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CLINICAL RESEARCH

Bariatric Surgery Improves Urinary Incontinence but Not Anorectal Function in Obese Women

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Abstract
Background While the association between obesity and urinary incontinence (UI) in women has been clearly documented, the relationship with anal incontinence (AI) is less well defined; moreover, while bariatric surgery has been shown to improve UI, its effect on AI is still unclear.
Methods A total of 32 obese women were studied by means of PFDI-20 and PFIQ-7 questionnaires and anorectal manometry before and after bariatric surgery and compared with 71 non-obese women.
Results Obese women showed worse overall questionnaire results (OR 5.18 for PFDI-20 and 2.66 for PFIQ-7). Whereas obese women showed worse results for urinary sub-items and a higher urge UI incidence (43.8 vs 18.3 %, p=0.013), they did not show worsening in colorecto-anal symptoms. Post-operatively, median PFDI-20 total score did not change (24.2 vs 26.6, p=ns), while there was an improvement in urinary score (14.6 vs 8.3, p<0.001); median PFIQ-7 improved (4.8 vs 0.0, p=0.044), but while the urinary score improved (2.4 vs 0.0, p=0.033), the colorecto-anal score did not change significantly. Although after surgery urge UI decreased from 43.8 to 15.6 % (p=0.029), the incidence of any AI increased from 28.1 to 40.6 % (p=ns) and flatus incontinence increased from 18.8 to 37.5 % (p=ns). Anorectal manometry did not show significant changes after surgery.
Conclusions Obese women had worse questionnaire results, but while showing a higher incidence of UI, they did not experience anorectal function worsening. After bariatric surgery, there was a slight improvement in PFD symptoms related to UI, but anorectal function did not change significantly and flatus incontinence increased.

Keywords Obesity · Bariatric surgery · Anorectal function · Pelvic floor disorders · Urinary incontinence · Anal incontinence

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Introduction

The term "pelvic floor disorders" (PFD) refer to an heterogeneous group of symptoms related to pelvic organs which affect 2 to 42 % of adult women and which negatively impact quality of life (QoL) [1, 2]. PFD include a large spectrum of clinical conditions such as urinary incontinence (UI), anal incontinence (AI), pelvic organ prolapse, and urinary and defecatory dysfunctions.

Obesity is considered an important independent risk factor for PFD [3–6], and a strong association between obesity and UI in women has been clearly documented [5, 7, 8]. On the other hand, the relationship between AI and obesity is less well defined [9].

Furthermore, while weight loss has clearly been shown to be effective in improving UI [1, 10–15], the effect of weight loss and bariatric surgery on AI is not well defined [9, 15], and recent studies failed to report a post-operative improvement in AI symptoms after bariatric surgery [14–17].

A main limitation of the available literature is represented by the fact that all the published studies are based only on subjective questionnaires and self-reported symptoms [4, 6, 8, 15, 16, 18–21], whereas to date no study reports an

objective evaluation of pelvic floor function, specifically with regard to anorectal function. The aims of the present study were to evaluate the incidence of PFD in a group of morbidly obese women undergoing bariatric surgery compared to normal-weight age-matched women and to study the effects of surgically induced weight loss on PFD analyzing subjective self-reported questionnaires and objective anorectal function by means of anorectal manometry.

Materials and Methods

A total of 32 consecutive obese women undergoing bariatric surgery entered the study. Inclusion criteria were female gender, standard criteria for bariatric surgery [22], absence of previous surgical, obstetrical, or traumatic anal sphincterial injuries, absence of previous anorectal surgery, absence of chronic diarrhea, inflammatory bowel diseases, and neurological diseases involving pelvic innervation, and informed consent to the study protocol.

As control group, 71 age-matched healthy volunteer non-obese women selected with the same inclusion criteria, except for obesity, were enrolled. All the 103 women completed an anonymous form containing demographic data and validated questionnaires for PFD.

Demographic data collected were age in years, weight in kilogram, height in meter, body mass index (BMI) in kg/m^2 (calculated as weight in kg divided by height in m^2), the presence of arterial hypertension (defined as PAD>90 mmHg and/or PAS>140 mmHg and/or any anti-hypertensive medication use), the presence of type II diabetes (defined as blood glycemia>126 mg/dl and/or HbA1c>7 % and/or use of oral hypoglycemic agents and/or insulin), tobacco use (defined as positive when actively smoking or use stopped since less than 10 years), and obstetric history (presence and number of gestations and vaginal deliveries).

The questionnaires used were the Pelvic Floor Distress Inventory—Short Form 20 (PFDI-20) and the Pelvic Floor Impact Questionnaire—Short Form 7 (PFIQ-7) [23]. The PFDI-20 and the PFIQ-7 assess distress and impact of three main domains: pelvic organ prolapse (POPDI-6 and POPIQ-7), colorectal-anal (CRADI-8 and CRAIQ-7), and urinary (UDI-6 and UIQ-7). Each domain has a subscale score from 0 to 100, with higher scores representing more severe symptoms. Questionnaires were analyzed both for global scores and for item sub-scores. Moreover, an affirmative answer to questions 9, 10, and 11 of the PFDI-20 questionnaire was used to define the presence of AI (for solid stools, liquid stools, and flatus, respectively), while an affirmative answer to questions 16, 17, and 18 defined the presence of UI (urge incontinence, stress incontinence, and any incontinence, respectively; see "Appendix 1"). The subjects also completed the Wexner Incontinence Score and the Wexner Constipation Score [24, 25].

