

Bowel Habits After Bariatric Surgery

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Abstract

Background Disordered bowel habits might influence quality of life after bariatric surgery. Different types of bariatric operations—gastric banding (AGB), Roux-en-Y gastric bypass (RYGB), or biliopancreatic diversion (BPD)—might alter bowel habits as a consequence of the surgical procedure used. Whether change in bowel habits affects quality of life after AGB, RYGB, or BPD differently is unknown. **Methods** The study group contained 290 severely obese patients undergoing bariatric surgery between August 1996 and September 2004 [BPD: $n=103$, 64.1% women, age 43 ± 1 years (mean \pm SEM), BMI 53.9 ± 0.9 kg/m², weight 153.4 ± 2.9 kg; Roux-en-Y gastric bypass: $n=126$, 73.0% women, age 43 ± 1 years, BMI 44.2 ± 0.3 kg/m², weight 123.8 ± 1.5 kg; adjustable gastric banding (AGB): $n=61$, 57.4% women, age 44 ± 1 years, BMI 49.9 ± 0.5 kg/m², weight 146.1 ± 2.0 kg]. Changes in bowel habits, flatulence, flatus odor, and effects on social life were estimated at least 4 months after surgery using a self-administered questionnaire.

Results Fecal consistency changed significantly after surgery. Loose stools and diarrhea were more frequent after BPD and RYGB ($P<0.001$) but more so after BPD than after either RYGB or AGB ($P<0.002$). Constipation was more likely after AGB ($P=0.03$). In addition, malodorous flatus affecting social life was more frequent after BPD than after either RYGB or AGB ($P<0.003$). Furthermore, flatus frequency increased after BPD and RYGB, and patients were more bothered by their malodorous flatus than after AGB (all $P<0.001$). Flatus severity score was highest in BPD, intermediate in RYGB, and lowest in AGB patients (all $P<0.001$), a difference that was not influenced by frequency of metabolic syndrome before and after surgery. Moreover, observation period after surgery had no influence on overall results of bowel habits. Subscore quality of life bariatric analysis and reporting outcome system (BAROS) scores were largely similar between all three groups. However, flatulence severity score correlated inversely with quality of life estimated by BAROS in BPD and RYGB, but not in AGB patients.

Conclusions The type of bariatric surgery affects bowel habits in an operation-specific manner, resulting mainly in diarrhea after BPD and RYGB, and constipation after AGB. Flatulence severity impairs quality of life most in BPD, is intermediate in RYGB, and is only minor after AGB, a phenomenon that was only partially mirrored in quality-of-life measures of BAROS.

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Introduction

Biliopancreatic diversion (BPD) for the treatment of obesity is very effective at weight reduction and maintenance and also treats obesity-related comorbidities [1–3]. In terms of weight loss maintenance, it is thought to be the most effective surgical treatment of obesity [4]. The bariatric analysis reporting outcome system (BAROS) [5], which combines weight loss, improvements in comorbidities, complications, reoperations, and changes in quality of life, was designed as a way to address the lack of standards for comparing outcome after bariatric surgery [6]. BAROS has been accepted as the standard for reporting results after bariatric surgery in German-speaking countries, Brazil, and Spain and is also used by surgeons in many centres in Europe and the USA [5]. In a recent long-term study of outcome after BPD, Marinari et al. [4] found that 85.5% of patients scored good or better; however, little is known about the direct consequences of changes in defecation and flatulence after BPD on quality of life. In exchange for weight loss in treating severe obesity, BPD represents a compromise in intestinal absorption capacity since the digestive juices bypass 90% of the small intestine, resulting in fat and carbohydrate malabsorption leading to an increased flatulence. In addition, a change in the equilibrium of intestinal flora and bacterial overgrowth syndrome may also increase malodorous gas and discomfort. These changes are well tolerated in 80% of patients [7], but 20% of patients will present with more serious symptoms over a spectrum of severity. Changes in bowel habit may have a direct influence on quality of life reported by patients after BPD, yet are rarely reported.

The purpose of this study was to investigate changes in bowel habits and flatulence and their consequences on quality of life after bariatric surgery in patients undergoing BPD, Roux-en-Y gastric bypass (RYGB), and adjustable gastric banding (AGB).

