's thoughts on the belching were explored to highlight any unhelpful thinking patterns linked to the belching, such as that the SGB is helping to relieve heartburn or release air from the stomach. Patients were coached to use self-talk to challenge these unhelpful thoughts and remind themselves to implement the exercises at the appropriate time.

***Behavioral component.*** The treatment exercises consisted of teaching the patients (1) diaphragmatic breathing, and (2) mouth opening/tongue position to make SGB difficult. Patients were instructed on slow and steady diaphragmatic breathing, inhaling for 3 s and exhaling for 3 s. They were instructed to place both hands on their anterior abdominal wall, and to watch its rise and fall during this process. Patients were then asked to breathe through their mouth with the mouth held moderately open, and if possible placing the tongue behind the top front teeth. Initially this exercise combining the diaphragmatic breathing and mouth position was practised at least twice per day for 3–5 min in a supine or sitting position. Once patients were familiar and confident with the diaphragmatic breathing and the position of the mouth, they were instructed to use the exercises daily as often as possible to prevent belching. This involved recognizing the warning signals identified, and using this signal to immediately start the diaphragmatic breathing and open the mouth, continued until the urge to belch decreased.

### Assessment of treatment and outcomes

***Objective evaluation.*** Objective evaluation of outcomes was based on MII-pH before and after the five CBT sessions (i.e., at 8 weeks). Parameters analyzed were the number of SGBs, number of gastric belches the total AET, number of acid reflux episodes, and the proportion of acid reflux episodes and AET associated with SGBs.

***Subjective evaluation.*** Before CBT treatment, patients completed questionnaires to assess personality traits, hypervigilance, health-related quality of life (QOL) (the SF36 survey) belching symptom severity using a four-item visual analog scale (VAS). After treatment (at 8 weeks), patients repeated the VAS and SF-36.

***Questionnaires.*** *BFI-10:* The BFI-10 is a 10-item version of the Big Five Inventory that assesses personality across the dimensions of extraversion, agreeableness, conscientiousness, neuroticism, and openness (17).

*SSAS:* The Somatosensory Amplification Scale (SSAS), a 10-item questionnaire, assesses hypervigilance to bodily sensations and the tendency to experience normal somatic sensations as uncomfortable or troubling (18). The items are rated on a five-point scale from 1 (Not at all true) to 5 (Extremely true) and ratings are summed to produce a total amplification score that ranges from 10 to 50, (19) with average SSAS scores between 24 and 29; (20) scores higher than 30 may indicate increased somatization (21).

### VAS

A four-item VAS adapted from Hemmink *et al.* (9) was used to measure subjective changes in belching symptom severity throughout the intervention. The VAS questions, rated from 0 (absence of symptoms) to 100 (very severe symptoms), asked patients to rate how bothered they are by their belching, their ability to control belching, the impact of the belching on daily activities, and the impact on social activities. A composite score from 0 (absence of symptoms) to 400 (very severe symptoms) was also reported.

*SF-36:* The Short Form Health Survey (SF-36) assesses eight domains including four physical subscales of physical functioning (daily life limitations due to health problems), bodily pain (pain frequency and interference with normal roles), limitations in fulfilling physical roles (due to physical health problems), general health (individual perception of health), and four psychological subscales of limitations in fulfilling emotional roles (due to emotional problems), vitality (energy/fatigue), social functioning (ill health interference with social activities), and mental health (psychological distress). A scoring algorithm is used to convert the raw scores into the eight dimensions listed above. The scores are transformed to range from zero (where the respondent has the worst possible health) to 100 (where the respondent is in the best possible health). Data from our patients with SGB were compared against normative data from the ONS Omnibus Survey in Britain (22).

### Statistical analysis

Throughout the manuscript data are presented as mean±SEM or SD or median and interquartile range. The number of SGBs and VAS scores pre and post CBT were compared using the Wilcoxon signed rank test.

