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Postprandial bloating after laparoscopic Nissen fundoplication

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Objective: To evaluate the prevalence and possible contributing factors to postprandial bloating in patients having chronic gastroesophageal reflux disease (GERD) before and after laparoscopic Nissen fundoplication. **Design:** A prospective cohort study. **Setting:** A tertiary care teaching hospital. **Patients:** Five hundred and seventy-eight patients with proven GERD. **Intervention:** Laparoscopic Nissen fundoplication. **Outcome measures:** Symptom severity scores for postprandial bloating and dysphagia, esophageal motility and 24-hour pH measurement before and at 6 months, 2 years and 5 years after laparoscopic Nissen fundoplication. **Results:** Of the 598 patients, 436 (73%) reported some postprandial bloating before the procedure. The symptom score for bloating significantly improved after surgery ($p < 0.0001$). There were no significant differences in the lower esophageal sphincter basal pressures or 24-hour pH scores between those who reported improvement or worsening of their postprandial bloating. At 6 months after surgery, 54% of patients experienced postprandial bloating; of these, 49% reported improvement, 21% reported worsening and 30% reported no change in bloating symptoms compared with the preoperative state. Of the patients who reported worsening of postprandial bloating 6 months after surgery, 86 were reassessed 2 years after surgery and 71% reported improvement of this symptom over this time interval. **Conclusions:** Bloating is a common symptom in patients who suffer from chronic GERD. Laparoscopic Nissen fundoplication lessens the severity of this symptom in most patients. In a small subgroup of patients, antireflux surgery may exacerbate the bloating, but this improves over time.

Objectif : Évaluer la prévalence du ballonnement postprandial et les facteurs qui peuvent y contribuer chez les patients atteints de reflux gastro-œsophagien pathologique (RGOP) avant et après une fundoplicature par laparoscopie. **Conception :** Étude prospective de cohortes. **Contexte :** Hôpital universitaire de soins tertiaires. **Patients :** Cinq cent soixante-dix-huit patients atteints de RGOP avéré. **Intervention :** Fundoplicature par laparoscopie. **Mesures de résultats :** Indices de gravité des symptômes de ballonnement postprandial et de dysphagie, motilité œsophagienne et mesure du pH aux 24 heures avant la fundoplicature par laparoscopie et six mois, deux ans et cinq ans après l'intervention. **Résultats :** Sur les 598 patients, 436 (73 %) ont signalé un ballonnement postprandial avant l'intervention. L'indice des symptômes de ballonnement s'est amélioré considérablement après l'intervention chirurgicale ($p < 0{,}0001$). Les pressions basales au niveau du sphincter œsophagien inférieur ou les pH à 24 heures ne présentaient pas de différences significatives entre les sujets qui ont signalé une amélioration ou une aggravation de leur ballonnement postprandial. Six mois après l'intervention chirurgicale, 54 % des patients éprouvaient un ballonnement postprandial : sur ce total, 49 % ont signalé une amélioration, 21 %, une aggravation, et 30 % n'ont signalé aucun changement des symptômes de ballonnement comparativement à leur état avant l'intervention. Chez les patients qui ont signalé une aggravation du ballonnement postprandial six mois après l'intervention chirurgicale, 86 ont été réévalués deux ans après l'intervention et 71 % ont signalé une atténuation du symptôme pendant cette période. **Conclusions :** Le ballonnement est un symptôme fréquent chez les patients atteints de RGOP. La fundoplicature par laparoscopie atténue la gravité des symptômes dans la plupart des cas. Chez un petit sous-groupe de patients, une intervention chirurgicale antireflux peut aggraver le ballonnement, mais ce symptôme s'atténue avec le temps.