Methods

Patients

A total of 290 severely obese patients undergoing bariatric surgery between August 1996 and September 2004 were included in the present study. Inclusion and selection criteria of surgical procedure have been in accordance to the Swiss guidelines and the ASBS Consensus Conference 2004 [8] where appropriate. BPD with or without duodenal switch was undertaken in 103 obese patients [64.1% women, age 43 ± 1 years (mean \pm SEM), BMI 53.9 ± 0.9 kg/m², weight 153.4 ± 2.9 kg], 126 obese patients underwent Roux-en-Y gastric bypass (73.0% women, age 43 ± 1 years,

BMI 44.2 ± 0.3 kg/m², weight 123.8 ± 1.5 kg), and AGB was undertaken in 61 patients (57.4% women, age 44 ± 1 years, BMI 49.9 ± 0.5 kg/m², weight 146.1 ± 2.0 kg). BPD patients had a greater BMI than patients undergoing either RYGB ($P < 0.001$) or AGB ($P = 0.001$).

Questionnaire

All patients completed a specially designed questionnaire at least 3 months after surgery, between November 2004 and March 2005 [BPD: median 6.4 years, range 4 months–8.4 years, BMI at time of investigation 34.2 ± 0.7 kg/m², excessive weight loss (EWL) $63 \pm 2.0\%$; RYGB: median 2.1 years, range 4 months–5.4 years, BMI 30.4 ± 0.4 kg/m², EWL $65 \pm 2\%$; AGB: median 5.7 years, range 3.7–8.4 years, BMI 35.4 ± 0.8 kg/m², EWL $53 \pm 3\%$], which asked about bowel habits and flatulence before and after surgery. An English translation of the questionnaire is shown in Appendix 1. The questionnaires were mailed to the patients with a stamped, addressed return envelope. With the aid of visual analogue scales, patients documented their bowel habits and flatus before and after surgery, whether the frequency of loose bowel motions was affected by fatty meals, and whether flatus was upsetting or interfered with social interactions. In total, 359 questionnaires were sent out, but 69 (19.2%) were either not returned or incomplete. These patients were excluded from the study. In 20 subjects, questionnaire was filled out twice within 6 months. Coefficient of variation for all questions was below 6%. In addition, answers to the quality of life section of the BAROS score, completed at each annual check-up, were extracted for each patient in order to compare overall quality of life reported after surgery with the perceived changes in bowel motions and flatulence.

In order to compare quality-of-life measures of BAROS with results from the questionnaire, numerical responses to questions 2–5 were added, and the overall questionnaire score (flatus severity score) was then correlated with the quality of life score of BAROS.

Metabolic Syndrome

Metabolic syndrome components (type 2 diabetes mellitus, dyslipidemia, hypertension) were defined according to the guidelines of the National Cholesterol Education Program (NCEP) expert panel (ATP III) with minor modifications. Thus, type 2 diabetes mellitus was diagnosed in patients taking hypoglycemic medication or exhibiting serum glycosylated hemoglobin (HbA1c) 7% or greater. Dyslipidemia was defined as elevated serum triglycerides [≥ 1.69 mmol/l (150 mg/dl)] and/or reduced high-density lipoprotein cholesterol [HDL; ≤ 1.04 mmol/l (40 mg/dl) in

men and ≤ 1.29 mmol/l (50 mg/dl) in women] or use of lipid-lowering drugs. Hypertension was diagnosed in patients taking hypotensive therapy or having elevated systolic and/or diastolic blood pressure (≥ 130 or 85 mmHg, respectively).

Surgical Techniques

The surgical techniques for BPD, RYGB, and AGB have been described previously [9, 10]. Briefly, gastric bands were inserted laparoscopically using the pars flaccida technique. More than 90% of RYGB were performed laparoscopically with a small tubular pouch of estimated 15 to 30 ml volume along the lesser curvature and 80 to 100 cm Roux limb. The majority of BDPs were performed through laparotomy. In all patients, alimentary limb was 250 cm and common channel 50 to 100 cm [Scopinaro operation: $n=5$; AGB with ($n=33$)/ without ($n=64$) duodenal switch, Marceau operation: $n=1$].