## RESULTS

### Patients

In total, 51 patients with pathological SGB attended the first CBT explanatory session (51% females, mean age 45, range 20–72). Of these, 12 patients did not complete the CBT protocol (31% female, mean age 44, range 32–54). Reasons being: (a) lack of confidence in the method ($n$=3), (b) traveling difficulties ($n$=5) and (c) preferred other treatments ($n$=4).

39 patients finished the standardized CBT protocol and had full subjective evaluation with VAS and SF-36 questionnaire

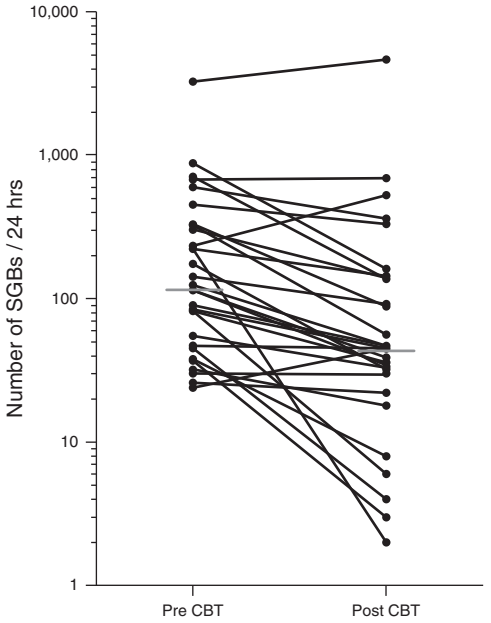


**Figure 2.** Number of supragastric belches (SGBs) before and after cognitive behavioral therapy (CBT) treatment (log 10 scale). Median values shown by horizontal lines.

scores before and after treatment. 31 patients agreed to undergo a second MII-pH monitoring and had both full subjective and objective evaluation before and after treatment. Belching was a problematic symptom in all patients. It was the symptom of primary concern in just over half of the patients (56%), followed by heartburn (23%), regurgitation (21%), and abdominal pain (10%).

### Effect of treatment on objective outcomes

In patients who had MII-pH monitoring before and after CBT treatment, the number of SGBs decreased significantly after CBT therapy from a median of 116 (47–323) episodes to 45 (22–139) ($P$=0.0003) (**Figure 2**). Sixteen of the 31 patients had a reduction in the number of SGBs by more than 50% relative to baseline. (Example tracing, **Figure 3**).

The number of SGB was reduced by 66% (43–91%) in patients with predominant belching ($n$=15) and by 39% (1–78) in patients with predominant reflux symptoms ($n$=16) ($P$=0.09).

At pre-treatment evaluation, the number of gastric belches represented 3.7% (5–12%) of the total number of belches in all patients. CBT treatment slightly increased the number of gastric belches from a median of 6 (1.5–15.5) episodes to 9 (4.25–17) ($P$=0.01).

The total number of acid and non acid reflux episodes was significantly reduced from 71±43 at baseline to 54±39 post CBT ($P$=0.0055). The acid reflux episodes were significantly reduced from 42±30 at baseline to 27±20 post CBT ($P$=0.0002).

In the patients with increased SGBs and pathological acid exposure, we assessed the acid reflux episodes associated with SGBs (**Figure 4**).

Seventeen out of 31 patients had pathological acid exposure at baseline (9.0±3.2%). In these patients, acid reflux associated with SGBs contributed to a median of 26% of the total AET (range 1% to 100% of the 24-hour acid exposure). Of those 17 patients with pathological acid exposure at baseline there was a significant reduction in acid exposure from 9.0±3.2% to 6.1±3.5% ($P$=0.0053).

In patients that had improvement in AET the mean acid clearance time before CBT was 107 s (83–196) and after CBT was 96 s (67–116) $P$=0.12.