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Postprandial bloating is one of the most common and troublesome symptoms after laparoscopic fundoplication.[1,2] For most patients the symptom improves in the first few months postoperatively, and no long-term treatment may be necessary. However, in some patients the symptom persists and in up to 3% it may be so severe as to limit their food intake and produce weight loss.[1]

A number of factors have been proposed as causing this symptom, namely aerophagia, inability to belch, delayed gastric emptying,[3] reduced gastric volume and heightened perception of gastric filling by the patient.[4] However, no study has provided direct evidence to support any of these as the sole cause.

The treatment options have included reduction in the size of meals, avoidance of carbonated drinks, use of pro-kinetic agents,[5] dilatation of the wrap,[2] conversion to Toupet fundoplication[6] and even laparoscopic pyloroplasty.[2]

The aim of this study was to evaluate prospectively the symptom of postprandial bloating using a cohort of patients with proven gastroesophageal reflux disease (GERD) who underwent laparoscopic Nissen fundoplication. Assessments were made before the procedure and at 6 months, 2 years and 5 years after, and the correlation between postprandial bloating and a number of objective parameters including the lower esophageal sphincter (LES) pressure were evaluated.

Methods

Patients

Five hundred and seventy-eight patients (378 women, 200 men) with a proven diagnosis of GERD who were referred for laparoscopic fundoplication were symptomatically assessed using a validated GERD symptom score, which evaluated the severity and frequency of postprandial bloating as well as 5 other specific symptoms of GERD. In addition, all patients underwent preoperative gastroscopy, 24-hour pH recording and esophageal manometry, and all completed a quality of life questionnaire (SF-36).

All patients in this cohort underwent a laparoscopic Nissen fundoplication between July 1992 and November 1998, by a single surgeon experienced with this technique.

Surgical technique

The technique of laparoscopic Nissen fundoplication without routine division of short gastric vessels using the technique of minimal paraesophageal dissection has been described previously.[7]

Symptom assessment

The symptom of postprandial bloating or fullness and 5 other symptoms — heartburn, regurgitation, dysphagia, epigastric pain and cough — were evaluated using a previously described scoring system. Each symptom was given a score derived as a product of severity (0–3) and frequency (0–4).[7,8] Thus, each symptom had a score with a possible range from 0 to 12, for which 0 indicated absence of the symptom and 12 the highest possible severity score. A cumulative GERD symptom score was also obtained for each patient by adding the scores for all 6 symptoms (range from 0–72).

Follow-up investigations

All patients were invited to have repeat symptom assessment as well as repeat 24-hour pH recording and esophageal manometry and to complete quality of life questionnaire at 6 months, 2 years and 5 years after surgery.

Statistical analysis

All calculations were performed using Statview 4.5 for the Macintosh (SAS Institute, Cary, NC). Data are reported as the mean (and standard deviation) and shown on the figures as the mean (and 95% confidence interval [CI]). Comparisons between preoperative and 6 months, 2 years and 5 years postoperative data were made by factorial analysis of variance with post hoc comparisons by Fisher's protected least significant difference. Changes between paired data points were assessed by paired *t*-tests, and results are expressed as the mean paired difference (and 95% CI). Comparisons between unpaired data points were made by unpaired *t*-tests, and results expressed as the mean difference (and 95% CI).

Results

The Nissen fundoplication was completed laparoscopically in all but 5 patients (conversion rate of 0.9%). The mean (and SD) operative time was 55.8 (24.5) minutes (range from 20–195 minutes).

Five hundred and sixty-three patients underwent preoperative esophageal motility testing in our laboratory, and 535 underwent preoperative 24-hour pH monitoring in our laboratory. At the time of reporting, 461 patients were eligible for 6-month follow-up, 433 (94%) had undergone laboratory follow-up, 25 refused and 3 died for reasons unrelated to their surgery. Three hundred and seventeen patients were eligible for 2-year follow-up, 258 (81.4%) of these had undergone laboratory follow-up, 55 (17.3%) refused follow-up or could not be located (due to moving or failure to return phone calls and letters) and 4 (1.3%) had died. Seventy-two patients were eligible for 5-year follow-up, 31 (43.0%) of these had undergone laboratory follow-up, 21 (29.2%) refused, 17 (23.6%) could not be located, 2 (2.8%) had died, and 1 (1.4%) had been booked for testing.

