ARTICLE IN PRESS
+ MODEL
Journal of Plastic, Reconstructive & Aesthetic Surgery (2017) xx, 1–5

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JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

Body contouring procedures in three or more anatomical areas are associated with long-term body mass index decrease in massive weight loss patients: A retrospective cohort study

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Received 21 March 2017; accepted 28 May 2017

KEYWORDS
Bariatric surgery;
Body contouring;
Plastic surgery;
Morbid obesity;
Massive weight loss

Summary *Background:* Massive weight loss (MWL) patients who undergo body contouring plastic surgery (BCPS) display superior long-term weight maintenance. The effect of the number of anatomical areas contoured on weight dynamics is undetermined.
Objectives: To determine whether body mass index (BMI) dynamics following BCPS are associated with the number of anatomical areas operated.
Methods: A retrospective cohort study was conducted. Study groups were defined by the number of anatomical areas operated (1, 2, and 3+). BMI velocity was defined as a ratio between BMI change following BCPS and follow-up time. Multinomial logistic regression was performed to assess the independent association with BMI velocity.
Results: A total of 222 patients undergoing 513 BCPSs between 2009 and 2014 were included in the study (mean age 36.8 ± 10.9 years, 77% females). Group 3+ ($n = 88$) had a negative mean BMI velocity compared with positive values in Groups 1 and 2 (−0.11 ± 1.0 vs. 0.44 ± 1.4 and 0.03 ± 1.2, respectively; $p = 0.03$). Independent risk factors for positive BMI velocity (>0.5 kg/m^2/year) included single anatomical area BCPS compared to three or more (OR = 3.37; CI 95% 1.24–9.14; $p = 0.017$) and psychiatric medication use (OR = 6.73; CI 95% 1.15–39.35; $p = 0.034$). Independent protective factors included diabetes mellitus (OR = 0.094; CI 95% 0.01–0.99; $p = 0.049$).

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http://dx.doi.org/10.1016/j.bjps.2017.05.055

Conclusions: BCPS in three or more anatomical areas following MWL is associated with a long-term weight loss following BCPS. As part of the health strategy to maintain normal BMI values and achieve overall quality of life improvement in MWL patients, clinicians and health policy makers should positively consider recommending BCPS in multiple anatomical areas.

Introduction

Background

Obesity is a growing phenomenon that carries severe medical and economic consequences for individuals and for the entire society.[1–4] Accordingly, bariatric surgery, an effective method for weight reduction and long-term body mass index (BMI) maintenance, is being increasingly performed.[4–6] Despite the numerous benefits of weight loss, patients after massive weight loss (MWL) suffer from redundant excess skin that may cause health, self-image, and quality-of-life disturbances.[6–8] Body contouring plastic surgery (BCPS) has emerged as an effective method for the removal of excess skin and is gaining prominence in the process of weight loss and maintenance of normal BMI in formerly obese patients.[9]

Rationale

It has been previously shown that BCPS may aid in the long-term maintenance of normal BMI in patients after MWL.[8,10] This is most probably due to improved satisfaction, quality of life, body image, and physical function reported by these patients.[9–13] Patients may undergo surgery in a variety of anatomical areas according to their pattern of weight loss and excess skin.[7] We hypothesize that treating more anatomical areas will have a positive effect on factors such as postoperative weight reduction, patient satisfaction, and motivation, which ultimately translate into improved ability to maintain and further decrease BMI over time.

Objectives

The primary objective of this study was to examine the association between the number of anatomical areas undergoing BCPS and BMI velocity (Δkg/m^2 per year) throughout the follow-up period. The information obtained in this study may aid in surgical decision-making when creating patient-specific body contouring surgical plan in patients following MWL.