### Outcome Subjective evaluation

***Personality and hypervigilance in patients with pathological SGB.*** Compared to the general population, (17) and contrary to study expectations, our patients with pathological SGB scored higher on the BFI-10 on agreeableness (3.7±0.7 vs 3.2±0.8, $P$<0.001) but lower on neuroticism (3.1±1.1 vs 3.5±0.8, $P$<0.05) and openness (3.2±0.8 vs 3.4±0.9, $P$<0.05)

The mean SSAS (hypervigilance) score for our cohort was 28.95. This score was within the average normal range (23–28).

***Severity of belching (VAS scores).*** The self-reported severity of belching improved significantly with CBT treatment (**Table 1**). The VAS composite scores decreased from 260 (210–320) to 140 (80–210); $P$<0.0001. Half of the patients (51%) had a reduction of at least 50% in their VAS composite scores (**Figure 5**).

The VAS scores decreased by 53% (36–65%) in patients with predominant belching ($n$=15) and by 50% (12–64%) in patients with predominant reflux symptoms ($n$=16)

***QOL (SF-36 scores).*** All patients with pathological SGB reported an impaired QOL before CBT. Compared to normal values from the British population, patients with pathological SGB scored lower in all domains. After CBT treatment, the parameters of physical function, general health, vitality and social function improved significantly ($P$<0.05) (**Table 2**). Despite these improvements, the SF-36 scores post treatment remained significantly lower than the UK normative values for all domains.

## DISCUSSION

Excessive belching is a frequently reported symptom in patients with upper gasterointestinal disorders.(1,2) Furthermore, belching can be associated with increased acid gastroesophageal reflux. (5) Esophageal impedance monitoring allows distinction between gastric and SGB, (29) the first being related to physiological gastric venting during transient relaxation of the lower esophageal sphincters and the second being a behavioral condition associated to rapid intraesophageal movement of air. In this study, we assessed the effectiveness of cognitive behavioral therapy in reducing pathological SGB, and investigated whether CBT-induced reduction in SGB can decrease acid gastroesophageal reflux.

Our study confirmed that patients with untreated pathological SGB have impaired QOL, and some patients are additionally burdened with SGB-driven pathological acid GER. Our study showed that patients who completed treatment experienced a significant