Data Collection and Statistics

All patients were fully informed about the surgical procedures, gave their consent, and agreed to complete the questionnaire. Patient data were extracted from our self-developed computer database, ObesityBase 2000 (Zürich, Switzerland), and statistical analyses were performed with the use of SPSS software (Advanced Models 11.0 for Windows, SPSS, Chicago, USA), accepting $P < 0.05$ as statistically significant. Data presented in the text represent mean \pm SEM or median, as stated. Kruskal–Wallis test for nonparametric ANOVA, Mann–Whitney, and Wilcoxon test were used where appropriate. Bowel habits might change as a consequence of bowel adaptation to the respective surgery over time. Therefore, results are given for all patients and in subset of patients after matching for time of observation after surgery (median observation period 4.5 years and $n=25$ for each operative procedure, respectively).

Results

Bowel Habits Before Surgery in Severely Obese Patients

Adjustable Gastric Banding The majority of patients undergoing AGB reported their bowel motions to be normal before surgery (73.8%), and loose stools or diarrhea were only rarely reported (4.9%, Table 1). Similarly, the majority of patients reported a normal frequency of flatus presurgery (77.0%); frequent flatus was reported by 14.8%. This flatus was sometimes malodorous [median 5 on visual analogue score (VAS)] and bothered patients a little (median 5 on VAS), but the malodorous flatus rarely affected their social lives (median 3 on VAS).

Roux-en-Y Gastric Bypass Most patients undergoing RYGB reported their bowel motions to be normal before surgery (62.7%), and few reported loose stools or diarrhea (7.9%, Table 1). Similarly, most patients reported a normal frequency of flatus presurgery (69.8%), and few reported frequent flatus (5.6%). The questionnaire revealed that this flatus was sometimes malodorous (median 5 on VAS), but it rarely bothered patients (median 4 on VAS) and almost never affected their social lives (median 2 on VAS).

Biliopancreatic Diversion Most patients undergoing BPD reported their bowel motions to be normal before surgery (70.9%) and few reported loose stools or diarrhea (7.8%, Table 1). Similarly, most patients reported a normal frequency of flatus presurgery (67.0%), and few reported frequent flatus (4.9%). Regarding flatus, the questionnaire revealed that it was sometimes malodorous (median 5 on VAS), that patients were a little bothered by the malodorous flatus (median 5 on VAS), and that it sometimes affected their social lives (median 5 on VAS).

Bowel Habits Between Groups Before Surgery As expected, bowel habits and frequency of flatus were similar

Table 1 Changes in bowel motions before and after bariatric surgery

Group	Normal		Constipated		Loose		Diarrhea		P value (within group)		P value (between groups)		
	Before	After	Before	After	Before	After	Before	After	Before vs. after	Before	After	Before vs. after	
	BPD ($n=103$)	70.9	17.5	21.4	4.9	6.8	60.2	1.0	17.5	<0.001	NS	<0.001 ^a	0.002 ^a
RYGB ($n=126$)	62.7	46.8	29.4	7.1	6.3	40.5	1.6	5.6	<0.001	NS	<0.001 ^a	0.002 ^a	
AGB ($n=61$)	73.8	57.4	21.3	39.3	4.9	3.3	0.0	0.0	<0.03	NS	<0.001 ^a	<0.001 ^a	

Results are given as percentage of patients of the respective group.

BPD biliopancreatic diversion, RYGB Roux-en-Y gastric bypass, AGB adjustable gastric banding

^a Versus other groups

Table 2 Changes of flatus frequency before and after bariatric surgery

Groups	Normal		Rare		Frequency ^a		<i>P</i> value (within group) Before vs. after	<i>P</i> value (between groups)		
	Before	After	Before	After	Before	After		Before	After	Before vs. after
BPD (<i>n</i> =103)	67.0	35.9	28.2	8.7	4.9	55.3	<0.001	NS	NS	NS
RYGB (<i>n</i> =126)	69.8	44.4	24.6	6.3	5.6	49.2	<0.001	NS	NS	NS
AGB (<i>n</i> =61)	77.0	70.5	8.2	21.3	14.8	8.2	<0.05	<0.002 ^b	<0.001 ^b	<0.001 ^b

Results are given as percentage of patients of the respective group.

