



Impact of Preoperative Weight Loss on Postoperative Weight Loss Revealed from a Large Nationwide Quality Registry

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Abstract

Purpose Weight loss before bariatric surgery is not mandatory, but questions remain as to whether preoperative weight loss has an impact on weight loss after surgery. Most studies have small sample sizes. The objective was to evaluate the relationship between preoperative and successful postoperative weight loss defined as $\geq 25\%$ total weight loss (TWL) at 1 and 2 years after primary bariatric surgery with regard to the obesity-related comorbidities.

Materials and Methods Data were extracted from a large nationwide quality registry of patients who underwent a sleeve gastrectomy (SG) or gastric bypass (GBP) between January 2015 and January 2018. Patients with completed screening and preoperative and postoperative data were included. A multivariate logistic regression analysis was performed for each technique and follow-up years separately.

Results In total, 8751 were included in the analysis. Patients with preoperative weight loss were more likely to achieve $\geq 25\%$ postoperative TWL in both procedures. Patients with higher preoperative weight loss of 5–10% had an increased likelihood for achieving 25% TWL compared to 0–5%, OR 1.79 (CI (1.42–2.25), $p < 0.001$) vs 1.25 (CI (1.08–1.46), $p < 0.004$) for the GBP group for year 2 postoperative. This was the same for the SG group at year 2, OR 1.30 (CI (1.03–1.64), $p < 0.029$) vs 1.14 (CI (0.94–1.38), $p < 0.198$).

Conclusion Patients with preoperative weight loss were more likely to achieve $\geq 25\%$ postoperative TWL at 1 and 2 years after surgery in both procedures; moreover, the extent of preoperative weight loss contributes to the significance and odds of this success.

Keywords Preoperative weight loss · Bariatric surgery · Postoperative weight loss

Key points

- Preoperative weight loss is associated with achieving $\geq 25\%$ TWL postoperative.
- More preoperative weight loss leads to higher odds of achieving $\geq 25\%$ TWL.
- Diabetes mellitus and sleep apnea decrease the odds of achieving $\geq 25\%$ TWL.

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Introduction

Preoperative weight loss is not a definitive criterion to be eligible for bariatric surgery. Although reasonable attempts at other weight loss techniques are required, there is no demand for mandatory weight loss [1, 2]. The Enhanced Recovery After Surgery guideline reviewed preoperative weight loss in the literature published between January 1966 and January 2015 [3]. Summarizing the key findings, a systematic review by Cassie et al. and a large cohort study comprising 22,327 patients by Anderin et al. suggested that preoperative

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weight loss was associated with a reduction in postoperative complications [4, 5]. Additionally, preoperative weight loss appeared to be associated with postoperative weight loss in adults and adolescents [6, 7].

On the contrary, recent studies from 2019 demonstrated that patients receiving mandatory weight loss goals before surgery did not have improved weight loss or comorbidity resolution up to 4 years after surgery [8, 9].

Questions remain as to whether preoperative weight loss could have an impact on weight loss after surgery as well, and most studies have small sample sizes. In a large Swedish national bariatric registry data set comprising 9570 patients, preoperative weight loss was associated with sustained improved postoperative weight reduction and there was a relationship between the degree of pre- and postoperative weight loss [10]. However, Gerber et al. solely included the gastric bypass (GBP) procedure and it seemed unclear which comorbidities were taken into account.

The present nationwide retrospective cohort study evaluated the association between preoperative weight loss and successful postoperative weight loss defined as $\geq 25\%$ total weight loss (TWL) in sleeve gastrectomy (SG) and GBP patients at 1 and 2 years after surgery with regard to the obesity-related comorbidities.