The 32 obese women also underwent a preoperative clinical examination to exclude sphincterial injuries and other pelvic floor dysfunction; the clinical visit included a digital examination and an anorectal endoscopic evaluation with rigid retroscope.

Finally, the obese women underwent anorectal manometry evaluation using a low-compliance pneumohydraulic system (Dyno 2000™; Menfis BioMedica, Bologna, Italy). No bowel preparation was used; patients were placed in a semirecumbent position and evaluated using an eight-channel, water-perfused manometry system and a standard catheter. Signals sensed by the pressure transducer were transmitted via an A/D converter to a personal computer: data storage and evaluation were performed with dedicated software. Maximum anal resting pressure was measured by continuous pull-through (speed 1 mm/s). Maximum squeeze pressure and time were also recorded. To elicit the rectoanal inhibitory reflex, increments of 10 ml to a maximum of 50 ml air were insufflated into an anorectal balloon at a speed of 10 ml/s. The parameters were the threshold for the patient's first sensation, urge to defecate, and maximum tolerated volume.

The post-operative evaluation of the 32 obese women was performed after a minimum % excess BMI loss (%EBMIL; calculated as 100−[(follow-up BMI−25)/(preoperative BMI−25)×100]) of 35 % and a minimum follow-up of 6 months. Post-operative evaluation included the same questionnaires and the anorectal manometry.

Statistical Methods

Patient's characteristics were analyzed using Fisher's exact test for qualitative variables and Mann–Whitney and Wilcoxon tests for quantitative ones. Bivariate non-parametric correlations were used to describe the degree of linear relationship between continuous variables (PFDI-20, PFIQ-7, Wexner Incontinence Score, and Wexner Constipation Score, manometry values) before and after bariatric surgery. The PFDI-20 and PFIQ-7 cutoff scores, ideal for accuracy, sensitivity, and specificity, were identified using the area under the curve of the receiver operating characteristic (ROC) analysis. The selected PFDI-20 and PFIQ-7 cutoffs score (18.2 and 2.4, respectively) were used as dependent variable in univariate and multivariate binary logistic regression models. In the same models, arterial hypertension (yes vs no), diabetes (yes vs no), deliveries (any vs none), smoke (yes vs no), and BMI (≤ 25 vs> 25 kg/m^2) were used as independent risk factors. All reported *p*-values were obtained by two-sided exact method at the conventional 5 % significance level; data were analyzed by SPSS 19.0.0. The study protocol was approved by the local Ethical Committee.

Results

The 32 obese women who entered the study showed a mean preoperative age of 39.4 years (range, 23.0–58.0) and a mean preoperative BMI of 46.3 kg/m^2 (range, 36.3–60.1). In the control group of 71 normal-weight women, mean age and BMI were 41.3 years (range, 22.0–64.0; p=ns) and 21.9 kg/m^2 (range, 15.2–24.9; p<0.001), respectively. The obese group showed a significantly higher incidence of arterial hypertension (43.8 vs 9.9 %, p<0.001) and type II diabetes (15.6 vs 0 %, p=0.004) compared with the normal-weight group. On the other hand, the percentage of women who had at least one vaginal delivery (43.8 vs 39.4 %, p=ns) and who were smoker (18.8 vs 19.7 %, p=ns) were not significantly different between groups. In both groups, no woman had previous major pelvic surgery (i.e., surgery for urinary incontinence, hysterectomy, prolapse repairs). The main characteristics of the two groups are summarized in Table 1.

Questionnaire results were studied in univariate and multivariate binary logistic regression models to analyze risk factors for poor result. To define a questionnaire poor result, ROC analyses were performed and the cutoff point chosen was 18.2 for the PFDI-20 and 2.4 for the PFIQ-7. Obese women showed significant worsening in overall questionnaire result: in the uni- and multivariate regression model, the presence of a BMI>25 kg/m^2 resulted as a significant risk factor for questionnaire poor result, with OR 5.18 (95 % CI 2.21–12.13, p<0.001) for the PFDI-20 and OR 2.66 (95 % CI 1.09–6.51, p=0.032) for the PFIQ-7 (Table 2).

Despite the worse overall questionnaire result, when analyzing the different questionnaire sub-items, obese women did not show significant worsening in colorecto-anal symptoms. While the median PFDI-20 value was significantly higher in obese women compared to normal-weight women (24.2 vs 12.5, p=0.003), the ColoRectal-Anal Distress Inventory did not show significant differences between groups (median value 6.7 vs 3.1, p=ns). Also, overall median PFIQ-7 value was significantly higher in obese women than in normal-weight subjects (4.8 vs 0, p=0.002), while the ColoRectal-Anal Impact Questionnaire was not significantly different between groups (median value 0 vs 0, p=ns). Also, the incidence of AI was not significantly different between groups, neither for type of incontinence (solid stool, liquid stool, or flatus) nor for the presence of any AI (28.1 vs 14.1 %, p=ns; Fig. 1).