The mean (and SD) age of the patients was 45.6 (13.6), with no difference between men and women. Reflux appeared to be symptomatically more severe in men (35.8 [14.4])

than in women (41.6 [15.8], $p < 0.0001$), and consistent with this the 24-hour pH score was more severe in men (11.7 [10.9]) than in women (8.0 [8.8], $p < 0.0001$). There were no differences in LES tone. In contrast, the quality of life scores were lower for both physical ($p < 0.0001$) and mental health ($p < 0.001$) in women (physical health 36.8 [11.3], mental health 42.7 [9.4]) than in men (physical health 43.1 [12.4], mental health 47.1 [19.9]).

There was significant improvement in the 24-hour pH scores compared with preoperative values at 6 months ($p < 0.0001$), 2 years ($p < 0.0001$) and 5 years ($p < 0.0001$), but there were no differences among the values at 6 months, 2 and 5 years (Fig. 1).

Compared with preoperative values there were significant improvements in the LES tone at 6 months ($p < 0.0001$), 2 years ($p < 0.0001$) and 5 years ($p < 0.0001$). Post hoc comparisons showed a mean fall compared with 6 months in the LES tone at 2 years of 1.7 mm Hg ($p = 0.0192$). There was a further mean fall from 2 to 5 years of 2.1 mm Hg that was not statistically significant ($p = 0.1$). At 5 years the mean LES tone was 15.6 (9.8) mm Hg, still well above the preoperative value of 6.4 (5.6) mm Hg (Fig. 2).

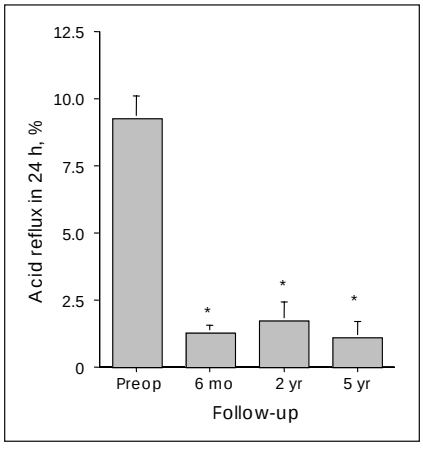

FIG. 1. The improvement in acid reflux after surgery measured by 24-hour pH recording. Data are expressed as mean and 95% confidence intervals. *$p <$ 0.0001 compared with preoperative value.

Postprandial bloating

Of the 521 patients who completed the bloating scoring preoperatively, 380 (73%) reported experiencing some postprandial bloating. The symptom score for bloating significantly improved after surgery from a mean (and SD) of 6.2 (4.7) to 3.9 (4.6) at 6 months ($p < 0.0001$), 4.1 (4.7) at 2 years ($p < 0.0001$) and 4.3 (4.4) at 5 years ($p = 0.0023$) after laparoscopic Nissen fundoplication (Fig. 3).

At six months after surgery, 433 patients were available for symptom evaluation. Of these, 234 (54%) experienced postprandial bloating. Of the patients with postprandial bloating, 115 (49%) reported improvement, 49 (21%) reported worsening and 70 (30%) reported no change compared with the preoperative state. There were no significant differences in the LES basal pressures ($p = 0.1173$) or 24- hour pH score ($p = 0.1015$) between the patients who reported improvement in bloating and those who experienced worsening of their postprandial bloating.