Methods

Registry

The Dutch Audit for Treatment of Obesity (DATO) is a nationwide mandatory quality registry for all bariatric procedures [11]. The database covers all 18 bariatric centers in the Netherlands with approximately 12,000 procedures being added annually. To be registered in this system and therefore suitable for bariatric surgery as approved by a multidisciplinary team, patients must be 18 years or older and have a body mass index (BMI) of $\geq 40 \text{ kg/m}^2$ or a BMI $\geq 35 \text{ kg/m}^2$ in combination with one of the 6 major obese-related comorbidities: diabetes mellitus, hypertension, dyslipidemia, obstructive sleep apnea syndrome (OSAS), gastroesophageal reflux disease (GERD), and musculoskeletal pain. The follow-up is recorded at 3, 6, 9, 12, 24, 36, 48, and 60 months. A retrospective cohort study was conducted by using the DATO database. No informed consent was needed as this is an opt-out registry. The study was performed in accordance with the ethical standards as stated in the Dutch law and the regulations of the Dutch Institute for Clinical Auditing (DICA).

Patient Selection

Patients who underwent primary sleeve gastrectomy or Roux-en-Y gastric bypass between January 2015 and January 2018 were extracted from the DATO database. Only patients with completed follow-up data 2 years after surgery were included. Patients who gained 5% of their total weight or lost more than 10% preoperatively were deemed as outliers, and thus excluded to adhere to the research question.

Collected patient characteristics were age, gender, weight, height, preoperative obese-related comorbidities, American Society of Anesthesiologists score (ASA), date of surgery, and type of surgery. Weight and height were measured at screening, day of surgery, and 1 and 2 years postoperatively. Screening was within 1 year of the operative intervention, and the annual follow-up had a range of ± 3 months.

Preoperative weight loss was calculated as the percentage difference between weight at screening and weight at day of surgery. Postoperative weight loss was defined as the percentage difference between weight at screening and weight at 1 year or 2 years postoperative. Successful postoperative weight loss was defined as $\geq 25\%$ TWL.

Statistical Analysis

Depending on the distribution, differences for continuous variables between types of surgery were measured using the one-way analysis of variance or the Mann-Whitney *U* test. Differences between types of surgery for categorical variables were analyzed using the chi-square test. Normally distributed, continuous variables were presented as mean and standard deviation. Not normally distributed data were reported as median and interquartile range (IQR). Categorical data were described in an absolute number as well as a percentage of the subgroup: SG or GBP.

Univariate logistic regression analysis was used to determine the association between the baseline characteristics, preoperative weight loss, and the dependent variable; successful postoperative weight loss was presented as the odds ratio (OR) with a 95% confidence interval (CI). Characteristics with a $p < 0.05$ or clinically relevant were included in the subsequent multivariable logistic regression analysis using stepwise backward elimination. Two multivariable logistic regression analyses were performed for the two different outcome variables: successful postoperative weight loss at 1 year after surgery and successful postoperative weight loss 2 years after surgery. Additionally, the logistic regression analyses were conducted for the SG and GBP cohort separately. Multicollinearity and effect modification were assessed for all included variables in the final multivariable logistic regression.

Statistical analyses were performed using SPSS software (version 26). Significance levels were set for p value < 0.05 .

Results

Of the 8751 patients included in the final analysis, 1739 (19.9%) were male and 7012 (80.1%) female, with a mean age of 45.2 ± 11.3 years and median baseline BMI of 41.7 kg/m^2 (IQR $39.3\text{--}45 \text{ kg/m}^2$). The majority underwent a Roux-en-Y gastric bypass procedure ($n = 6178$ (70.6%)).

Both cohorts lost a significant amount of preoperative weight (Table 1). This was achieved within a median of 18 weeks (IQR $13\text{--}28$). Weight loss at 1 year was for both procedures substantial (SG -12.6 kg/m^2 , GBP -13.7 kg/m^2). After 2 years of surgery, there was a slight weight regain in the SG cohort compared to year 1 with a median BMI increase of 0.4 kg/m^2 , whereas results for GBP were comparable at year 1 and year 2, median BMI from 27.6 to 27.5 kg/m^2 .

