Irritable bowel syndrome-like symptoms before and after bariatric surgery and association with short-chain fermentable carbohydrates consumption: an observational prospective study

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Abstract

Background and aims: **Irritable Bowel Syndrome (IBS)-like symptoms are frequent following bariatric surgery. This study aims to evaluate the frequency of IBS symptoms severity before and after bariatric surgery and their association with short-chain fermentable carbohydrates (FODMAPs) consumption.**

Patients and methods: **IBS symptoms severity in a cohort of obese patients was evaluated prospectively before, 6 and 12 months after bariatric surgery by validated questionnaires and tools (Irritable Bowel Syndrome Severity Scoring System (IBS SSS), Bristol Stool Scale (BSS), Quality of Life Short- Form-12 (SF-12), Hospital Anxiety and Depression scale (HAD)). FODMAPs consumption and its association with IBS symptom severity was evaluated by using a food frequency questionnaire focused on high-FODMAPs food consumption.**

Results: **Fifty-one patients were included (41 female; mean age 41 years (SD: 12)), 84% received a sleeve gastrectomy, and 16% a Roux-en-Y gastric bypass. Symptoms compatible with IBS were observed in 43% of patients before surgery, in 58% of patients at 6 months and 33% at 12 months (NS, p-value=0,197 and 0,414). In a multivariate model, a significant association was found between the IBS SSS score and lactose consumption at 6 months (β = + 58, 1; p = 0.03), and with polyols consumption at 12 months (β = + 112,6; p = 0.01).**

Conclusions: **Mild to moderate IBS symptoms are frequent in obese patients before bariatric surgery. A significant association between lactose and polyols consumption and IBS SSS score was observed after bariatric surgery, suggesting a potential link between the severity of IBS symptoms and some specific FODMAPs consumption.**(Acta gastroenterol. belg., **2023,** 86, **288-297**).

Keywords: IBS, FODMAPs, bariatric surgery, obesity.

Introduction

Irritable Bowel Syndrome (IBS) is a common functional bowel disorder characterized by recurrent abdominal pain associated with a change in bowel frequency and/or consistency (1). Short-chain fermentable carbohydrates (FODMAPs) can trigger symptoms in IBS, and a diet with reduced FODMAP intake (Low FODMAP Diet, LFD) has shown efficacy in the treatment of patients suffering from IBS (2). While IBS affects 4.1% to 25% of the population worldwide (3,4), its prevalence would be even higher in obese people (5,6,7,8). Obesity is a pandemic and affects 21% of adult population worldwide (9). Although diet and physical activity remain the cornerstone of the treatment, bariatric surgery is also increasingly used in the treatment of morbid obesity and its comorbidities.

Bariatric surgery induces important physiological changes in the digestive system that may cause or modify digestive symptoms (10,11,12,13). Nevertheless, the prevalence of IBS-like symptoms in patients undergoing bariatric surgery is poorly documented. Moreover, the role of reduced tolerance to FODMAPs in those patients has been rarely considered and has yet never been investigated in prospective studies.

The aim of the current study was to evaluate the prevalence of IBS-like symptoms before and after bariatric surgery and their association with FODMAPs consumption in obese patients. The primary outcome was therefore to evaluate the frequency and severity of digestive symptoms suggestive of IBS in obese patient before, 6 and 12 months after bariatric surgery. The secondary outcome was to evaluate the level of FODMAPs intake and its association with IBS-like symptoms.

Materials and Methods

Population

Inclusion criteria

Obese patients aged between 18 to 65 years old applying for bariatric surgery at the obesity clinic in Erasme hospital were eligible for this study. To be included, patients had to meet Belgian eligibility criteria for access to bariatric surgery (having body mass index (BMI) ≥ 40 kg/m² or BMI ≥ 35 kg/m² associated with at least one associated comorbidity such as diabetes, hypertension, sleep apnoea obstructive syndrome or a reoperation after complication or insufficient result of a previous bariatric intervention), and and to be evaluated by the multidisciplinary team (dietician, psychologist, internist, endocrinologist and surgeon). The type of surgery performed was determined at the end

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of the bariatric workup, based on patient's willingness, comorbidities and eating profile.

Exclusion criteria

Patients with an organic digestive disease such as coeliac disease, inflammatory bowel disease or a history of oncological digestive disease were excluded, based on the medical history and after the routine bariatric workup that included blood and urine analysis and an upper GI endoscopy. Complementary workup was performed depending on patient's age, symptoms, clinical and familial history. Patients treated with a GLP1 analogous (liraglutide, semaglutide) were also excluded in the light of their potential digestive side effects.

Evaluation tools

A binder including the following validated questionnaires was used to evaluate symptom severity, quality of life and anxiety or depression: Irritable Bowel Syndrome Severity Scoring System (IBS-SSS); Bristol Stool Scale (BSS); Quality of Life- Short Form-12 (SF-12); Hospital Anxiety and Depression Scale (HAD)). A home-developed food frequency questionnaire (FFQ) and a visual analogue scale (VAS) for symptom evaluation were also included.