BPD biliopancreatic diversion, RYGB Roux-en-Y gastric bypass, AGB adjustable gastric banding

^a>24 times/24h

^bVersus the other groups

in patients before undergoing AGB, RYGB, or BPD (Tables 1 and 2), with the exception that AGB patients were three times more likely to report frequent flatus before surgery compared to patients undergoing BPD or RYGB ($P<0.001$, $P=0.002$ vs. AGB, respectively, Tables 1 and 2). Presurgical frequency of malodorous flatus was similar between the three groups (Fig. 1). Interestingly, patients undergoing BPD were more likely to be bothered by malodorous flatus before surgery when compared to patients undergoing RYGB or AGB (Fig. 2), and also reported that their malodorous flatus impaired their presurgical social life more frequently than patients undergoing ABG or RYGB (Fig. 3). Reported bowel habits did not change between the three groups after matching patients for time after surgery ($n=25$ in each group, median observation period 4.5 years).

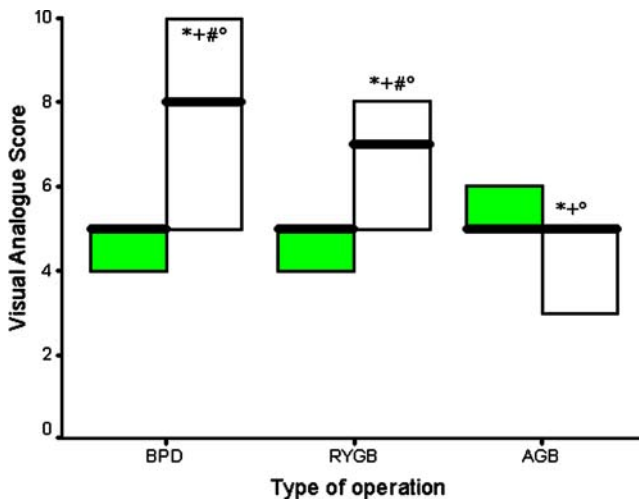


Fig. 1 Results are depicted in box plots. Box plots represent the median with 25th and 75th percentiles, respectively. Grey-shaded boxes denote results before surgery, white-shaded boxes denote results after surgery. BPD biliopancreatic diversion, $n=103$; RYGB Roux-en-Y gastric bypass, $n=126$; AGB adjustable gastric banding, $n=61$; within group before vs. after surgery, $*p<0.001$; between groups after surgery, $+p<0.003$ vs. other groups; change between the groups as a consequence of surgery, $^{\circ}p<0.01$ BPD vs. RYGB, $\#p<0.001$ AGB vs. BPD and RYGB

Metabolic Syndrome and Bowel Habits Before Surgery Patients with AGB, RYGB, and BPD demonstrated similar frequencies of metabolic syndrome (60.7%, 56.4% and 65.1% of patients, respectively). Flatus severity score was similar in patients with or without metabolic syndrome before surgery (17.7 ± 0.7 vs. 17.6 ± 0.5).

Bowel Habits After Surgery

Adjustable Gastric Banding Consistency of bowel motions changed after AGB implantation ($P<0.03$). In contrast to both BPD and RYGB, AGB patients were more likely to complain of constipation after surgery (39.3% vs. 21.3% pre-operation), and fewer patients reported normal bowel motions (57.4% vs. 73.8% pre-operation). The frequency of flatus decreased after surgery ($P<0.05$), and although the