Impact of Preoperative Weight Loss

The multivariate analysis is demonstrated in Table 2. Preoperative weight loss remained significantly associated with successful postoperative weight loss ($\geq 25\%$ TWL) at 1 and 2 years for the gastric bypass cohort. After adjusting for confounders, the category 0–5% preoperative weight loss demonstrated an OR of 1.45, 95% CI (1.27–1.71), $p < 0.001$ at year 1 and OR 1.25 95% CI (1.08–1.46), $p < 0.004$ at year 2. This was also seen for the gastric sleeve procedure at year 1, OR for preoperative weight loss 0–5% 1.32 95% CI (1.07–1.62), $p < 0.009$. However, at year 2, preoperative weight loss was only significant if at least 5% was lost, OR 1.30 95% CI (1.03–1.64), $p < 0.029$.

Patients with higher preoperative weight loss of 5–10% had an increased likelihood for achieving 25% TWL compared to 0–5%, OR 2.13 (CI (1.64–2.77), $p < 0.001$) vs 1.45 (CI (1.23–1.71) $p < 0.001$) for the GBP group at year 1 and OR 1.79 (CI (1.42–2.25), $p < 0.001$) vs 1.25 (CI (1.08–1.46), $p < 0.004$) for year 2. This was the same for the SG group at year 1, OR 1.76 (CI (1.36–2.28), $p < 0.001$) vs 1.32 (CI

Table 1 Patient characteristics and weight loss data

	Roux-en-Y gastric bypass	Sleeve gastrectomy	P value
Number of patients	6178	2573	
Demography			
Gender			
Male	1122 (18.2%)	617 (24%)	0.001
Female	5056 (81.8%)	1956 (76%)	
Age, mean, years (SD)	46.3 (10.5)	42.7 (12.6)	0.001
Hypertension	2262 (36.6%)	849 (33%)	0.001
Diabetes mellitus type 2	1283 (20.8%)	372 (14.5%)	0.001
Dyslipidaemia	1401 (22.7%)	440 (17.1%)	0.001
Gastroesophageal reflux disease	1311 (21.2%)	316 (12.3%)	0.001
Sleep apnoea syndrome	1196 (19.4%)	460 (17.9%)	0.107
Musculoskeletal pain	2996 (48.5%)	1101 (42.8%)	0.001
ASA classification			
(<2)	2637 (42.7%)	809 (31.4%)	
(>2)	3533 (57.2%)	1760 (68.4%)	
Unknown	8 (0.1%)	4 (0.2%)	0.001
Preoperative data			
Weight at screening day, kg, median – (IQR)	118.4 (108.2–130.4)	123.8 (112–138.7)	0.001
Weight at operation day, kg, median – (IQR)	116 (106–129)	121 (109–136)	0.001
BMI at screening day, kg/m^2 , median – (IQR)	41.3 (39–44.3)	42.6 (40.1–46.7)	0.001
BMI at operation day, kg/m^2 , median – (IQR)	40.7 (38.1–43.7)	41.8 (38.9–45.8)	0.001
Postoperative data			
Weight at 1 year after surgery, kg, median – (IQR)	79 (70–89)	87 (76–99)	0.001
Weight at 2 years after surgery, kg, median – (IQR)	78 (70–89)	88 (77–101)	0.001
BMI at 1 year after surgery, kg/m^2 , median – (IQR)	27.6 (25.3–30.4)	30.1 (27–33.6)	0.001
BMI at 2 years after surgery, kg/m^2 median – (IQR)	27.5 (25–30.4)	30.5 (27.2–34.3)	0.001

SD standard deviation, BMI body mass index, ASA American Society of Anesthesiologist, IQR interquartile range

Table 2 Multivariate logistic regression for the gastric bypass and sleeve gastrectomy cohort at 1 and 2 years after surgery