Irritable Bowel Syndrome – Severity Scoring System (IBS-SSS)

The IBS-SSS evaluates the severity of several IBS symptoms and impact on daily life and summarized in a simple numeric score. Scores between 75 and 175 indicate mild, between and 175 to 300 moderate, and above 300 severe IBS. There is no significant IBS with scores below 75. A change of 50 points is considered clinically relevant (14).

Bristol Stool Scale (BSS)

The BSS describes stool consistency with pictograms on a 7 points scale (15).

Quality of life short-form 12 (SF-12)

SF-12 is a standard tool to evaluate mental and physical quality of life (16).

Hospital Anxiety and Depression scale (HAD)

Because of the known association between psychological comorbidities and IBS symptoms, we included the HAD scale grading anxiety and depression (17).

Dietetic questionnaires focused on FODMAPs consumption (FFQ-FODMAPs)

A dietetic questionnaire was created for the purpose of this study to evaluate the average FODMAPs consumption. Food items containing high FODMAPs levels are listed in this qualitative food frequency questionnaire (FFQ). Intake frequencies are listed for each food item in a multiple-choice table. The food list was based on the "food guide" established by the Monash University in their FODMAPs official app (Monash University Low FODMAP Diet™). Using response scores in our table, a score was computed to estimate FODMAPs frequency consumption by a numeric quantitative value used for correlation analyses. A numeric score is recorded for each of the 5 FODMAP subgroups (fructose, lactose, fructans, galactans, polyols) and summarized in one overall score. The minimum value of the score is 0 (= no consumption) and the maximum is 4 (= daily consumption).

Frequencies of patients that were sometimes, regularly and daily consuming high FODMAPs food were pooled to evaluate their absolute consumption frequencies (supplementary material 3).

Visual analogue scale (VAS)of IBS-like symptoms

The presence and severity of abdominal pain/cramps, bloating, flatulence, diarrhoea, and constipation were assessed with the use of VAS going from 0 to 5 (0 = none; 1= very low; 2 = low ; 3 = moderate ; 4= severe ; 5 = very severe).

Design of the study

This was a longitudinal observational prospective study.

Questionnaires (IBS-SSS, BSS, SF-12, HAD, FFQ-FODMAPs, VAS) were submitted to patients three times along the study: after the initial bariatric workup, and 6 and 12 months after surgery. All questionnaires were self-administered.

Sample size and statistical analysis

We calculated that a sample size of 100 patients was necessary to demonstrate a clinically relevant difference of 50 points in the main endpoint (IBS-SSS) with an α threshold set at 5% and a power of 80%.

Data were collected in an eCRF using REDCap software. A Java software was developed in the scope of this study to automate calculation of clinical scores (source code publicly on GitHub.com [https://github.com/vVYou/StudyReport]).

Standard descriptive analyses were performed. Results are expressed as their mean (standard deviation), median (interquartile intervals) and proportion (percentage) depending on the type of variable and the distribution of the data. Wilcoxon paired t test, ANOVA, Student t test and Student paired t-tests have been used to assess differences of mean or median. Choice of tests was based on the type of data and normality. Correlation analyses were used to assess the association between the IBS SSS score, FODMAPs consumption and other clinical variables through univariate and multivariate linear regressions (Pearson's r).

There was no imputation of missing data.

Results were obtained using Stata/IC 16.0 and Microsoft Excel Office 365 software. The statistical significance threshold is 5%.

Results

Inclusion and follow-up

Patients were included before their surgery between August 2019 and May 2020, and then followed-up during a 12-months period.

During the 15 months of the inclusion period, 165 patients underwent bariatric surgery at Erasme hospital. Fifty-six patients were included in the study but five of them had to be excluded from baseline analyses because of inclusion failure. Forty patients completed their follow-up at six months after surgery. Twenty-one patients completed their follow-up at twelve months (Figure 1). Due to COVID-19 crisis, the recruitment had to be stopped for 4 months inducing a smaller sample size as based on previous years expectations.

General characteristics

Description of the study population

There was a majority of women (80%) with a mean age of 41years (SD: 12). Ten patients (20%) had undergone a previous bariatric procedure (Table 1)

Characteristics related to surgery

Forty-nine of the 51 included patients eventually underwent bariatric surgery. The most frequent procedure was sleeve gastrectomy (SG) (84%). Alternatively, a Roux-en-Y gastric bypass was performed (8/49 (16%)). Nine cases were re-intervention ("re-do") because of a weight regain and/or dysphagia.