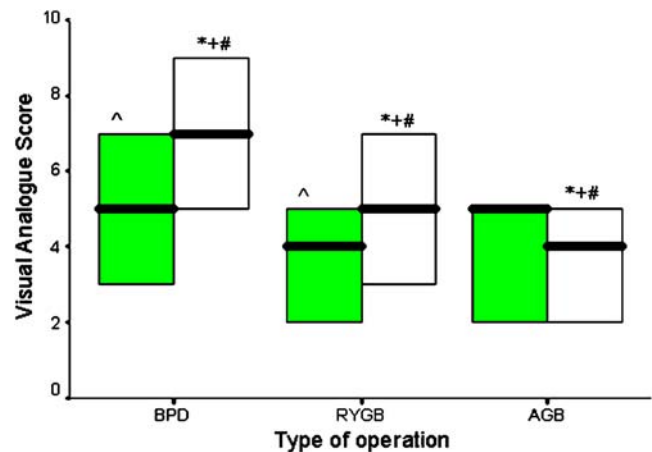


Fig. 2 Results are depicted in box plots. Box plots represent the median with 25th and 75th percentiles, respectively. Grey-shaded boxes denote results before surgery, white-shaded boxes denote results after surgery. BPD biliopancreatic diversion, $n=103$; RYGB Roux-en-Y gastric bypass, $n=126$; AGB adjustable gastric banding, $n=61$; within group before vs. after surgery, $*p<0.001$; between groups before surgery, $\wedge p<0.01$ BPD vs. RYGB; between groups after surgery, $+p<0.001$ vs. other groups; change between the groups as a consequence of surgery, $\#p<0.001$ AGB vs. BPD and RYGB

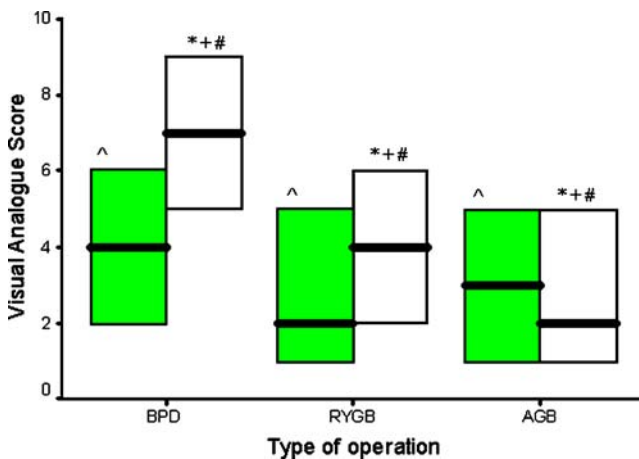


Fig. 3 Results are depicted in box plots. Box plots represent the median with 25th and 75th percentiles, respectively. Grey-shaded boxes denote results before surgery, white-shaded boxes denote results after surgery. BPD: biliopancreatic diversion; $n=103$. RYGB: Roux-en-Y gastric bypass; $n=126$. AGB: adjustable gastric banding; $n=61$; within group before vs. after surgery, $*p<0.003$; between groups before surgery, $^{\wedge}p<0.05$ BPD vs. AGB and RYGB; between groups after surgery, $+p<0.002$ vs. other groups; change between the groups as a consequence of surgery, $\#p<0.01$ vs. other groups

majority of patients still reported flatus frequency to be normal (70.5% vs. 77.0% pre-operation), the number of patients reporting flatus to be rare is more than double (21.3% vs. 8.2% pre-operation, Table 1). After surgery, flatus was less often malodorous ($P<0.001$, Fig. 1), patients were less bothered by their malodorous flatus ($P<0.001$, Fig. 2), and their social life was less likely to be influenced by their flatus ($P=0.002$, Fig. 3).

Roux-en-Y Gastric Bypass Patients after RYGB reported a sevenfold increase in the number of loose stools or diarrhea affecting nearly half the patients (46.1% vs. 7.9% pre-operation, Table 1). A similar, ninefold increase affecting half the patients was observed in the incidence of frequent flatus (49.2% vs. 5.6% pre-operation, Table 2). Flatus was more often malodorous ($P<0.001$, Fig. 1) after surgery, the patients were more bothered by their malodorous flatus ($P<0.001$, Fig. 2), and their social life was more likely to be influenced negatively by their flatus ($P<0.001$, Fig. 3).

Biliopancreatic Diversion Patients undergoing BPD reported a tenfold increase in the number of loose stools or diarrhea (77.7% vs. 7.8% pre-operation, Table 1). Moreover, the frequency of normal bowel motions decreased by 75% (from 70.9% pre-operation to 17.5%, Table 1). Constipation was rare (Table 1). The incidence of frequent flatus increased tenfold, affecting more than half the patients (55.3% vs. 4.9% pre-operation, Table 1). Flatus was more often malodorous ($P<0.001$, Fig. 1), patients

were more bothered by their malodorous flatus ($P<0.001$, Fig. 2), and their social life was more likely to be negatively influenced by their flatus ($P<0.001$, Fig. 3).