On the other hand, obese women showed significantly worse questionnaire results for urinary sub-items; for PFDI-20, median UDI score was 14.6 in the obese group vs 4.2 in the control group (p=0.033), and for PFIQ-7, median UIQ score was 2.4 and 0, respectively (p=0.001). Also, the incidence of urge UI was significantly different between groups (43.8 vs 18.3 %, p=0.013), although the presence of any UI was not significantly different (59.4 vs 39.4 %, p=ns; Fig. 1).

The 32 obese women were re-evaluated after bariatric surgery, at a mean follow-up of 15.6 months (range, 6.0–24.0 months). Mean body weight decreased from 122.8 to 83.2 kg (p<0.001) and mean BMI decreased from 46.3 to 31.3 kg/m^2 (p<0.001); mean %EBMIL was 71.8 % (range, 36.7–132.1 %). The bariatric procedure was laparoscopic Roux-en-Y gastric bypass in 18 cases, laparoscopic vertical banded gastroplasty in ten, laparoscopic gastric banding in two, and laparoscopic sleeve gastrectomy in two.

At follow-up evaluation, the median PFDI-20 questionnaire total score did not show a significant change (from 24.2 to 26.6, p=ns), while there was a significant improvement in the urinary score (from 14.6 to 8.3, p<0.001; Fig. 2). The median PFIQ-7 questionnaire showed a significant improvement in the total score (from 4.8 to 0.0, p=0.044), but while there was a significant improvement in the urinary score (from 2.4 to 0.0, p=0.033), the colorecto-anal and the prolapse scores did not change significantly (Fig. 2). Mean Incontinence Wexner Score was 1.1 preoperatively and 1.0 post-operatively (p=ns), and mean Constipation Wexner Score was 3.9 preoperatively and 5.1 post-operatively (p=ns).

With regard to incontinence rates, AI showed worsening in the post-operative evaluation, although it did not reach statistical significance: 28.1 % of patients showed the presence of any AI before surgery versus 40.6 % after

Table 1 Main characteristics of the two groups of women included in the questionnaire analysis

	Obese women	Normal-weight women	p value
N	32	71	
Age in years, mean ± SD	39.4 ± 9.5	41.3 ± 14.0	NS
Weight in kg, mean ± SD	122.8 ± 16.3	59.4 ± 9.2	<0.001
BMI in kg/m^2, mean ± SD	46.3 ± 6.3	21.0 ± 2.3	<0.001
Hypertension, *N* (%)	14 (43.8)	7 (9.9)	<0.001
Diabetes, *N* (%)	5 (15.6)	0 (0)	0.004
Vaginal deliveries, *N* (%)	14 (43.8)	28 (39.4)	NS
Smoker, *N* (%)	6 (18.8)	14 (19.7)	NS

SD standard deviation, *NS* not significant

Table 2 Univariate and multivariate binary logistic regression models of PFDI-20 and PFIQ-7 questionnaire results

	PFDI-20 questionnaire						PFIQ-7 questionnaire					
	Univariate analysis			Multivariate analysis			Univariate analysis			Multivariate analysis		
	OR	95 % CI	*p* value	OR	95 % CI	*p* value	OR	95 % CI	*p* value	OR	95 % CI	*p* value
Hypertension	2.54	0.95–6.81	0.064	1.32	0.44–4.00	0.625	5.70	1.98–16.40	0.001	3.96	1.30–12.06	0.016
Deliveries	2.15	0.96–4.78	0.062	1.98	0.83–4.69	0.122	1.33	0.60–2.97	0.488	–	–	–
Smoking	1.07	0.40–2.85	0.895	–	–	–	0.62	0.22–1.77	0.369	–	–	–
BMI>25 kg/m^2	5.18	2.21–12.13	<0.001	5.18	2.21–12.13	<0.001	3.75	1.63–8.65	0.002	2.66	1.09–6.51	0.032

surgery (p=ns), mainly related to the incidence of flatus incontinence, increased from 18.8 % before surgery to 37.5 % after surgery (p=ns; Fig. 1). On the other hand, urge UI showed a significant improvement in the post-operative evaluation (from 43.8 to 15.6 %, p=0.029), although the incidence of any UI decreased after surgery by a non-significant degree, from 59.4 to 50.0 % (p=ns; Fig. 1).

The clinical and anoscopic evaluation before surgery showed the presence of rectal mucosal prolapse in seven women (21.9 %), classified as mild in all cases; the post-operative evaluation did not show modifications in incidence and severity of prolapse; there were internal hemorrhoids in three cases and external hemorrhoids in eight; no polyps or mass of the anorectum was found.