Materials and methods

Study design and population

We performed a retrospective cohort study. A total of 273 patients underwent BCPS following MWL by a single plastic surgeon (T.F.) between 2009 and 2014. All patients were pre- and postoperatively followed at the clinic by the primary surgeon. The following patients were eligible to enter the study: those over 18 years of age, those who lost at least 50% of their excess weight, those who underwent at least one body contouring procedure, and those whose medical records were accessible. Following data acquisition, the study population was divided into three groups: patients who underwent BCPS in one anatomical area (Group 1), those who underwent BCPS in two anatomical areas (Group 2), and those who underwent BCPS in three or more anatomical areas (Group 3+). The study was approved by Assaf Harofeh Medical Center local Institutional Review Board (No. 246-14).

Data measurement

Demographic details, medical history, and operative data of all patients were extracted from patients' electronic medical records. In addition, a telephone interview was performed to validate information regarding current BMI, smoking status, and physical activity performance (June, 2016). Follow-up period was calculated depending on the last communication with the patient. BMI velocity (Δkg/m^2 per year) was calculated by dividing the difference between pre- and postoperative BMI (ΔBMI) by follow-up time in months. Weight loss, weight stability, and weight gain were defined as BMI velocity of ≤ -0.5 kg/m^2/year, between -0.5 and 0.5 kg/m^2/year, and ≥ 0.5 kg/m^2/year, respectively. Seven anatomical areas, namely the breast, abdomen, back, arms, thighs, buttock, and face, were investigated. The body lift procedure was considered two anatomical areas, i.e., abdomen and back. The number of operations performed was calculated separately.

Statistical methods

Statistical analysis was conducted using the SPSS software v.21 (SPSS technologies, IBM, USA). Continuous variables were presented as means and standard deviations and were compared using independent Student's *t*-test. Differences in categorical variables were compared using χ^2 test or Fisher's exact test. Multiple-group comparison of continuous variables was performed using analysis of variance, followed by a multiple comparison analysis using LSD test. To assess the risk of weight gain, we used a conditional logistic regression model (age and sex were forced into the model as controls). Multivariate analysis included age, gender, smoking status, physical activity, follow-up time, and whether the patient underwent bariatric surgery prior to BCPS. All statistical tests were two-sided, and results were considered statistically significant when p values were <0.05.

Results

Participants and descriptive data

Patient characteristics are presented in Table 1. A total of 222 MWL patients who underwent 286 surgeries with 513 body contouring procedures were included in the study. No significant difference was observed between the three study groups in terms of gender ($p = 0.55$), age ($p = 0.53$), comorbidities (diabetes, $p = 0.54$; hypertension, $p = 0.82$; asthma, $p = 0.82$; thyroid disease, $p = 0.57$; psychiatric diseases, $p = 0.13$), smoking rates ($p = 0.98$), and follow-up time ($p = 0.11$). The mean follow-up after BCPS was 29.3 ± 10.4 months. Fifty-six patients (25.3%) reported preoperative smoking, and bariatric surgery was the method of weight loss in the majority of patients ($n = 125$, 56.3%). Surgery was performed in one anatomical area in 69 patients (31%), in two anatomical areas in 65 patients (29.3%), and in three or more anatomical areas in 88 patients (39.6%, see Table 2). The most common anatomical area operated on was the abdomen ($n = 172$, 77.5%), followed by the chest ($n = 118$, 53.2%) and back ($n = 122$, 55%). The total complication rate (hematoma or bleeding, seroma, infection, dehiscence, venous thromboembolism, flap ischemia, or necrosis) was not significantly different between the three groups, with a mean rate of 30.6% ($p = 0.25$). The mean maximum BMI in the general study population was 41.9 ± 6.6 kg/m^2, and the mean BMI during last body contouring procedure was 26.3 ± 3.6 kg/m^2 ($p = 0.18$). The mean BMI at the end of follow-up was 26.7 ± 4.0 kg/m^2 ($p = 0.12$). The mean maximum BMI was significantly higher in Group 3+ than in Groups 1 and 2 (44.3 ± 6.8 vs. 40.2 ± 5.9 and 40.6 ± 6.0 kg/m^2, respectively; $p < 0.001$). The mean BMI at the end of follow-up was significantly different between all groups, and post hoc analysis found that Group 1 had higher BMI than Group 2 at the end of follow-up (27.6 ± 4.9 vs. 25.9 ± 3.0 kg/m^2, $p = 0.028$). The majority of patients in the general study population demonstrated stable BMI velocity throughout the follow-up period ($n = 107$, 48.2%). A similar fraction of the reminder demonstrated mean negative and positive BMI