Bowel Habits Between Groups After Surgery After surgery, the proportion of AGB patients reporting constipation was nearly five and a half times that of RYGB patients and eight times that of BPD patients who reported constipation. In contrast, loose stools and diarrhea together were reported by proportions of BPD and RYGB patients, respectively, 14 and nearly 24 times larger than the proportion of AGB patients who reported loose stools and diarrhea. The proportion of BPD patients reporting normal stool habits decreased by a factor of four, and the proportions of patients reporting diarrhea and normal stool habits were the same for BPD patients 3 years after surgery (17.5%; Tables 1 and 2; Figs. 1–3).

The incidence of frequent flatus increased about tenfold—interestingly to similar proportions—among BPD and RYGB patients. This compares to over a doubling in the number of AGB patients who reported flatus to be rare ($P<0.001$). Furthermore, compared to AGB patients, BPD and RYGB patients reported more malodorous flatus, were more bothered by flatus, and that flatus had a greater negative effect on their social lives compared to before surgery (all $P<0.001$). In addition, bowel motions became significantly looser for BPD patients than RYGB patients ($P=0.002$), and malodorous flatus after surgery was a greater problem for BPD patients than RYGB patients ($P=0.003$) and influenced social interactions more ($P=0.003$). When the three groups of patients were matched for observation period after surgery (median 4.5 years, $n=25$ in each group), similar results and statistical differences were observed for surgically induced changes in bowel habits.

Metabolic Syndrome and Bowel Habits After Surgery In AGB patients, frequency of metabolic syndrome decreased by 43.9% (preoperative 60.7% to postoperative 14.9%). Similar changes were observed after RYGB (minus 42%) and BPD (minus 35.4%). The unexpected low reduction in frequency of metabolic syndrome in BPD patients is mostly due to procedure-associated decrease in HDL cholesterol. Flatus severity score after surgery was similar in subjects with or without metabolic syndrome (22.9 ± 0.7 vs. 23.4 ± 0.9).

BAROS Score and Type of Bariatric Operation

Points in the BAROS quality of life subscore range between -3 and $+3$. A score of 0 therefore would indicate no change in quality of life as a consequence of bariatric surgery. In contrast to the results from the bowel and flatus questionnaire, quality of life scores from BAROS were

Table 3 Quality of life scores after bariatric surgery as measured by BAROS

	BPD	RYGB	AGB
Physical activity	0.28±0.02	0.27±0.02	0.27±0.02
Social interaction	0.20±0.02	0.20±0.02	0.15±0.03
Capacity for work	0.21±0.02	0.22±0.02	0.18±0.02
Sexual activity/interaction	0.03±0.02	0.07±0.02	0.08±0.02
Self esteem	0.57±0.04	0.63±0.04*	0.47±0.05*
Total	1.28±0.09	1.39±0.08	1.15±0.10

Range of possible points in the BAROS quality of life subscore are between -3 and +3. Therefore a score of 0 would demonstrate no change in quality of life as a consequence of bariatric surgery.

BPD biliopancreatic diversion, RYGB Roux-en-Y gastric bypass, AGB adjustable gastric banding

* $P < 0.01$

similar for the three different operations (Table 3). Interestingly, the self-esteem subscore was highest for RYGB patients and significantly higher than that for subjects who underwent AGB ($P=0.006$, Table 3). The flatus severity score was highest for BPD patients (28 ± 1 , for calculation see methods section), intermediate for RYGB patients (23 ± 1), and lowest for AGB patients (15 ± 1 ; all $P < 0.001$). Quality of life as estimated by BAROS correlated inversely with the flatus severity score after RYGB ($r = -0.3$, $P < 0.001$) and BPD ($r = -0.22$, $P < 0.03$), but not after AGB.