Body weight

Before bariatric surgery, mean body mass index (BMI) was 41,8 kg/m² (SD: 4,5) with a mean weight of 114 kg (SD: 13) (Table 1). The mean total body weight loss at 6 and 12 months after surgery was respectively equal to 22% (SD: 6) and 26% (SD: 9). The mean BMI at six and twelve months after surgery was respectively 31,9kg/m² (SD: 4,5) and 29,7kg/m² (SD: 4,3) (Table 2).

Gastrointestinal symptoms, IBS severity and FODMAPs consumption before bariatric surgery

IBS symptoms

Using a visual analog scale, most of the patients reported to have no or minor symptoms. Moderate to very severe symptoms were reported as following: abdominal pain (14%), bloating (34 %), flatus (37%), diarrhoea (16%) and constipation (26%) (Table 2a).

A normal stool consistency (BSS types 3 and 4) was reported most frequently (56%), while loose stool (BSS

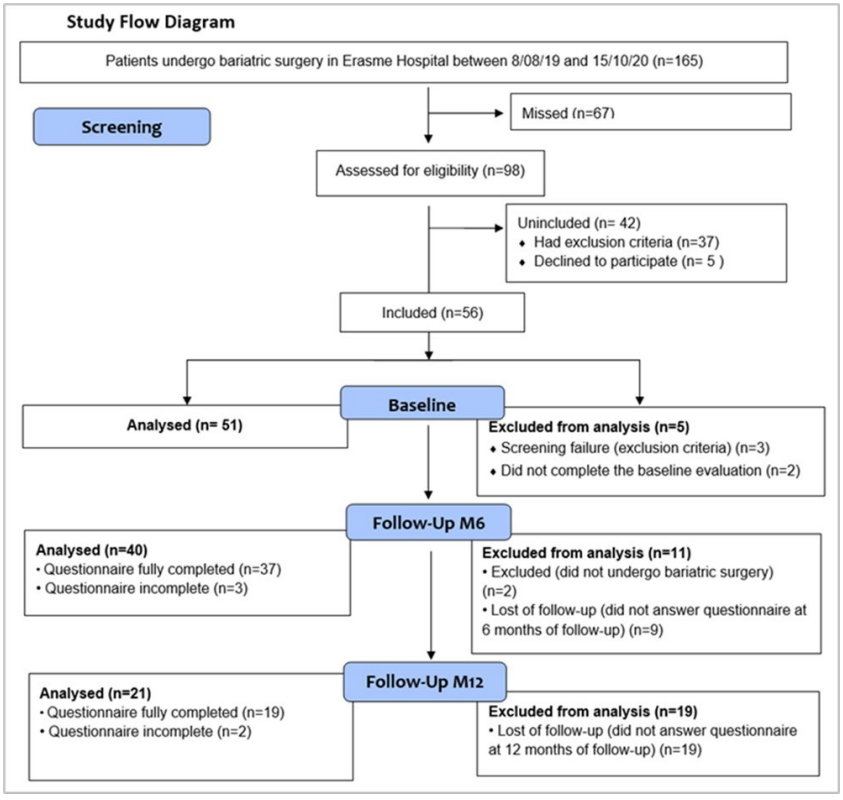

Figure 1. — Study flow chart.

Table 1. — **General characteristics of the sample (n=51)**

Characteristics of the included subjects		**(n=51)**
Age	Mean ± SD	41,3 ±11,9
	Median [IQR]	42 [31-49]
Weight (kg)	Mean ± SD	114 ±13
	Median [IQR]	111 [103-124]
BMI (kg/m²)	Mean ± SD	41,8 ±4.5
	Median [IQR]	40.8 [38,8-43,9]
		Number (%)
Gender	Male	10 (19,6%)
	Female	41 (80,3%)
Diabetes		7 (13,7%)
Hypertension		17 (33,3%)
Gastro-Esophagal Reflux Disease		17 (33,3%)
Sleep Apnea Obstructive Syndrome		21 (41,2%)
Previous bariatric surgery		10 (19,6%)
	Banding	4 (8%)
	RYBP	2 (4%)
	SG	1 (2%)
	SRVG	2 (4%)
	Endoscopic gastroplasty	1 (2%)

BMI : Body Mass Index ; RYBP : Roux-en-Y gastric bypass ; SG: sleeve gastrectomy ; SRVG: silastic ring vertical gastroplasty.

Table 2a. — **Clinical scores before and after bariatric surgery**

		Baseline	**6 months of follow-up**	**12 months of follow-up**
General symptoms (VAS)		**(n=51)**	**(n=40)**	**(n=21)**
Abdominal pain	*None to low*	44 (86)	35 (88)	18 (86)
	Moderate to very severe	7 (14)	5 (13)	3 (14)
Bloating	*None to low*	34 (67)	26 (65)	19 (90)
	Moderate to very severe	17 (34)	14 (36)	2 (10)
Flatus	*None to low*	32 (63)	27 (68)	13 (62)
	Moderate to very severe	19 (37)	13 (33)	8 (39)
Diarrhoea	*None to low*	43 (84)	34 (85)	17 (81)
	Moderate to very severe	8 (16)	6 (15)	4 (20)
Constipation	*None to low*	38 (75)	29 (73)	17 (81)
	Moderate to very severe	13 (26)	11 (28)	4 (19)

VAS: Visual analogue scale

5 to7) or hard stool (BSS 1 or 2) frequencies were 42% and 24% respectively (Table 2b).