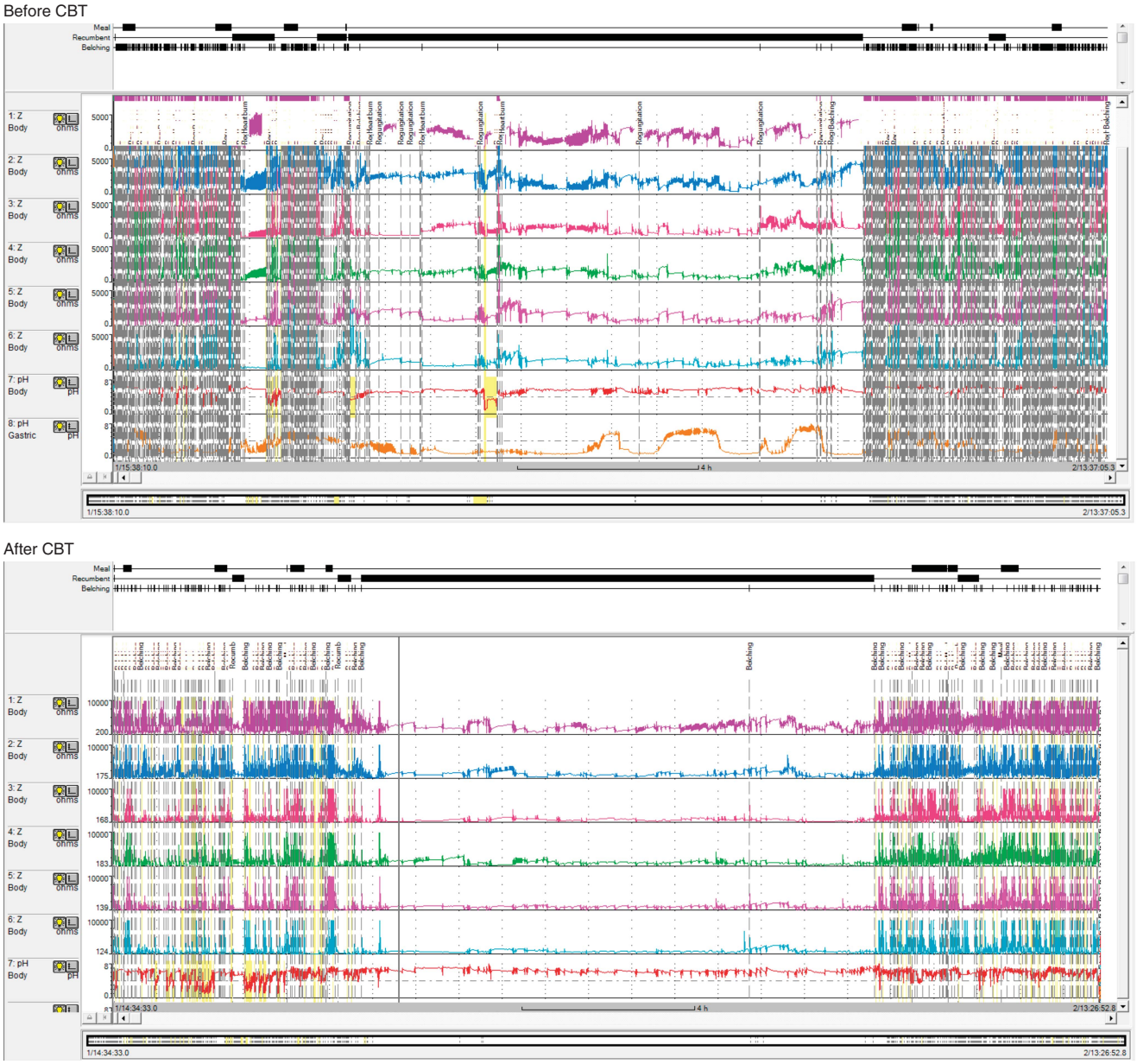


**Figure 3.** Example of 24-hour MII-pH recordings of a patient with severe pathological supragastric belching, performed before and after cognitive behavioral therapy (CBT) treatment. The patient marked his belching episodes during the studies (broken vertical lines). Pre treatment, the patient had 741 SGB/24hs. After treatment with CBT, he had 126 SGB/24hs and a significant improvement in subjective assessment.

benefit from CBT owing to (a) reduction in the number of SGBs, (b) reduction in the number of acid reflux episodes and total esophageal acid exposure (in patients in whom SGBs contributed significantly to the acid burden), and (c) improved perception of the severity of belching and overall QOL.

To our knowledge, our study describes the largest series to date of patients treated with CBT for pathological SGB. This is also the first study to systematically evaluate both subjective and objective parameters pre- and post-treatment for SGB, including the use of repeat 24 h MII-pH post-treatment to quantify both belching and acid reflux outcomes.

Hemmink *et al.* (23), used speech therapy and showed that 6 of 11 patients had a significant decrease of symptom severity (>30%). Katzka *et al.* (14) reported a case series of five patients who had a positive response using a simple technique based on diaphragmatic breathing and exercising slight mouth opening to prevent. Blondeau *et al.* (9) studied the effect of baclofen in patients with suspected rumination syndrome and/or SGB. In their study, belching was the predominant symptom in only 2 of the 12 patients and SGB episodes did not decrease significantly with baclofen. Finally, Kunte *et al.* (10) published a case report of a patient with severe belching who responded to combination of baclofen and pregabalin.