Finally, the obese women underwent a manometric study of anorectal function both preoperatively and at follow-up evaluation. Preoperatively, the sphincter length was 3 cm in two cases (6.2 %), 4 cm in 27 (84.4 %), and 5 cm in three (9.4 %); no changes were noted at post-operative evaluation. The median resting pressure at 1, 2, 3, 4, and 5 cm from the anal verge was 53, 51, 36, 19, and 11 mmHg before surgery and 56, 51, 40, 17, and 13 mmHg after surgery, respectively (p=ns for all). With regard to voluntary squeeze pressure, median sphincter pressure was 133 mmHg before surgery and 129 mmHg after surgery (p=ns), while median squeezing time was 20 s both before and after surgery (p=ns). Considering as normal for sphincter pressure a value equal or superior to 100 mmHg, the percentage of normal patients was 84.4 % before surgery and 84.4 % after surgery (p=ns); considering as normal for squeezing time a value equal or superior to 20 s, the percentage of normal patients was 53.1 % before surgery and 62.5 % after surgery (p=ns). With regard to intrarectal balloon distension, median volume at first sensation was 40 ml before surgery and 50 ml after surgery (p=ns), median volume at urgency to defecate was 100 ml both before and after surgery (p=ns), and median maximum tolerated volume was 155 ml before surgery and 160 after surgery (p=ns). Anorectal manometric results are reported in Figs. 3 and 4.

Discussion

In women, obesity represents an important independent risk factor for PFD [4–7, 19, 26], with strong negative impact on QoL [15, 19]. Whitcomb et al. [26] reported that PFD prevalence was higher in morbidly (57 %) and severely (53 %) obese compared to obese women (44 %). Interestingly, while the prevalence of PFD increased with higher degrees of obesity, the degree of QoL bother did not vary by degree of obesity [26]. In our results, the analysis of questionnaires completed by obese and normal-weight age-matched women confirmed these literature data since BMI resulted as a significant risk factor for a poor questionnaire result, both for PFDI-20 and PFIQ-7.

Among the PFD, UI is the most frequent and the most strongly related to obesity [1, 5–8, 18, 20, 27, 28], with reported OR for UI up to 1.6 per 5-unit increase in BMI [1, 20]. Our results are in line with these literature data, with urinary sub-items of both questionnaires significantly worse in obese women than in the control group and the incidence rates for urge UI significantly higher (44 vs 18 %).

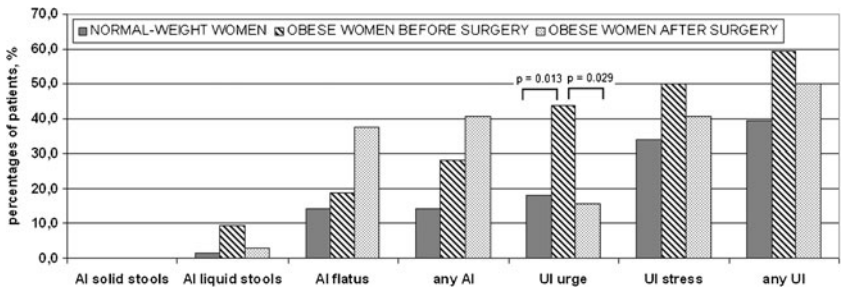

Fig. 1 Comparison between incidence of anal and urinary incontinence in normal-weight women and obese women before and after bariatric surgery. *AI* anal incontinence, *UI* urinary incontinence

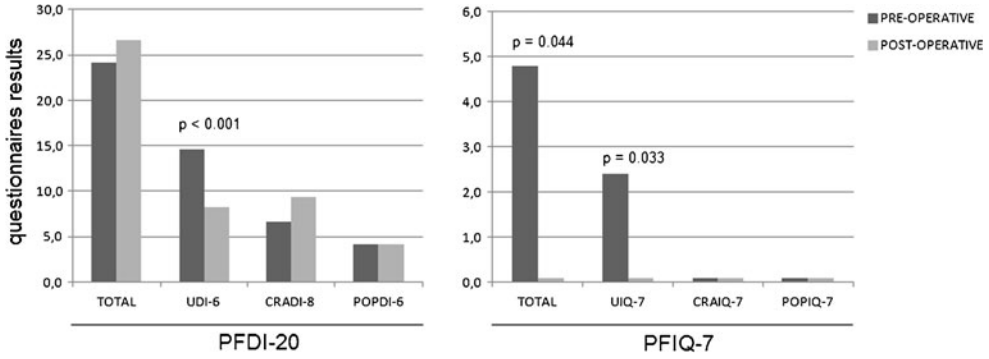

Fig. 2 Comparison between median preoperative and post-operative PFDI-20 and PFIQ-7 questionnaire results in obese women. *PFDI-20* Pelvic Floor Distress Inventory—Short Form 20, *POPDI-6* Pelvic Organ Prolapse Distress Inventory 6, *CRADI-8* ColoRectal-Anal Distress Inventory 8, *UDI-6* Urinary Distress Inventory 6, *PFIQ-7* Pelvic Floor Impact Questionnaire—Short Form 7, *POPIQ-7* Pelvic Organ Prolapse Impact Questionnaire, *CRAIQ-7* Colorectal-Anal Impact Questionnaire, *UIQ-7* Urinary Impact Questionnaire