Discussion

Bariatric surgery is an effective weight loss treatment for severe obesity [11], yet some of the side effects and their implications on quality of life have rarely been explored. This study demonstrates that constipation is a common effect after AGB. In fact, the number of patients reporting constipation after surgery increased by more than 40% compared to presurgery values (Table 1). In contrast, frequency of reported constipation decreased dramatically in patients undergoing BPD and RYGB, only 5% and 7%, respectively, of whom reported constipation after surgery. Therefore, RYGB or BDP, rather than AGB, should be considered as the bariatric operation of choice in severely obese patients with pre-existing constipation. Whether the increased frequency of constipation in patients undergoing AGB is due to the known fact of decreased amount of food and especially fibre intake after surgery awaits further study.

Loose stools and diarrhea are rarely considered as a relevant side effect of RYGB. Surprisingly, after RYGB, patients experienced loose stools/diarrhea five times more frequently than before surgery ($P < 0.001$, Table 1). Moreover, loose stools/diarrhea were ten times more frequent in RYGB patients compared to those restricted with AGB ($P < 0.001$, Table 1). Whether this finding is due to an increased frequency of acquired lactose intolerance after RYGB (about

5% in our patient population, unpublished data) remains to be demonstrated, since lactose intolerance was not routinely determined in the present study. It is of interest to note that the follow-up of BPD and AGB patients at the time of answering the questionnaire was about 6 years, compared to 2 years in RYGB patients. To assess the impact of different observation periods after surgery on procedural change of bowel habits, subjects were matched for a median observation period of 4.5 years. Interestingly, no change in reported results between the three groups was observed, indicating that at least in a time frame of 4.5 years, no adaptation of bowel habits occurs.

In clinical practice, frequency of acquired lactose intolerance after RYGB decreases with increasing time after surgery (unpublished data). Whether bowel habits in RYGB patients might change beyond 4.5 years to more normal behavior needs further study. As expected, change in consistency of bowel motions after BPD was even greater than after RYGB ($P = 0.002$), with nearly 80% of patients reporting loose stools or diarrhea even 6 years after the intervention. Whether this massive long-term change in bowel habits after BPD might influence long-term calcium and electrolyte homeostasis requires further study. Irrespective of the long-term pathophysiological consequences of change in bowel habits, patients should be carefully informed preoperatively in order to avoid long-term unwanted side effects of their chosen bariatric procedure. Flatus decreased after AGB, with twice as many patients reporting that flatus was rare ($P < 0.05$, Table 1). Moreover, the incidence of frequent flatus was cut in half after the operation. Reporting flatus is a typical clinical sign of lactose, fructose, or sorbitol malabsorption, which is very frequent in the general population [12]. Whether the reported decrease in flatus after AGB might be due to a decreased amount of ingested carbohydrates, especially fructose, or more generally might be due to decreased food intake requires further study. Irrespective of the mechanism, the decrease in flatus frequency is certainly welcomed by

every patient. In contrast, frequent flatus was reported about ten times more often after RYGB and BPD (both $P<0.001$, Table 1). The increased frequency of frequent flatus is not surprising in patients after BPD because of the known fact of fat malabsorption and thus altered fat digestion. However, the similarly increased rate of frequent flatus in patients after RYGB is surprising, since maldigestion/absorption of carbohydrates and/or fat is not a well-accepted fact of RYGB. Further studies are needed to investigate not only frequency of lactose intolerance in patients after RYGB, but also the fate of ingested carbohydrates and different types of fat by the operatively altered intestine.

Not only frequency of flatus changed as a consequence of type of bariatric method (Table 1), but also the odor of the flatus (Fig. 1). Whereas the odor of flatus was less often reported as smelly by AGB patients after surgery, RYGB and especially BPD patients reported dramatic increases in malodorous flatus on visual analogue scales (Fig. 1, $p<0.003$). Malodorous flatus in RYGB and especially in BPD patients was perceived as more bothersome (Fig. 2), a finding not seen in AGB patients. BPD patients also reported that malodorous flatus affects their social life significantly more than patients undergoing RYGB or AGB ($P<0.003$, Fig. 3). This finding indicates that social life and its quality might be detrimentally affected by BPD, a fact about which patients undergoing BPD should be thoroughly informed before surgery.

One drawback of our study design is the retrospective evaluation of bowel habits before surgery. Since reported bowel habits of all three groups before surgery were very similar after matching for observation period after surgery (median follow-up 4.5 years), reported results on bowel habits before surgery might similarly be influenced by the patient's memory in all three groups.