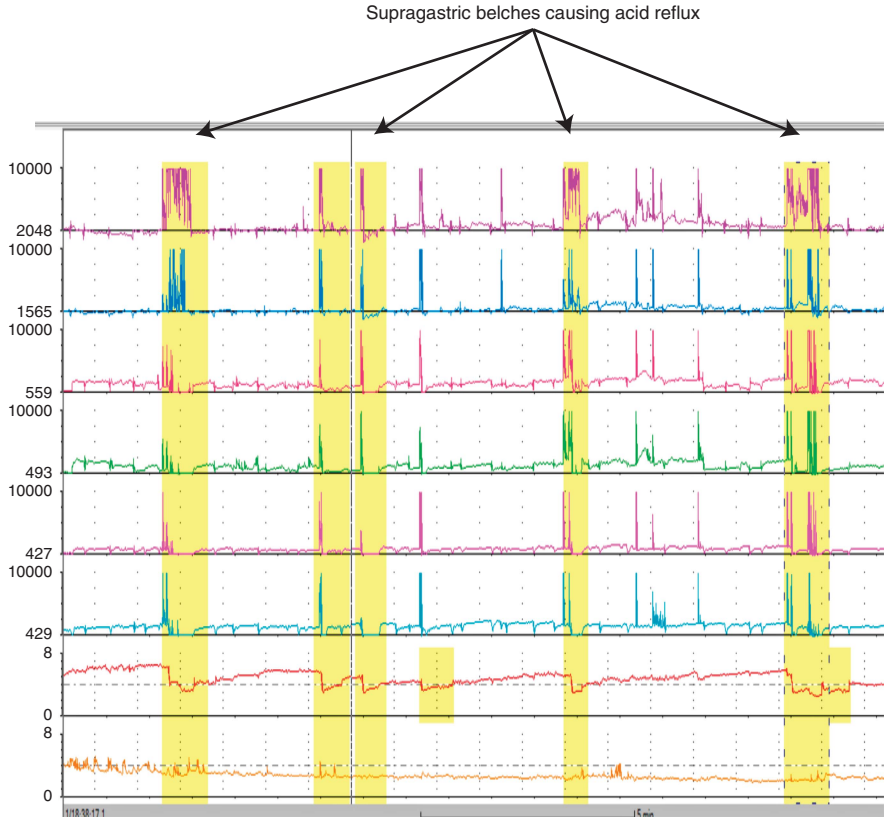


**Figure 4.** Example of esophageal impedance-pH tracing showing acid reflux episodes associated with supragastric belches.

**Table 1. VAS score (subjective symptom severity), four items pre and post CBT, *N*=39**

| | Pre CBT | Post CBT | *P* value |
|---|---|---|---|
| Q1: How bothered are you by your belching? | 80 (70–100) | 30 (20–60) | <0.0001 |
| Q2: How much can you control your belching? | 70 (50–90) | 30 (20–60) | <0.0001 |
| Q3: How much are your daily activities affected by your belching? | 70 (30–80) | 30 (20–50) | <0.0001 |
| Q4: How much are your social activities affected by your belching? | 60 (30–80) | 20 (10–40) | <0.0001 |

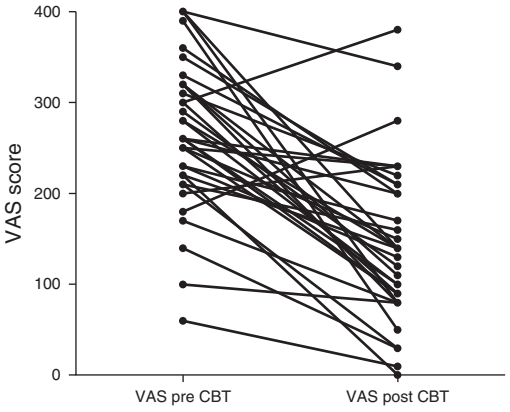


**Figure 5.** Subjective assessment of severity of belching by a composite visual analogue (VAS) score before and after cognitive behavioral therapy (CBT) treatment.