With regard to AI, it shows a prevalence in the general population, varying between 0.5 and 24 % [2, 29–31], with wide variations mainly related to the definition of AI used as including or not flatus incontinence [29]. In contrast to UI, the relationship between obesity and AI is less clearly defined [12]. Although AI seems to show higher values in the obese subjects [5, 6, 8, 14, 15, 18, 19, 30, 32–34] and studies have reported increased AI rate with increasing BMI [34], others did not demonstrate the same [8, 19, 32, 33, 35]. In Richter et al. [8], although AI prevalence rate in obese women undergoing bariatric surgery was as high as 32 %, BMI did not result to be significantly associated with the presence of AI. Also, in the National Health and Nutrition Examination Survey, obesity was not a significant risk factor for AI by multivariate analysis [35]. Finally, Wasserberg et al. [32] found no differences in mean BMI between obese women having or not AI. In our results, questionnaire sub-items for colorecto-anal symptoms were not significantly different between obese and normal-weight women; furthermore, the incidence rates of AI were not significantly different.

With regard to bariatric surgery and weight loss effects, several studies have demonstrated a positive effect on UI symptoms [10–14, 34, 36–38], with subsequent improvement in related QoL [39]. Laungani et al. [20], studying UI prevalence in 58 obese women before and after gastric bypass, showed an improved post-operative UI with the most significant reduction seen in stress UI. Our results are in line with these observations again, with a significant improvement in post-operative urinary sub-items questionnaires results and a post-operative decrease in the incidence of urge UI from 44 to 16 %.

On the other hand, the effects of weight loss and bariatric surgery on AI are not completely understood. Burgio et al. [14] reported a reduction of 56 % in the prevalence of AI 12 months after gastric bypass, and Wasserberg et al. [15] reported a decrease in the prevalence of any PFD in 46 obese women from 87 % before surgery to 65 % after surgery. Nevertheless, analyzing this paper, it is important to underline that the decrease in PFD symptoms was mainly related to a significant decrease in urinary symptoms, decreased from 71 to 39 %, while colorecto-anal symptoms showed no significant improvement [15]. Very recently, a prospective cohort study of 64 female patients who completed the PFDI-20 and the PFIQ-7 before and after bariatric surgery has been reported [21]; although there was a significant weight loss result, there was no significant difference in the prevalence of pelvic floor symptoms before and after surgery (94 to 81 %).

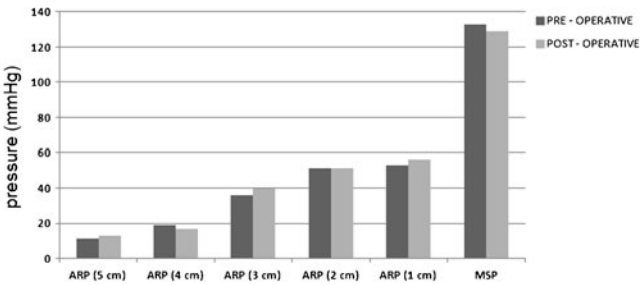

Fig. 3 Anorectal manometric findings in obese women before and after bariatric surgery: anal resting and voluntary squeeze pressures. *ARP* anal resting pressure at 5, 4, 3, 2, and 1 cm from the anal verge, *MSP* maximum squeeze pressure

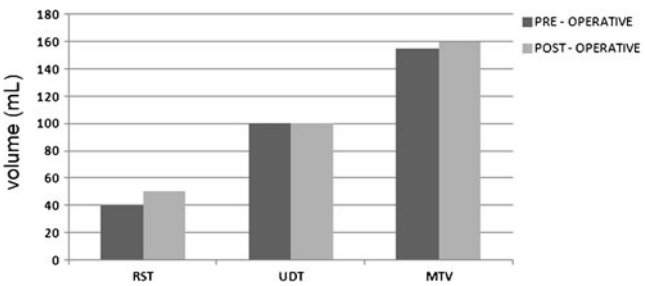

Fig. 4 Anorectal manometric findings in obese women before and after bariatric surgery: intrarectal balloon distension volumes. *RST* rectal sensitivity threshold, *UDT* urge to defecate threshold, *MTV* maximum tolerated volume

In our study, colorecto-anal symptoms and related QoL did not show a significant change after bariatric surgery. Furthermore, analyzing incidence rates of AI, we did not observe significant modifications, and we even observed an increase in post-operative flatus AI from 19 to 37.5 %.

The strength of our study is that anorectal manometric analysis confirmed the results of questionnaires. At the preoperative assessment, more than 80 % of obese women showed anatomical (i.e., sphincter length) and functional (i.e., resting pressure, voluntary squeeze pressure and time, sensory volumes) values in the normal ranges. These data demonstrated that the absence of significant differences in colorecto-anal questionnaire items between obese and normal-weight women was supported by a substantial normality of the anal sphincter complex in obese women.