	Roux-en-Y gastric bypass		Sleeve gastrectomy	
	Odds ratio (β) (95% CI)	<i>p</i> value	Odds ratio (β) (95% CI)	<i>p</i> value
Year 1 postoperative				
Preoperative weight loss				
–5 to 0% (ref)		0.001		0.001
0–5%	1.448 (1.226–1.710)	0.001	1.320 (1.073–1.623)	0.009
5–10%	2.133 (1.643–2.769)	0.001	1.763 (1.363–2.281)	0.001
Age, years	0.990 (0.981–0.998)	0.013	0.971 (0.963–0.979)	0.001
Gender	0.436 (0.364–0.521)	0.001	0.927 (0.746–1.151)	0.491
Baseline BMI (kg/m ²) <40 (ref)				
40–45	1.255 (1.049–1.502)	0.013	1.058 (0.841–1.332)	0.628
>45	1.275 (1.024–1.587)	0.030	1.219 (0.956–1.553)	0.110
Diabetes mellitus II	0.457 (0.382–0.546)	0.001	0.488 (0.383–0.621)	0.001
Musculoskeletal pain	1.354 (1.153–1.590)	0.001	0.873 (0.724–1.053)	0.155
OSAS	0.920 (0.759–1.115)	0.001	0.827 (0.653–1.047)	0.115
Year 2 postoperative				
Preoperative weight loss				
–5 to 0% (ref)		0.001		0.089
0–5%	1.252 (1.077–1.457)	0.004	1.136 (0.936–1.378)	0.198
5–10%	1.790 (1.423–2.252)	0.001	1.298 (1.027–1.641)	0.029
Age, years	0.990 (0.983–0.997)	0.008	0.976 (0.969–0.984)	0.001
Gender	0.475 (0.403–0.560)	0.001	0.883 (0.721–1.080)	0.227
Baseline BMI (kg/m ²) <40 (ref)				
40–45	1.279 (1.090–1.500)	0.003	1.184 (0.958–1.465)	0.119
>45	1.579 (1.289–1.933)	0.001	1.447 (1.155–1.812)	0.001
Diabetes mellitus II	0.461 (0.392–0.542)	0.001	0.541 (0.428–0.684)	0.001
Musculoskeletal pain	1.370 (1.185–1.582)	0.001	0.903 (0.759–1.073)	0.247
OSAS	0.810 (0.682–0.963)	0.017	0.893 (0.713–1.118)	0.324

BMI body mass index, OSAS obstructive sleep apnea syndrome

(1.07–1.62), $p < 0.009$) and year 2 postoperatively, OR 1.30 (CI (1.03–1.64), $p < 0.029$) vs 1.14 (CI (0.94–1.38), $p < 0.198$).

Discussion

In this nationwide study comprised of 8751 participants, patients with preoperative weight loss were more likely to achieve $\geq 25\%$ postoperative TWL at 1 and 2 years after primary bariatric surgery. Moreover, in the multivariable analysis, a higher threshold of preoperative weight loss led to higher likelihood for successful postoperative weight loss.

A recent review by Chinaka et al. investigated the effect of preoperative weight loss on postoperative weight loss and demonstrated a lot of controversial evidence [12]. They concluded that there is not enough evidence for a pre-specified weight loss practice and calls for a large-scale multi-center study. Additionally, in our study, baseline BMI was not only predictive in most cases for

postoperative success, higher baseline BMIs also demonstrated higher odds for success. This finding supports the work of a large cohort study by Jain et al. ($n = 4935$) which demonstrates that BMI is an important factor regarding postoperative weight loss [13]. However, this result has not been previously described by other cohort studies [14–16]. A systematic review from 2019 concluded that although baseline BMI is highly correlated with long-term weight loss, preoperative factors for weight loss are inconsistent in reporting and show methodological flaws [17].

Male individuals are associated with less successful postoperative weight loss in the GBP cohort in our study, but are not significant for the SG cohort. Findings in the literature of gender on postoperative weight loss also remain controversial. Some studies found no difference [18, 19], others found greater weight loss in men [20, 21] and other authors suggested more benefit for females [22]. An explanation could be that predictors for weight loss are different for men and women [23].