Of the 86 patients who reported worsening of postprandial bloating 6 months after surgery 42 were reassessed 2 years postoperatively and 29 (68%) reported improvement of their

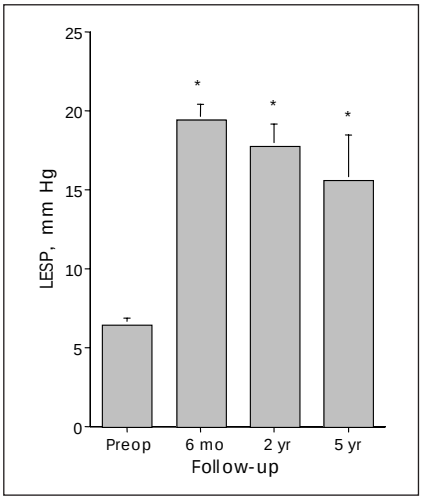

FIG. 2. Lower esophageal sphincter pressure (LESP) before and after surgery expressed as the mean and 95% confidence interval. *$p <$ 0.0001 compared with the preoperative value.

symptoms over this time interval. Fig. 4 shows the mean and 95% CI scores for bloating before, and 6 months and 2 years after fundoplication in the patients whose scores either improved or deteriorated at 6 months postoperatively. The patients whose scores were unchanged are omitted for clarity as there was no significant difference in their bloating scores.

To identify whether preoperative bloating scores could predict postoperative bloating we first categorized the preoperative bloating scores as follows: 0 no bloating, 1 to 3 mild, 4 to 6 moderate, 7 to 9 moderately severe and 10 to 12 severe. Using this scale we then examined the absolute

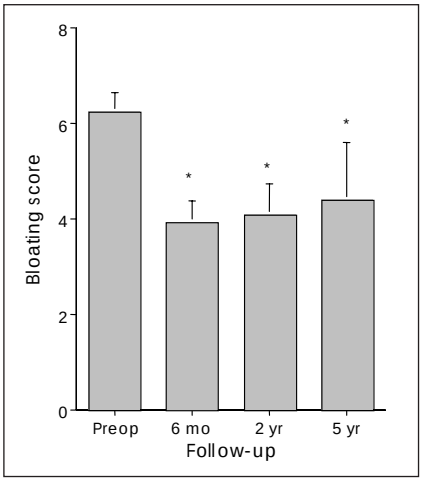

FIG. 3. The bloating symptom score before and after surgery with a possible range from 0 (symptom absent) to a maximum of 12. Data shown are means and 95% confidence intervals. *$p <$ 0.0001.

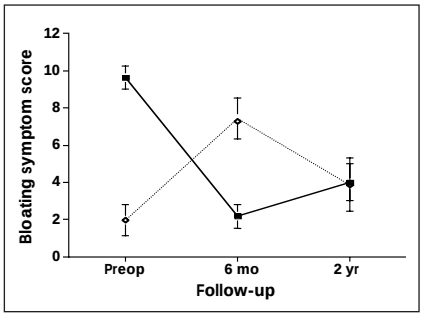

FIG. 4. Bloating symptom scores before, and 6 months and 2 years after surgery in the patients whose score at 6 months was either better (solid line) or worse (dotted line) than before surgery. Data are means and 95% confidence intervals.

change in bloating scores in each patient (postoperative score–preoperative score) at 6 months and 2 years. In 142 patients with either mild or absent bloating preoperatively (score <4) there was an increase in bloating postoperatively in 45 (32%) postoperatively. This increase, which is not unexpected after fundoplication, was small (Fig. 5). The 53 patients in whom the bloating was moderate (score 4–6) typically showed little change after surgery. The 222 patients with the highest preoperative bloating scores (>6) showed the greatest improvement. The pattern at 2 years is very similar to that at 6 months. The numbers are currently small but the same pattern was seen at 5 years (data not shown) .

We looked in more detail at the 276 patients who presented with severe bloating preoperatively and found that at 6 months' follow-up 108 (39%) now had either absent or mild bloating, 36 (13%) had moderate and 39 (14%) had moderately severe bloating. Two years after surgery 30 of 72 patients with severe bloating at 6 months were available for follow-up. By this time 67% (20 of 30) had improved and no longer complained of severe bloating.