Of particular importance in our study was the identification of the warning signal preceding the belch, which proved to be a critical stage to the behavioral treatment of SGB. Patients were asked to self-monitor the sensations preceding the belch. This allowed patients to increase their awareness of the antecedents prior to the onset of the belching and use this information to implement the treatment exercises to prevent the belch from eventuating. The majority of participants in our study were able to identify an antecedent to the belch, with 32 of the 39 patients reporting a preceding sensation, commonly described as a pressure or tension building in the thorax or above the diaphragm. Helping SGB patients to become more aware of signals and sensations that lead to belching enables greater opportunity to implement a competing response, namely the breathing exercises, to prevent the belch occurring.

Our treatment with CBT was efficient to reduce significantly the number of SGBs in more than half of the patients that completed the protocol. This effect was also observed in the subgroup of patients with moderate number of SGB (<75/24 h).

**Table 2. Health-related quality of life pre CBT and post CBT for all eight SF-36 domains, *N*=39.**

| SF-36 domain | Pre-CBT | Post-CBT | *P* value |
|---|---|---|---|
| Physical function | 60±32 | 69±29 | 0.009 |
| Role limitation physical | 54±44 | 64±39 | 0.11 |
| Bodily pain | 51±29 | 61±27 | 0.056 |
| General health | 46±22 | 54±20 | 0.008 |
| Vitality | 44±24 | 53±21 | 0.002 |
| Social function | 57±27 | 69±21 | 0.005 |
| Role limitation emotional | 65±42 | 72±36 | 0.25 |
| Mental health | 59±23 | 65±16 | 0.08 |

In patients with predominant belching, the reduction of SGB was slightly higher than that observed in patients with predominant reflux symptoms. However, this difference did not reach statistical significance. It is important to acknowledge that although a significant number of patients had >50% reduction of SGBs, almost none of them had a completely normal second MII-pH recording. Like healthy subjects and patients with GERD, our patients had a small number of gastric belches (relative to the total amount of belches), being most of them postprandial and probably occurring during TLESRs. CBT treatment did not reduce the number of gastric belches. If anything, we noticed a small increase of gastric belches, unlikely to have an impact in symptoms or esophageal acid exposure.

Hemmink *et al.* (9) previously described the association between SGB and acid gastroesophageal reflux. Subsequently, our group described a subgroup of patients where up to a third of their esophageal acid burden was owing to acid reflux episodes associated with SGBs. (5) In the current study we show, for the first time, that treatment of SGB with CBT can reduce daytime esophageal acid exposure. This further strengthens the case for a causal relantionship between supragatric belching and reflux in some patients. In most of these patients this was attributable to concomitant reduction of SGBs and acid reflux episodes; however, four patients still demonstrated decreased esophageal acid exposure without reduction in number of SGBs. It is possible that in these patients the diaphragmatic breathing exercises alone are sufficient to reinforce the antireflux barrier as suggested by Eherer *et al.*(24).

PPIs and/or antireflux surgery are the mainstays of treatment for patients with symptoms and objective demonstration of gastroesophageal reflux disease. However, our study suggests that careful analysis of MII-pH tracings allows identification of a subgroup of gastroesophageal reflux disease patients with acid reflux predominantly driven by SGB. In these patients, CBT can be a useful noninvasive adjunct that can at least partially reduce daytime esophageal acid exposure and may therefore reduce PPI requirements.

We postulate that CBT for SGB may also have a role in some gastroesophageal reflux disease patients undergoing anti-reflux surgery. A study by Broeders *et al.* (7) found that the frequency of SGBs increased post-operatively: this was thought to represent the futile efforts of such patients to vent air from the stomach in lieu of actual gastric belches (now made difficult by the presence of a fundoplication).