Irritable Bowel Syndrome – Severity Scoring System (IBS-SSS)

At baseline, as a group, the mean IBS-SSS score was 83,5 (SD: 81,6). Using the 75 points IBS-SSS threshold we recorded symptoms compatible with IBS in 43% of patients. No score compatible with severe IBS was observed before surgery. A significant difference in IBS-SSS score was observed in patients with a history of previous abdominal surgery (102,8 (SD: 92,2); n=29), compared to those without (58,2 (SD: 57,8); n=22) (p=0.05) (Table 2b).

Hospital Anxiety and Depression scale (HAD)

Pre-operatively, mean anxiety (HAD-A) and depression scores (HAD-D) were 9,7 (SD: 3,7) and 7,7 (SD : 4,1) respectively. According to the HAD score classification, 40% of patients suffered from anxiety and 28% from depression (Table 2b).

Table 2b. — **Irritable Bowel Syndrome Severity Scoring System (IBS SSS) score evolution**.

	Baseline	6 months of follow-up	12 months of follow-up	Changes (ANOVA)
Bristol Stool Scale (BSS)	**(n=50)**	**(n=38)**	**(n=21)**	
Type 1 and 2	12 (24%)	9 (24%)	2 (10%)	
Type 3 and 4	28 (56%)	23 (61%)	15 (71%)	
Type 5 to 7	21 (42%)	4 (11%)	4 (19%)	
Irritable Bowel Syndrome Severity Scoring System (IBS SSS)	**(n=51)**	**(n=38)**	**(n=21)**	**(n=21)**
Mean ±SD	83,5 ± 81,6	105,8 ± 91,3	83,3 ± 95,0	*p=0,29*
Median (IQR)	70 (20 - 120)	95 (30 - 160)	60 (20 – 100)	
Range	0 – 300	0 – 360	0 – 380	
Distribution - n (%)				
None (<75)	29 (57%)	16 (42%)	14 (67%)	
Mild (75-175)	15 (29%)	16 (42%)	4 (19%)	
Moderate (175 -300)	7 (14%)	4 (11%)	2 (10%)	
Severe (>300)	0 (0%)	2 (5%)	1 (5%)	
Physical Quality of Life Short-Form 12 (SF-12 P)	**(n=51)**	**(n=38)**	**(n=20)**	**(n=20)**
Mean ±SD	40,5 ± 11,5	48,7 ± 7,7	50,1 ± 8,6	*p=0,35*
Median (IQR)	40 (32 – 52)	50 (45 – 55)	(46,5 – 55,5)	
Range	19 – 57	29 – 59	29 – 58	
Distribution - n (%)				
Severe impairment (<30)	11 (22%)	1 (3%)	0 (5%)	
Moderate impairment (30-39)	13 (25%)	6 (16%)	2 (10%)	
Mild impairment (40-49)	11 (22%)	10 (26%)	4 (20%)	
Mean quality of life (≥50)	16 (31%)	21 (55%)	12 (65%)	
Mental Quality of Life Short-Form 12 (SF-12 M)	**(n=51)**	**(n=38)**	**(n=20)**	**(n=20)**
Mean ±SD	44,0 ± 11,1	48,8 ± 8,7	51,6 ± 9,5	*p=0,09*
Median (IQR)	45 (35 – 53)	50 (43 – 56)	(49,5 – 58,0)	
Range	20 – 69	27 – 61	28 – 61	
Distribution - n (%)				
Severe impairment (<30)	4 (8%)	1 (3%)	1 (5%)	
Moderate impairment (30-39)	15 (29%)	4 (10%)	2 (10%)	
Mild impairment (40-49)	13 (25%)	11 (29%)	2 (10%)	
Mean quality of life (≥50)	19 (37%)	22 (58%)	15 (75%)	
Anxiety - Hospital Anxiety and Depression scale (HAD – A)	**(n=50)**	**(n=38)**	**(n=20)**	**(n=20)**
Mean ±SD	9,7 ± 3,7	6,5 ± 3,1	5,6 ± 3,5	*p=0,54*
Median (IQR)	9,5 (7 – 13)	6 (5 – 8)	(3,0 – 6,5)	
Range	3 – 18	1 – 17	(2 – 18)	
Distribution - n (%)				
Non-cases (≤7)	13 (26%)	28 (74%)	17 (85%)	
Doubtful cases (8-10)	17 (34%)	8 (21%)	2 (10%)	
Cases (≥11)	20 (40%)	2 (5%)	1 (5%)	
Depression -Hospital Anxiety and Depression scale (HAD-D)	**(n=50)**	**(n=38)**	**(n=20)**	**(n=20)**
Mean ±SD	7,7 ± 4,1	4,1 ± 3,8	3,8 ± 4,9	*p=0,25*
Median (IQR)	8 (5 – 11)	3 (1 – 6)	(0 – 4)	
Range	0 – 16	0 – 14	0 – 17	
Distribution - n (%)				
Non-cases (≤7)	24 (48%)	31 (82%)	16 (80%)	
Doubtful cases (8-10)	12 (24%)	4 (10%)	2 (10%)	
Cases (≥11)	14 (28%)	3 (8%)	2 (10%)	