Table 2 Number of anatomical areas operated.

Number of anatomical areas		Frequency	Percent	Cumulative percent
Group 1	1	69	31.1	31.1
Group 2	2	65	29.3	60.4
Group 3+	3	59	26.6	86.9
	4	12	5.4	92.3
	5	13	5.9	98.2
	6	4	1.8	100.0
Total		222	100.0	

Table 1 Patient characteristics according to study groups.

Anatomical areas		1 ($n = 69$)	2 ($n = 65$)	3+ ($n = 88$)	p Value[a]
Female sex, n (%)		54 (78.3%)	47 (72.3%)	70 (79.5%)	0.55
Age at BCPS (years), mean ± SD		38.3 ± 12.2	36.2 ± 10.1	36.1 ± 10.5	0.53
Comorbidities, n (%)	Smoking	17 (25.0%)	17 (26.2%)	22 (25.0%)	0.98
	Diabetes	5 (7.2%)	3 (4.6%)	3 (3.4%)	0.54
	Hypertension	7 (10.1%)	7 (10.8%)	7 (8.0%)	0.82
	Asthma	1 (1.4%)	2 (3.1%)	2 (2.3%)	0.82
	Thyroid	3 (4.3%)	1 (1.5%)	4 (4.5%)	0.57
	Psychiatric	1 (1.4%)	6 (9.2%)	7 (8.0%)	0.13
S/P bariatric surgery, n (%)		34 (49.3%)	28 (43.1%)	63 (71.6%)	0.001
BMI (kg/m^2), mean ± SD	Maximal	40.2 ± 5.9	40.6 ± 6.0	44.3 ± 6.8	<0.001
	Minimal	25.8 ± 4.0	24.9 ± 2.7	25.4 ± 3.4	0.7
	Pre-BCPS	26.6 ± 4.3	25.6 ± 3.1	26.6 ± 3.2	0.18
	Study end	27.6 ± 4.9	25.9 ± 3.0	26.5 ± 3.6	0.03
Follow up (months)		27.2 ± 9.5	29.5 ± 10.7	30.7 ± 10.8	0.11
BMI velocity (Δkg/m^2/year), mean ± SD		0.44 ± 1.4	0.03 ± 1.2	−0.11 ± 1.0	0.03
BMI velocity category, n (%)	Loss (<−0.5)	14 (20.3%)	15 (23.1%)	29 (33.0%)	0.28
	Stable (−0.5 to 0.5)	34 (49.3%)	31 (47.7%)	42 (47.7%)	
	Gain (>0.5)	21 (30.4%)	19 (29.2%)	17 (19.3%)	
Anatomical areas operated, n (%)	Abdomen	32 (46.4%)	56 (86.2%)	84 (95.5%)	<0.001
	Chest	30 (43.5%)	23 (35.4%)	65 (73.9%)	<0.001
	Back	3 (4.3%)	41 (63.1%)	78 (88.6%)	<0.001
	Thighs	1 (1.4%)	4 (6.2%)	33 (37.5%)	<0.001
	Arms	6 (8.7%)	5 (7.7%)	28 (31.8%)	<0.001
	Buttocks	1 (1.4%)	1 (1.5%)	4 (4.5%)	0.39
Any complications,[b] n (%)		16 (23.2%)	21 (32.3%)	31 (35.2%)	0.25

[a] Comparison of continuous variables and categorical variables was performed using analysis of variance test and χ^2 test, respectively.
[b] Hematoma or bleeding, seroma, infection, dehiscence, venous thromboembolism, flap ischemia, or necrosis.