Our study confirms previous reports that SGB patients have impaired QOL, particularly in their social function. (2) The patient-reported severity of belching symptoms (as measured by VAS scores) improved significantly upon completion of the CBT program. Indeed over half experienced >50% subjective improvement, which is a clinically important outcome. This effect was similarly observed in both, patients with predominant belching and patients with predominant reflux symptoms. Patients felt less distressed, they had more control over belching, and this improvement impacted their social functioning and daily activities. Patients largely reported that mastery of the treatment exercises gave them a greater confidence to control the belching in various settings. This increased their ability to engage in social activities and reduced the stigma and embarrassment previously experienced. This was reflected to some extent in the SF-36 psychological domains that improved significantly in the subscales of vitality and social functioning, indicating that patients experienced increased energy levels, reduced fatigue, and lessened impact of ill health on social activities following the CBT intervention. However, the mental health subscale measuring psychological distress attained a small improvement with CBT. Although this is used as a screening tool for anxiety, depression, or the presence of a mental disorder (25), a specific measurement for anxiety or depression may have captured these changes in psychological distress more effectively.

Personality factors, especially neuroticism and hypervigilance, are commonly associated with functional gastrointestinal disorders (26–28,30,31). Surprisingly, our cohort of patients with SGB displayed lower levels of neuroticism, indicating that they are less likely to respond in an anxious or negative manner to their symptoms. Moreover, higher levels of agreeableness and lower openness scores were observed compared to the general population. Further studies using a more comprehensive personality assessment would enhance our knowledge of personality traits associated with SGB.

The finding that hypervigilance to bodily sensations was within the normal range in patients with SGB was not as we expected, as research has shown increased hypervigilance to contribute to the development and maintenance of functional gasterointestinal disorders. (32,33) On reflection, one possible explanation is that our study design investigated the general construct of hypervigilance to bodily sensations rather than specific hypervigilance to a particular sensation, as was previously found for esophageal hypervigilance. (33) Future investigations into symptom-specific hypervigilance may provide further insight into the psychosocial factors contributing to SGB. Cultural differences in the perception of bodily sensations and whether these are reported as disturbing may have also contributed to these results.

We acknowledge the following limitations of our study. An important limitation of this study is the lack of a comparative treatment arm. Indeed, we performed a per protocol analysis. We considered this as a "pilot study" and based on our positive results we are now starting a new controlled trial with a comparative treatment arm. The results presented were obtained from patients that completed the CBT protocol. The exclusion of patients who did not complete

treatment due to patient unavailability or reluctance may have resulted in selection bias as patients who do not derive benefit from treatment are more likely to drop out. We believe that recruitment of a sham controlled study would be difficult in this cohort of patients, especially since there is preliminary data suggesting efficacy of CBT. Thus far we have only evaluated and described treatment outcomes at 8-week follow-up; further data collection is scheduled for the 1-year time point to establish longer term efficacy.

## CONCLUSION

Cognitive behavioral therapy ameliorated SGB in patients who completed treatment. It reduced the number of belches and improved social and daily activities in 50% of patients. Careful analysis of MII-pH allows identification of a subgroup of gastroesophageal reflux disease patients with acid reflux predominantly driven by SGB. In these patients, CBT can reduce daytime esophageal acid exposure.

### CONFLICT OF INTEREST

**Guarantor of the article:** D Sifrim.

**Author Contributions:** DS and PH conceived and designed the study protocol. EG, JO, KN, EY, and PW recruited patients. EG analyzed all impedance-pH-monitoring studies. EW performed psychological interviews and followed up all patients. JA recruited patients and performed statistical analysis. EG, PH, and DS interpreted results of studies, prepared figures, and drafted the manuscript. PW, EW, JO, and PH edited and revised the manuscript with final approval from DS.

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**Potential competing interests:** The remaining authors declare no conflicts of interest with this study.

## Study Highlights

### WHAT IS CURRENT KNOWLEDGE

- ✓ SGB is a variant of belching with a behavioral etiology.
- ✓ Excessive SGB can be associated with increased gastroesophageal acid reflux.
- ✓ SGB can be identified using esophageal impedance measurements.

### WHAT IS NEW HERE

- ✓ Structured CBT can improve QOL in patients with excessive SGB.
- ✓ CBT causes a subjective and objective reduction in SGB in a significant proportion of patients.
- ✓ In those patients with pathological esophageal acid exposure at baseline, CBT treatment for SGB significantly reduces acid exposure.

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