An important issue when evaluating the effects of bariatric surgery on anorectal function concerns the effects of surgery on bowel habits since the anatomical changes of bariatric surgery may lead to constipation related to decreased water ingestion after restrictive procedures or diarrhea related to the effects of malabsorptive procedures and gastric bypass [9], and these effects could worsen AI symptoms after surgery. Roberson et al. [16] recently reported that AI may even begin or worsen after bariatric surgery: not only 48 % of women reported AI for liquid stools and 21 % for solid stools after surgery, but also 55 % reported that their symptoms were worse after surgery. Another study aimed at analyzing bowel habits after bariatric surgery [17] reported an impressive five times increase in loose stools/diarrhea after gastric bypass. Burgio et al. [14] reported not only a significant reduction in loss of liquid and solid stools after surgery but also a significant increase in the prevalence of flatus incontinence, from 13 to 30 %, and an increase in overall AI symptoms when solid stools, liquid stools, and flatus were combined. In our study, patients underwent different bariatric procedures; to analyze the possible effects of type of surgery, they have been classified in two groups: 14 patients undergoing restrictive surgery (gastric band, vertical banded gastroplasty, and sleeve gastrectomy) and 18 undergoing gastric bypass. The analysis of post-operative changes in AI based on type of surgery did not show differences among the two groups, with both experiencing post-operative worsening in flatus AI from 7.1 to 14.3 % in the restrictive group (p=ns) and from 27.8 to 55.6 % in the gastric bypass group (p=ns). This finding supports the hypothesis that the increased incidence of flatus incontinence could be related to the bloating effects of bariatric procedures, this symptom being not related to an impairment of anorectal sphincter function at the manometric evaluation.

The different effects of obesity on UI and AI may have a pathophysiologic explanation. Indeed the link between obesity and PFD may be mainly related to the increased intra-abdominal pressure acting as a source of mechanical stress on the pelvic floor [6, 27, 40, 41]. In the normal-weight adult, the intra-abdominal pressure shows values ranging between 5 and 6 mmHg, while in the obese this pressure is increased in 77 % of cases to over 7 mmHg [42], until mean values of 13 mmHg in the study by Sugerman [43]. A systematic review observed that intra-abdominal pressures were higher, averaging 9–14 mmHg, in morbidly obese than in non-obese subjects [44], and more recently Frezza [45] demonstrated that increased BMI is associated with increased intra-abdominal pressures in a linear regression association. The increase in intra-abdominal pressures, and consequently in endovesical pressure, could promote UI, due both to detrusorial instability both to urethral incompetence, and stress the pelvic floor with consequent structural damage and/or neurological dysfunction [11]. Studies on patients who underwent weight loss showed an improvement in stress UI with decrease in abdominal pressure [36], urinary bladder pressure [36], coughing-transmitted pressure, and urethral motility [11], supporting the theory of the abdominal pressure [10–12, 36]. Consequently, the effects of weight loss on UI could be related to the post-operative decrease of intra-abdominal pressure with subsequent decrease of pressure ratio between intra-bladder pressure and urethral sphincter pressure. Since the urethral sphincter pressure is low due to its limited musculature, an increase in intra-abdominal pressure could overcome the pressure of the sphincter in stress situations (such as coughing) with consequent UI, whereas the decreased intra-abdominal pressure after weight loss could reduce the frequency and severity of these episodes [11]. On the other hand, with the anorectal sphincter being more complex and with a greater muscular component compared to the urinary one, it is plausible that the decrease in intra-abdominal pressure may have smaller effects on it.

While the association between high BMI and stress UI has been largely described, for urge UI the association appears to be weaker [46]. The pathophysiology of urge UI is not completely understood and seems to be related with an impaired transmission between the bladder and the nervous system [47]. In view of this, obesity-related conditions such as diabetic microangiophaty and neurophaty [48], discal hernias [49], and nervous conduction anomalies [50] could contribute to the onset of urge UI in the obese woman.

Furthermore, the association between UI and diabetes mellitus has been described [6, 16, 48], probably as a result of the diabetic microvascular compromise leading to damage to the urethral sphincter mechanism [6, 48]. In our study, there were five obese patients with diabetes, while none of the control cases was diabetic. In order to evaluate a potential confounding effect of the different diabetes incidences between groups, questionnaires and manometric

evaluation of the five diabetic cases have been compared to the non-diabetic controls and obese women, showing no significant differences.

We recognize as main limit of the present study the fact that our research study protocol did not include additional examinations, such as defecography; we excluded the radiological analyses for ethical concern since we considered pelvic irradiation on young and asymptomatic women to be not acceptable for research purposes. Despite this, the major strength of the study is the fact that it is the first to give findings of anorectal manometry before and after bariatric surgery.

In summary, our results confirmed that obese compared to normal-weight women matched by age and risk factors reported significant worsening in PFD questionnaires, but while obese women presented a higher incidence of UI, they did not experience significant worsening of anal function. After bariatric surgery, obese women showed a slight improvement in PFD symptoms, related to UI improvement. Nevertheless, surgically induced weight loss did not change anorectal function and led to higher flatus incontinence rates.