Correlation between postprandial bloating and dysphagia scores

Before fundoplication there was a significant correlation between the bloating score and the dysphagia score (Spearman rho 0.379, $p < 0.0001$). There was a significant fall in the mean dysphagia scores compared with baseline at 6 months ($p < 0.0001$), 2 years ($p < 0.0001$) and 5 years ($p = 0.0071$). The patients whose bloating improved at 6 months had a mean dysphagia score of 2.4 (3.6), significantly lower ($p = 0.0418$) than the patients whose bloating got worse (mean score of 3.4 [4.1]) (Fig. 6). Among the patients whose bloating improved, there was no change in the dysphagia score at 2 years (mean 2.2 [3.1]), but the dysphagia score improved in the patients whose bloating was initially worse (mean 2.5 [3.5]). At 2 years after surgery there was no significant difference in the dysphagia scores between the 2 groups (mean difference 0.3, 95% CI 1.5 to –0.9, $p = 0.6272$).

Discussion

This study confirms that bloating is a common symptom experienced by patients who suffer with chronic GERD;[7,9] 73% of our cohort of 578 patients with confirmed GERD referred for antireflux surgery experienced bloating or fullness after meals.[7] Factors including aerophagia, heightened sense of gastric filling,[4] and delayed gastric emptying[5] have been proposed in its etiology. No study to date, however, has shown a direct relationship to any of these factors.

Antireflux surgery may increase postprandial bloating.

On the one hand, fundoplication reduces fundic volume and impairs the stomach's ability to accommodate and store food, although it may accelerate liquid and even solid gastric emptying.[10] On the other hand, the increase in basal and nadir pressures[11] at the LES may impair belching and thus aggravate or produce symptoms of bloating and fullness.[1]

Another potential factor that may exacerbate post-fundoplication symptoms of bloating and fullness includes

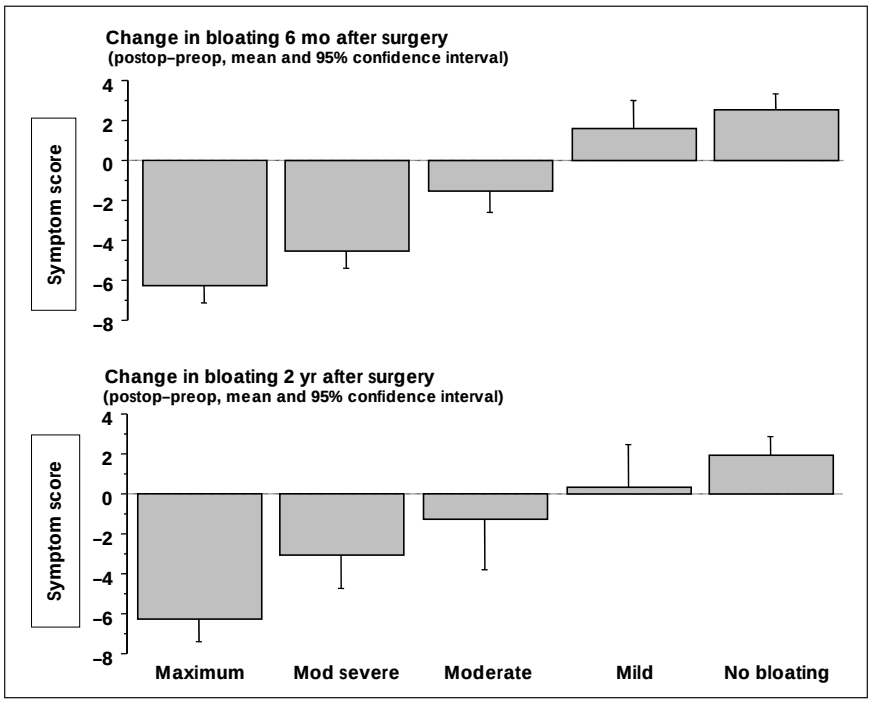

FIG. 5. The change in bloating symptom scores (postoperatively compared with preoperatively) at 6 months and 2 years. The change is expressed as mean differences and 95% confidence intervals.