Table 3. — **FODMAPs consumption frequency scores before and after surgery**

	Baseline (n=51)	6 months of follow-up (n=36)	12 months of follow-up (n=19)
Total FODMAPs	0.76 ± 0.38	0,60 ± 0,30	0,65 ± 0,34
Fructose	0.76 ± 0.40	0,56 ± 0,28	0,57 ± 0,29
Lactose	0.95 ± 0.55	0,82 ± 0,52	0,78 ± 0,49
Fructans	0.74 ± 0.39	0,57 ± 0,28	0,57 ± 0,39
Galactans	0.79 ± 0.46	0,61 ± 0,39	0,69 ± 0,39
Polyols	0.84 ± 0.49	0,66 ± 0,39	0,67 ± 0,37

Quality of life short-form 12 (SF-12)

At baseline, mean scores for mental and physical quality of life were 44,0 (SD: 11,1) and 40,5 (SD : 11,5) respectively. Both scores correspond to a mild impairment of quality of life. (Table 2b)

FODMAPs consumption evaluation

The most consumed FODMAPs sub-group was lactose (26%), then polyols (23%), galactans (21%), fructose (20%) and finally fructans (19%) (Supplementary materials 1). The most high-FODMAPs containing food consumed before surgery were wheat bread (78%), onions (73%), garlic (61%), cream cheese (59%), mushrooms (57 %), yogurts and apples (51%). (Supplementary materials 3). Fifteen patients (29%) had identified one or more trigger foods (Supplementary materials 2).

Evolution of gastrointestinal symptoms, IBS severity and FODMAPs consumption after bariatric surgery

IBS symptoms

Frequencies of self-reported gastrointestinal symptoms showed a decrease in bloating frequency at 12 months after bariatric surgery. Scores for abdominal pain, flatulence, diarrhoea and constipation did not vary significantly 6 or 12 months after surgery (Table 2a). Regarding stool consistency, loose stool was reported less frequently 6 and 12 months after surgery, and hard stool less frequently at 12 months (Table 2b).

Irritable Bowel Syndrome – Severity Scoring System (IBS-SSS)

At 6 and 12 months follow-up, mean IBS SSS score were 105.8 (SD: 91,3) and 83.3 (SD: 95,01) respectively, which were not different from baseline (p-value = 0,29) (ANOVA). (Table 2)

Using the 75 points IBS-SSS threshold we recorded symptoms compatible with IBS in 58% of patients at 6 months and 33% at 12 months. These proportions are not significantly different from baseline (p-value=0,197 and 0,414). On the one hand, 32% of patients increased the level of IBS severity at 6 months, and 24% at 12 months. Among them, 2 patients had an increase in IBS SSS reaching a level compatible with a severe IBS (Figure 2). On the other hand, 16% and 28,5% patients decreased their IBS SSS score at 6 and 12 months respectively by at least one IBS severity level.

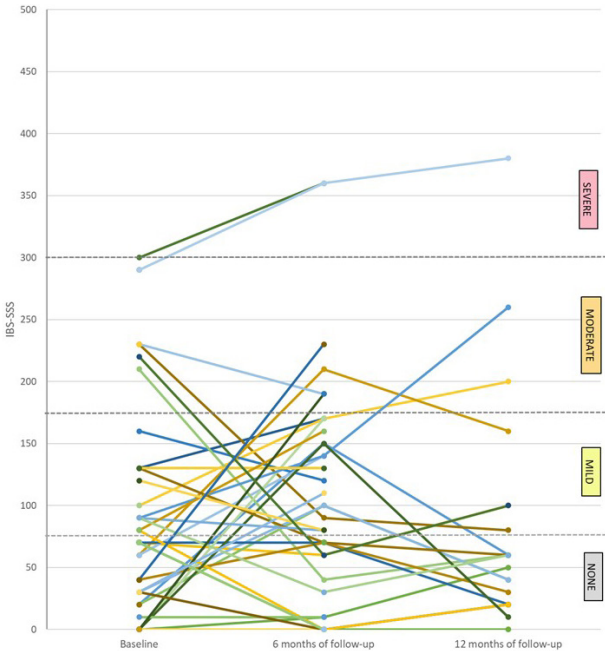

Fig. 2. — IBS-SSS score evolution across the time post bariatric surgery.