Disclosures Gitana Scozzari, Fabrizio Rebecchi, Claudio Giaccone, Paolo Chiaro, Massimiliano Mistrangelo and Mario Morino have no commercial associations that might be a conflict of interest in relation to this article.

References

1. Greer WJ, Richter HE, Bartolucci AA, et al. Obesity and pelvic floor disorders: a systematic review. Obstet Gynecol. 2008;112:341–9.
2. Johanson JF, Lafferty J. Epidemiology of fecal incontinence: the silent affliction. Am J Gastroenterol. 1996;91:33–6.
3. Elia G, Dye TD, Scariati PD. Body mass index and urinary symptoms in women. Int Urogynecol J Pelvic Floor Dysfunct. 2001;12:366–9.
4. Kapoor DS, Davila GW, Rosenthal RJ, et al. Pelvic floor dysfunction in morbidly obese women: pilot study. Obes Res. 2004;12:1104–7.
5. Uustal Fornell E, Wingren G, Kjølhede P. Factors associated with pelvic floor dysfunction with emphasis on urinary and fecal incontinence and genital prolapse: an epidemiological study. Acta Obstet Gynecol Scand. 2004;83:383–9.
6. Lawrence JM, Lukacz ES, Liu IL, et al. Pelvic floor disorders, diabetes, and obesity in women: findings from the Kaiser Permanente Continence Associated Risk Epidemiology Study. Diabetes Care. 2007;30:2536–41.
7. Brown JS, Seeley DG, Fong J, et al. Urinary incontinence in older women: who is at risk? Study of Osteoporotic Fractures Research Group. Obstet Gynecol. 1996;87:715–21.
8. Richter HE, Burgio KL, Clements RH, et al. Urinary and anal incontinence in morbidly obese women considering weight loss surgery. Obstet Gynecol. 2005;106:1272–7.
9. Poylin V, Serrot FJ, Madoff RD, et al. Obesity and bariatric surgery: a systematic review of associations with defecatory dysfunction. Colorectal Dis. 2011;13:e92–e103.
10. Deitel M, Stone E, Kassam HA, et al. Gynecologic–obstetric changes after loss of massive excess weight following bariatric surgery. J Am Coll Nutr. 1988;7:147–53.
11. Bump RC, Sugerman HJ, Fantl JA, et al. Obesity and lower urinary tract function in women: effect of surgically induced weight loss. Am J Obstet Gynecol. 1992;167:392–7.
12. Subak LL, Johnson C, Whitcomb E, et al. Does weight loss improve incontinence in moderately obese women? Int Urogynecol J Pelvic Floor Dysfunct. 2002;13:40–3.
13. Kuruba R, Almahmeed T, Martinez F, et al. Bariatric surgery improves urinary incontinence in morbidly obese individuals. Surg Obes Relat Dis. 2007;3:586–90. discussion 590–1.
14. Burgio KL, Richter HE, Clements RH, et al. Changes in urinary and fecal incontinence symptoms with weight loss surgery in morbidly obese women. Obstet Gynecol. 2007;110:1034–40.
15. Wasserberg N, Petrone P, Haney M, et al. Effect of surgically induced weight loss on pelvic floor disorders in morbidly obese women. Ann Surg. 2009;249:72–6.
16. Roberson EN, Gould JC, Wald A. Urinary and fecal incontinence after bariatric surgery. Dig Dis Sci. 2010;55:2606–13.
17. Potoczna N, Harfmann S, Steffen R, et al. Bowel habits after bariatric surgery. Obes Surg. 2008;18:1287–96.
18. Chen CC, Gatmaitan P, Koepp S, et al. Obesity is associated with increased prevalence and severity of pelvic floor disorders in women considering bariatric surgery. Surg Obes Relat Dis. 2009;5:411–5.
19. Wasserberg N, Haney M, Petrone P, et al. Morbid obesity adversely impacts pelvic floor function in females seeking attention for weight loss surgery. Dis Colon Rectum. 2007;50:2096–103.
20. Laungani RG, Seleno N, Carlin AM. Effect of laparoscopic gastric bypass surgery on urinary incontinence in morbidly obese women. Surg Obes Relat Dis. 2009;5:334–8.
21. McDermott CD, Terry CL, Mattar SG, et al. Female pelvic floor symptoms before and after bariatric surgery. Obes Surg 2012;22:1244–50.
22. NIH conference. Gastrointestinal surgery for severe obesity. Consensus Development Conference Panel. Ann Intern Med. 1991;115:956–61.
23. Barber MD, Walters MD, Bump RC. Short forms of two condition-specific quality-of-life questionnaires for women with pelvic floor disorders (PFDI-20 and PFIQ-7). Am J Obstet Gynecol. 2005;193:103–13.
24. Jorge JM, Wexner SD. Etiology and management of fecal incontinence. Dis Colon Rectum. 1993;36:77–97.
25. Agachan F, Chen T, Pfeifer J, et al. A constipation scoring system to simplify evaluation and management of constipated patients. Dis Colon Rectum. 1996;39:681–5.
26. Whitcomb EL, Lukacz ES, Lawrence JM, et al. Prevalence and degree of bother from pelvic floor disorders in obese women. Int Urogynecol J Pelvic Floor Dysfunct. 2009;20:289–94.
27. Cummings JM, Rodning CB. Urinary stress incontinence among obese women: review of pathophysiology therapy. Int Urogynecol J Pelvic Floor Dysfunct. 2000;11:41–4.
28. Phelan S, Kanaya AM, Subak LL, et al. Prevalence and risk factors for urinary incontinence in overweight and obese diabetic women. Diabetes Care. 2009;32:1391–7.
29. Macmillan AK, Merrie AE, Marshall RJ, et al. The prevalence of fecal incontinence in community-dwelling adults: a systematic review of the literature. Dis Colon Rectum. 2004;47:1341–9.
30. Erekson EA, Sung VW, Myers DL. Effect of body mass index on the risk of anal incontinence and defecatory dysfunction in women. Am J Obstet Gynecol. 2008;198:596. e1-596.e4.
31. Bharucha AE, Zinsmeister AR, Locke GR, et al. Prevalence and burden of fecal incontinence: a population-based study in women. Gastroenterology. 2005;129:42–9.
32. Wasserberg N, Haney M, Petrone P, et al. Fecal incontinence among morbid obese women seeking for weight loss surgery: an underappreciated association with adverse impact on quality of life. Int J Colorectal Dis. 2008;23:493–7.