In our study, older age was associated with less successful weight loss at 1 and 2 years after surgery. These results reflect those of previous research [14, 24, 25].

Obesity-related comorbidities demonstrated a lower likelihood in achieving 25% TWL, except for musculoskeletal pain in the GBP cohort with an OR of 1.35 (CI 1.15–1.60, $p < 0.001$) at year 1 and OR 1.37 (CI 1.19–1.58, $p < 0.001$) at year 2 postoperative. Although this finding was not significant for the SG cohort, contrary to expectations the OR was 0.87 (CI 0.72–1.05), $p < 0.155$ and 0.90 (CI 0.76–1.07), $p < 0.247$ at year 1 and 2, respectively, a decreased likelihood. Whereas some authors state pain and musculoskeletal comorbidities are common barriers to physical activity [26], others demonstrated that many of the perceived barriers to physical activity are not obesity related [27]. In addition, an older systematic review suggests that no study has tested the hypothesis that pain is a barrier to physical activity in bariatric surgery patients [28].

In our study, the presence of OSAS appeared to be significantly associated with unsuccessful weight loss in the GBP cohort. Although OSAS is a bidirectional association and not fully understood [29, 30], some authors suggested that sleep apnea could cause weight gain [31] and discontinuation of CPAP postoperative was associated with weight gain [32].

The only significant comorbidity for both cohorts at all time points in our study was diabetes mellitus. Consistent with the literature, diabetes was negatively associated with weight loss postoperative [33–36]. However, a large retrospective cohort study stated that preoperative use of insulin was associated with better long-term weight loss [16]. It is difficult to interpret these results as we did not distinguish between insulin- and non-insulin-dependent diabetes in our study.

Notably, between the SG and GBP cohorts, the variables gender, musculoskeletal pain, and baseline BMI are differently associated with the outcome successful postoperative TWL. SG and GBP are the most frequently performed procedures in bariatric surgery and consequently there is a lot of ongoing research on the potential different outcomes. Lee et al. stated based on their systematic review that GBP procedures resulted in greater loss of BMI compared to SG at year 1 and year 3 postoperative [37], whereas the authors of another meta-analysis concluded there was not any statistical difference between groups within this time period [38]. Although there is no consensus on the weight loss patterns between these different procedures yet, it could be an explanation to the differences in our findings.

There are several limitations to this study. It had a non-randomized, retrospective design and the quality registry consists of indirect source data. On the other hand, this mandatory registry is subject to an auditing system. Additionally, the time frame in which patients lost weight ranged from

1 week to 1 year and it remained unclear whether screening BMI was the highest BMI for a patient or after already losing weight by a preconditioning program. Furthermore, the method of achieving preoperative weight loss is unknown as it is not mandatory in the national guideline [39]. Nevertheless, this is one of the largest nationwide cohort studies evaluating the association of preoperative weight loss on successful postoperative weight loss including both sleeve gastrectomy and Roux-en-Y gastric bypass procedures.

Conclusion

Patients with a preoperative weight loss of $>5\%$ were associated with successful weight loss defined as $\geq 25\%$ TWL up to 2 years after surgery for both sleeve gastrectomy and Roux-en-Y procedures. The extent of preoperative weight loss contributes to the significance and odds of this success. No specific threshold of loss was identified to oblige a certain amount of preoperative weight loss; nevertheless, it should be encouraged firmly. Large randomized controlled studies with longer follow-up are needed to evaluate the sustainability of preoperative weight loss.

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Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

Conflict of Interest The authors declare no competing interests.

Informed Consent Informed Consent does not apply as this is an opt-out registry and the study has been performed in accordance with the ethical standards as stated in Dutch law and the regulations of the Dutch Institute for Clinical Auditing (DICA).

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