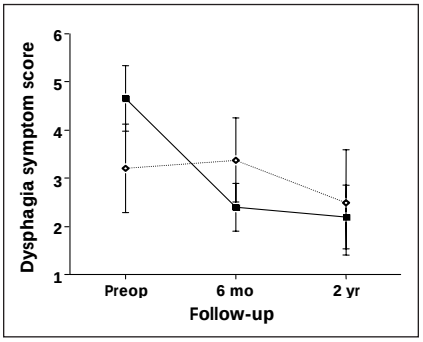

FIG. 6. Dysphagia symptom scores before, and 6 months and 2 years after surgery in patients who reported improvement in bloating symptoms (solid line) compared with those who experienced increased bloating after surgery (dotted line).

incidental damage to the vagal fibres during surgery.[1] This may affect gastric contractile efficiency and emptying. Injury to the main vagal trunks during fundoplication is rare. A recent study has shown that including or excluding the posterior vagus in the wrap does not alter vagal function.[12] Although injury to the main trunks is rare, injury to the smaller branches is more common, particularly the hepatic branch, which supplies the primary innervation to the pylorus via a small branch known as nerve of McRae.[13] Thus, injury to the smaller branches may have a significant effect on gastric emptying, and the best method to avoid these sequelae is to minimize the extent of paraesophageal dissection and to avoid electrocautery during the dissection as much as possible.[1]

In this study, using a technique that minimized the risk of injury to the vagal supply of the fundus, we observed an overall improvement in the prevalence of postprandial bloating after meals. In a retrospective analysis of 25 patients Lundell and associates[3] found some correlation between occurrence of post-fundoplication gas-bloat syndrome and evidence of preoperative delay in gastric emptying but surprisingly not a postoperative delay. In another study, a prospective comparison of 18 patients[9] with gas-bloat syndrome, Ireland and associates[14] were unable to show a significant correlation with post-fundoplication gastric emptying or wrap pressure; however, patients with gas-bloat syndrome demonstrated significant impairment in the ability to belch after gastric distension with 750 mL of carbon dioxide compared with post-fundoplication patients without gas-bloat syndrome. In this study, we did not examine gastric emptying, but we found no correlation between the changes in pressure profile of LES and incidence and severity of postprandial bloating after antireflux surgery, confirming Ireland's observation that higher wrap pressures are not the cause of postprandial bloating and fullness.

Our observation suggests that patients with severe bloating symptom before operation are likely (2 out of 3 chance) to experience improvement after laparoscopic antireflux surgery, whereas patients with no bloating or mild bloating preoperatively have a 1 in 3 chance of experiencing worsening of their bloating postoperatively. In the latter group, the exacerbation of bloating is generally very mild and is unlikely to have significant clinical or lifestyle implications for the patient. However, results will allow surgeons to better educate the patients about the potential risks of increased bloating after laparoscopic fundoplication.

The evidence in the literature and our observations during this study confirm the view that the cause of bloating is multifactorial. In our view, the most significant factor is likely to be the way patients process afferent vagal signals during gastric distension. The hypothesis that the heightened sense of gastric filling is a major contributing factor in bloating experienced by patients with chronic GERD as well as patients after antireflux surgery will require direct investigation. Recently developed techniques will allow us to evaluate the processing of afferent vagal signals from the esophagus and stomach in patients with GERD and compare them to normal controls.

Conclusions

Bloating is a common symptom in patients who suffer from chronic GERD. Laparoscopic Nissen fundoplication ameliorates this symptom in most patients. In a small subgroup, antireflux surgery may exacerbate this symptom, but the effect improves over time. Thus, early surgical intervention to treat bloating in this subgroup may be unnecessary and may lead to further unwanted consequences. Additional studies are necessary to evaluate the relative contribution of various proposed causative factors in the development of bloating symptoms.

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