33. Altman D, Falconer C, Rossner S, et al. The risk of anal incontinence in obese women. Int Urogynecol J Pelvic Floor Dysfunct. 2007;18:1283–9.
34. Varma MG, Brown JS, Creasman JM, et al. Fecal incontinence in females older than aged 40 years: who is at risk? Dis Colon Rectum. 2006;49:841–51.
35. Whitehead WE, Borrud L, Goode PS, et al. Fecal incontinence in US adults: epidemiology and risk factors. Gastroenterology. 2009;137:512–7.
36. Sugerman H, Windsor A, Bessos M, et al. Effects of surgically induced weight loss on urinary bladder pressure, sagittal abdominal diameter and obesity co-morbidity. Int J Obes Relat Metab Dis. 1998;22:230–5.
37. Markland AD, Richter HE, Burgio KL, et al. Weight loss improves fecal incontinence severity in overweight and obese women with urinary incontinence. Int Urogynecol J. 2011;22:1151–7.
38. Subak LL, Wing R, West DS, et al. Weight loss to treat urinary incontinence in overweight and obese women. N Engl J Med. 2009;360:481–90.
39. Auwad W, Steggles P, Bombieri L, et al. Moderate weight loss in obese women with urinary incontinence: a prospective longitudinal study. Int Urogynecol J Pelvic Floor Dysfunct. 2008;19:1251–9.
40. Noblett KL, Jensen JK, Ostergard DR. The relationship of body mass index to intra-abdominal pressure as measured by multichannel cystometry. Int Urogynecol J Pelvic Floor Dysfunct. 1997;8:323–6.
41. Mommsen S, Foldspang A. Body mass index and adult female urinary incontinence. World J Urol. 1994;12:319–22.
42. Varela JE, Hinojosa M, Nguyen N. Correlations between intra-abdominal pressure and obesity-related co-morbidities. Surg Obes Relat Dis. 2009;5:524–8.
43. Sugerman H, Windsor A, Bessos M, et al. Intra-abdominal pressure, sagittal abdominal diameter and obesity comorbidity. J Intern Med. 1997;241:71–9.
44. De Keulenaer BL, De Waele JJ, Powell B, et al. What is normal intra-abdominal pressure and how is it affected by positioning, body mass and positive end-expiratory pressure? Intensive Care Med. 2009;35:969–76.
45. Frezza EE, Shebani KO, Robertson J, et al. Morbid obesity causes chronic increase of intraabdominal pressure. Dig Dis Sci. 2007;52:1038–41.
46. Legendre G, Fritel X, Capmas P, et al. Urinary incontinence and obesity. J Gynecol Obstet Biol Reprod (Paris). 2012;41:318–23.
47. De Groat WC. The urothelium in overactive bladder: passive bystander or active participant? Urology. 2004;64:7–11.
48. Epanomeritakis E, Koutsoumbi P, Tsiaoussis I, et al. Impairment of anorectal function in diabetes mellitus parallels duration of disease. Dis Colon Rectum. 1999;42:1394–400.
49. Heliövaara M. Body height, obesity, and risk of herniated lumbar intervertebral disc. Spine. 1987;12:469–72.
50. Nathan PA, Keniston RC, Myers LD, et al. Obesity as a risk factor for slowing of sensory conduction of the median nerve in industry. A cross-sectional and longitudinal study involving 429 workers. J Occup Med. 1992;34:379–83.