Hospital Anxiety and Depression scale (HAD)

Mean anxiety and depression scores after bariatric surgery were not significantly different from baseline. (Table 2) The anxiety score was positively correlated to the IBS SSS before and after surgery. The depression score was positively correlated to the IBS SSS at 12 months post-surgery (Table 2).

Quality of life short-form 12 (SF-12)

Mean mental and physical quality of life scores improved after surgery (NS). More than half of the patients reached a "mean quality of life" for mental, as well as for physical, quality of life 6 and 12 months after bariatric surgery. (Table 2)

FODMAPs consumption evaluation

Six months after bariatric surgery, the most consumed FODMAPs sub-group was still lactose (19%), followed by polyols (16%), galactans (15%), fructans (14%) and fructose (12%). Twelve months after bariatric surgery, the most consumed FODMAPs sub-group was lactose (22%), followed by galactans (19%), fructose (18%), polyols (17%) and fructans (14%). The most high-

Table 4. — **Linear regressions before and after bariatric surgery**

Univariate and multivariate linear regression of factors potentially associated with IBS SSS score before bariatric surgery				
Exposure variable and co-variables	**Univariate correlation coefficient (r Pearson)**	**p-value**	**Multivariate regression coefficient (b±SE)**	**p-value**
Total FODMAPs score (0-4)	+0,23	0,097		
Fructose score (0-4)	+0,20	0,16		
Lactose score (0-4)	+0,29	0,04*	+32,0 ± 18,7	0,09
Fructans score (0-4)	+0,25	0,08		
Galactans score (0-4)	+0,19	0,19		
Polyols score (0-4)	+0,14	0,32		
HAD-A (0-21)	+0,36	0,01*	+7,0 ± 2,8	0,02*
HAD-D (0-21)	+0,15	0,29		
Age	-0,05	0,75		
Sex	-0,11	0,43		
Weight	-0,03	0,82		
BMI	-0,18	0,21		
History of abdominal surgery	+0,27	0,05*		
History of bariatric surgery	+0,37	0,01*	60,1 ± 25,6	0,02*
Univariate and multivariate linear regression of factors potentially associated with the IBS SSS score six months after bariatric surgery				
Exposure variable and co-variables	**Univariate correlation coefficient (r Pearson)**	**p-value**	**Multivariate regression coefficient (b±SE)**	**p-value**
Total FODMAPs score (0-4)	+0,19	0,27		
Fructose score (0-4)	+0,26	0,13		
Lactose score (0-4)	+0,29	0,08	+58,1 ± 25,7	0,03*
Fructans score (0-4)	+0,10	0,57		
Galactans score (0-4)	+0,05	0,78		
Polyols score (0-4)	+0,23	0,19		
HAD-A (0-21)	+0,61	<0,001*	+16,5 ± 4,8	0,002*
HAD-D (0-21)	+0,23	0,10		
Age	+0,03	0,84		
Sex	+0,00	0,98		
Weight	+0 ,15	0,44		
Weight loss %	-0,32	0,09	-441,3 ± 206,8	0,04*
BMI	+0,06	0,77		
Δ BMI	-0,32	0,09		
History of abdominal surgery	+0,29	0,08		
History of bariatric surgery	+0,30	0,06		
Univariate and multivariate linear regression of factors potentially associated with the IBS SSS score twelve months after bariatric surgery				
Exposure variable and co-variables	**Univariate correlation coefficient (r Pearson)**	**p-value**	**Multivariate regression coefficient (b±SE)**	**p-value**
Total FODMAPs score (0-4)	+0,49	0,03*		
Fructose score (0-4)	+0,30	0,22		
Lactose score (0-4)	+0,50	0,03*		
Fructans score (0-4)	+0,42	0,07		
Galactans score (0-4)	+0,57	0,01*		
Polyols (0-4)	+0,54	0,02*	+112,62 ± 37,61	0,01*
HAD-A (0-21)	+0,59	0,006*		
HAD-D (0-21)	+0,63	0,003*	+10,52 ± 2,45	0,01*
Age	-0,07	0,77		
Sex	-0,16	0,49		
Weight loss %	-0,39	0,16	+86,49 ± 199,92	0,67
BMI	+0,32	0,22		

HAD-A : Hospital anxiety and depression scale-anxiety ; HAD-D : Hospital anxiety and depression scale-depression ; BMI : Body Mass Index

FODMAPs containing food consumed six months and twelve months after surgery were wheat (pasta, rusks, and bread), alliaceae vegetables (onions, garlic, and shallots), yogurts and mushrooms (Supplementary materials 3). FODMAPs consumption was similar compared to pre-surgery observations.