It is of interest to note that preoperative frequency of metabolic syndrome as defined by ATP III criteria did not

influence bowel habits after either surgical procedure, indicated by similar flatus severity scores in patients with or without metabolic syndrome before and after surgery. Preoperative duration of metabolic syndrome including type 2 diabetes was not assessable in most patients. Therefore, the impact of duration of metabolic syndrome before bariatric surgery on bowel habits after surgery remains an open question.

Quality of life as measured by the BAROS [5] was similar irrespective of type of operation used to treat morbid obesity, with the exception of the self-esteem question, where RYGB patients scored higher ($P=0.006$, Table 3). This finding might be due to the fact that the follow-up time after operation was shorter by 4 years, and the BMI achieved was much lower in RYGB patients (BMI 30.4 ± 0.4 kg/m²) than in AGB (BMI 35.4 ± 0.8 kg/m²) or BPD patients (BMI 34.2 ± 0.7 kg/m²). It is well known that peak improvements of quality of life are observed during the first year after surgery, whereas during the subsequent years, possibly due to weight regain, a gradual decrease occurs in measures of quality of life [13]. It is of interest to note that flatus severity score was inversely correlated with the self-esteem subscore and total quality of life score as estimated by BAROS for BPD ($r=-0.22$, $P<0.03$) and RYGB ($r=-0.3$, $P<0.001$), but not AGB patients. No such correlation was detected between bowel motion and BAROS scores of quality of life in all three groups. Therefore, patient quality of life after bariatric surgery seems to be affected by frequency of flatus and its smell, but not by bowel motion. However, overall rating of quality of life in the three different operations investigated was not influenced by flatulence and its smell, indicating that other factors such as amount of weight reduction, improvement of comorbidities, etc. are more important in overall rating of quality of life after bariatric surgery than flatulence and its smell.

Appendix 1

Questionnaire

Instructions:

For questions with boxes, please mark the most appropriate answer with a cross in the box.

For questions with lines and numbers, please place a cross on the scale from 0–10 marking your most appropriate answer.

1. **BEFORE** my operation, my bowel motions were:

Rather liquid (diarrhea)	Like rice-water (diarrhea)	Normal	Rather constipated
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. **SINCE** my operation, my bowel motions are:

Rather liquid (diarrhea)	Like rice-water (diarrhea)	Normal	Rather constipated
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

→ **In Question 2, if you crossed Rather liquid (diarrhea) above, please answer Questions 3, 5 & 6.**

→ **In Question 2, if you crossed Like rice-water (diarrhea) above, please answer Questions 4, 5 & 6.**

→ **Otherwise, turn directly to Questions 5 & 6.**

3. You report **Rather liquid** bowel motions:

a) How often per day? _____ times.

b) How often per week? 1 2 3 4 5 6 7 times

c) How much does it bother you?

Not at all		Sometimes		Very much					
1	2	3	4	5	6	7	8	9	10

d) Do fatty foods seem to have an effect?

No, never		Sometimes		Yes, always					
1	2	3	4	5	6	7	8	9	10

4. You report bowel motions **Like rice-water**:

- a) How often per day? _____ times
- b) How often per week? 1 2 3 4 5 6 7 times
- c) How much does it bother you?
- Not at all Sometimes Very much
- | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
-
-

- d) Do fatty foods seem to have an effect?
- No, never Sometimes Yes, always
- | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
-
-

5. **BEFORE** my operation, my wind (flatulence) was:

- a) Frequency
- | | | |
|--------------------------|--------------------------|---------------------------------------|
| Infrequent | Normal | Rather frequent (>24 times in 24 hrs) |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
- b) Odour
- | | | | | | | | | | |
|--------------|---|---|---|------------------|---|---------------|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Never smelly | | | | Sometimes smelly | | Always smelly | | | |
-
-
- c) The smelly wind bothered me:
- | | | | | | | | | | |
|-------|---|---|---|----------|---|-----------|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Never | | | | A little | | Very much | | | |
-
-
- d) Because of my smelly wind, I had difficulty in the company of other people:
- | | | | | | | | | | |
|-------|---|---|---|-----------|---|-----------|---|---|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Never | | | | Sometimes | | Very much | | | |
-
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