The means FODMAPs consumption frequency scores (for all FODMAPs and by FODMAPs subgroups) remains low after bariatric surgery. (Table 4) Overall, an average of three quarters of patients never or rarely ate high FODMAPs-containing food before or after bariatric surgery.

A third of the patients identified one or more trigger foods at follow-up (supplementary materials 2).

Factors associated with irritable bowel syndrome severity

Before bariatric surgery

The IBS SSS recorded before surgery was positively and significantly associated to the lactose consumption score (LCS), the anxiety score (HAD-A), the presence of previous abdominal surgery and the presence of previous bariatric surgery. (Table 4)

After adjustment for the anxiety score (HAD-A) and the presence of a history of previous bariatric surgery, the association between IBS SSS and the LCS was no longer significant (β=+32.0; p=0 ,09). Therefore, for all variables remaining stable, an increase of one unit of the LCS was associated with an average increase of 32 points in the IBS SSS at baseline (NS).

Six months after bariatric surgery

The IBS SSS measured six months after surgery was positively and significantly associated with the anxiety score (HAD-A). (Table 4)

After adjustment for the HAD-A score and the weight loss percentage, the association between IBS SSS and the LCS was statistically significant (β= +58.1; p=0.03). An increasing of one unit of the LCS, and for all the other variables remaining stable, was associated to an average increase of 58 points in the IBS SSS at six months post-bariatric surgery.

Twelve months after bariatric surgery

The IBS SSS 12 months after surgery was positively and significantly associated with the anxiety score (HAD-A), as well as with the depression score (HAD-D) and with several FODMAPs consumption scores (total FODMAPs, lactose, galactans and polyols). (Table 4)

After adjustment for the HAD-D score and the weight loss percentage, the association between IBS SSS and the polyol consumption score (PCS) was statistically significant (β= +112.62; p=0.01). An increase of one unit of the PCS, and for all other variables remaining stable, was associated with an average increase of 112.6 points in IBS SSS score 12 months after bariatric surgery.

Discussion

Our study aimed to evaluate the prevalence and severity of IBS-like symptoms and their association with FODMAPs consumption before and after bariatric surgery. We observed a high prevalence of mild to moderate IBS-like symptoms before and after surgery. If the severity of symptoms decreased in about one out of four patients, it increased among another quarter of patients after surgery. In a multivariate model, a significant association was found between the IBS severity and lactose consumption at 6 months and with polyols consumption at 12 months.

Strengths and perspectives

A prospective design and the use of validated and auto-administrated questionnaires are strengths of this study. This is the first study evaluating prospectively both FODMAPs consumption and IBS-like symptoms after bariatric surgery. Quality of life, anxiety, depression, and medico-surgical history parameters have also been taken into account for multivariate analysis.

Prevalence of IBS-like symptoms

Based on IBS-SSS score cut-off values, prevalence of IBS before, six and twelve months after bariatric surgery were equal to 43%, 58% and 33% respectively. Those numbers are higher when compared to the reported prevalence of IBS in the general population, varying from 4.1% to 25% based on the diagnostic criteria used (3,4). Mean IBS-SSS scores observed in our sample before, as well as after bariatric surgery, are also higher than in a non-obese control group (14). Besides, the results of our study are consistent with several other studies reporting higher prevalence of IBS among obese patients (7,18). We did not observe any significant variation of the mean IBS-SSS score after surgery. However, it is important to note that a fifth of the patient had a history of bariatric surgery at baseline. The history of bariatric surgery is associated with higher values of the IBS SSS score. This finding could be an explanation of the lack of difference between the mean IBS SSS score before and after surgery. When considering individual scores, one third of the patients notified an increased severity of IBS at six months and one quarter at twelve months of follow-up, 2 patients with a high pre-operative IBS-SSS score reporting severe symptoms in the follow-up of their RYBP. At 6 months, the proportion of patients who increased their score was twice as high as those who decreased their score. In our series, the majority of the 49 operated patients underwent a sleeve gastrectomy. Due to the low number of patients operated with RYBP, it was not possible to analyse differences in the symptoms' evolution after surgery between the 2 groups.

Besides, frequencies of self-reported gastrointestinal symptoms did not show significant variations at 6 or 12 months after surgery, except for bloating. Moderate to severe bloating had been less frequently reported at 12 months post-bariatric surgery. Weight loss resulting in an objective reduction of abdominal volume could therefore explain that patient experienced less bloating.

FODMAPs consumption

Overall, high FODMAPs containing food consumption is low before as well as after bariatric surgery, which could be explained by two hypotheses. First, inadequate food habits, especially with insufficient quantities of fruits and vegetables, are frequently observed in obese patients (19). Secondly, according to instructions for the post-bariatric surgery management (19,20), dietary advice is focused on high-protein food consumption (meat, chicken, eggs, fish, dairy products). Dietary advices given after surgery recommend reducing carbohydrates and sweets. Fruits and vegetables consumption are also reduced due to the allowed extra-small servings. Those two hypotheses could therefore explain also why lactose is the most consumed compared to other types of FODMAPs. Unfortunately, to date there are no data available regarding mean amount of FODMAPs consumed in general population to compare these observations to.

Association between IBS severity, anxiety score, and FODMAPs consumption

First, we showed that higher values of the anxiety score (HAD-A) and a previous bariatric surgery have an additional contribution in higher IBS SSS score. Association between anxiety and IBS have been widely described as a predictor of IBS severity which is confirmed in our study (7,21).

Second, we observed that an increase of one unit of the lactose consumption score (LCS) was associated with an average increase of 58 points of the IBS SSS score 6 months after bariatric surgery, an increase of more than 50 points of the IBS SSS score being considered clinically relevant (14,18). Indeed, lactose malabsorption and intolerance may be observed following bariatric surgery (22,23). Two mechanisms can lead to a potential impairment of lactose tolerance after bariatric surgery: modifications of oro-caecal transit time and colonic microbiota modifications. On the one hand, a longer oro-caecal transit time is associated with better lactose tolerance and fewer gastrointestinal symptoms (24,25). Several studies have shown that gastric emptying time is reduced after SG (26,27). Oro-caecal transit time is also reduced after RYGBP, which could possibly contribute to the development of lactose intolerance exceeding the capacities of lactase to hydrolyse lactose into absorbable monosaccharides. On the other hand, recent studies highlighted modifications of intestinal microbiota after bariatric surgery that could lead to modified lactose digestion (28,29). Finally, the association between LCS and IBS severity was no more significant in the multivariate model at 12 months of follow-up. Our observation is supported by the hypothesis of intestinal adaptive modifications (hyperplasia of the jejunal alimentary limb with villosity hypertrophia) induced by RYGBP (30). One year after a bariatric intervention, patients are usually able to eat a "normal size" serving comparable to general population.

We also observed that an increase of one unit of the polyols consumption score (PCS), for all other variables remaining stable, was associated with an average increase of 112,6 points of the IBS SSS score at one-year post-bariatric surgery. Such an increase of the score is, from our point of view, highly clinically relevant because higher polyols consumption is associated with more severe IBS symptoms. In the general population, a consumption of more than 20g of polyols per day usually leads to digestive symptoms such as a laxative effect (31,32). Future studies should therefore include a detailed quantitative dietary anamnesis to evaluate more precisely if tolerance cut-off regarding polyols consumption is reduced compared to the general population.

Our results suggest a link between severity of IBS-type symptoms after bariatric surgery and specific FODMAPs consumption, such as lactose and polyols. Lactose intolerance after bariatric surgery, and especially after SG, could be evaluated more specifically with a lactose hydrogen breath test. Future research should also put the light on polyols tolerance cut-off value after bariatric surgery.

Bias and limitations

In the scope of this study, the 75-points of IBS-SSS score has been used as a cut-off value to suggest the absence or presence of IBS when compatible symptoms are present. According to Francis et al. (1997), the IBS-SSS score has not been designed to diagnose IBS. However, the fact that organic diseases like IBD or coeliac disease were excluded during the preoperative work-up of patients and the presence of typical symptoms make the diagnosis of IBS quite confident in our patients.

Absence of a validated dietary questionnaire, length of the full questionnaire-folder, a possible selection bias due to the exclusive recruitment of patients in an academic center and the fact that, due to COVID-19 induced slow-down of activities, fewer patients were included compared to the calculated sample size, are limitations of this study. The dietary questionnaire and its derived scores have been created for this study because no free validated tool was available to evaluate FODMAPs consumption. It should also be noted that serving's sizes are not taken into account by the dietary score. We suggest to validate the FFQ and to revise its scores by assigning a weighting following the serving sizes for futures studies. Moreover, a causality association and comparison analyses are not possible in the absence of a control group.

We regret also the high drop out rate during the study which is a common limitation for prospective studies on patients with obesity.

In conclusion, this is the first prospective study evaluating the prevalence of IBS-like symptoms and their association with FODMAPs consumption in obese patients who underwent a bariatric surgery. Our results suggest that mild to moderate IBS symptoms are frequent in obese patients. Despite anatomical and physiological alterations induced by surgical procedures, IBS symptoms do not get worse after surgery in the majority of the patients, even if one third of the patients experienced increased severity of symptoms at six months, and one patient out of four after twelve months. An association between IBS severity score and lactose consumption score at six months, and with polyols consumption score at twelve months, suggests a link between the severity of IBS symptoms and specific FODMAPs consumption, such as lactose and polyols, after bariatric surgery.

Ethics and authorisations

The study was approved by ULB-Erasme Ethics Committee.

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