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velocities ($n = 58$, 26.1% and $n = 57$, 25.7%, respectively). The mean BMI velocity was of positive value in Groups 1 and 2 (0.44 ± 1.4 and 0.03 ± 1.2 kg/m^2/year, respectively) and of negative value in Group 3+ (−0.11 ± 1.0 kg/m^2/year; $p = 0.03$), as shown in Figure 1.

Multivariate analysis

Weight loss category served as a reference outcome. BCPS in one anatomical area was found to be an independent risk factor for weight gain in comparison to BCPS in three or more anatomical areas (OR = 3.37; CI 95% 1.24–9.14; $p = 0.017$). Similarly, the use of psychiatric medications was found to be an independent risk factor for weight gain (OR = 6.73; CI 95% 1.15–39.35; $p = 0.034$). Diabetes mellitus was found to be an independent protective factor from weight gain (OR = 0.094; CI 95% 0.01–0.99; $p = 0.049$). Bariatric surgery was shown to reduce the chance of weight stability (OR = 0.43; CI 95% 0.2–0.9; $p = 0.023$).

Discussion

Key results

The main objective of our study was to evaluate whether the number of anatomical areas operated in BCPS following MWL is associated with a trend of BMI velocity. The distribution of BMI velocity trends (weight loss, stable weight, or weight gain) was not significantly different between the three groups; however, the relative percentage of patients who lost weight during the follow-up period was the highest in Group 3+ (see Table 1). The mean BMI velocity was positive in Groups 1 and 2 and negative in Group 3+, suggesting a pattern of further weight loss following BCPS in three or more anatomical areas. Furthermore, it was found that BCPS in one anatomical area is independently associated with a positive BMI velocity in comparison to BCPS in three or more anatomical areas. This finding remained valid in multivariate analysis controlling for possible cofounders such as age, gender, maximum BMI, bariatric surgery, and follow-up time. This again suggests that BCPS in three or more anatomical areas is associated with additional weight loss over time in comparison to BCPS in one anatomical area.

The mean maximum BMI and the rate of bariatric surgery were significantly higher in Group 3+ than in Groups 1 and 2. This association between patients with higher baseline BMI and the increased use of bariatric surgery as the method of weight loss in Group 3+ suggests that the patients in this subgroup lost more weight in total and ultimately had more excess skin. This in turn may have led these patients to desire contouring more anatomical areas with BCPS. Multivariate analysis was performed to control the effects of bariatric surgery rate on BMI velocity as bariatric surgery is a well-established factor favoring long-term weight loss.[4]

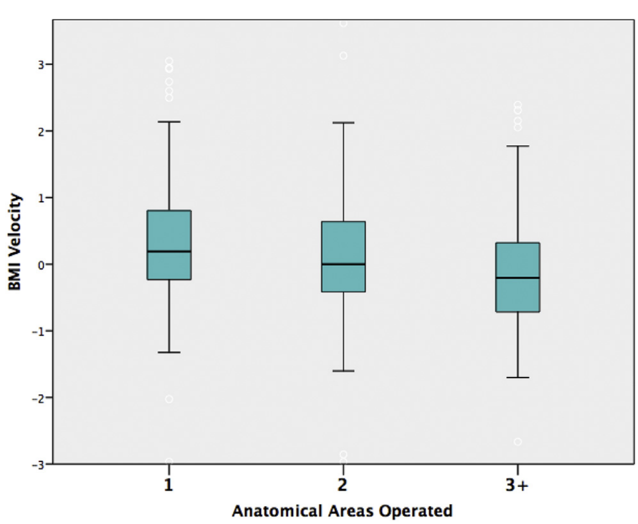

Figure 1 BMI velocity according to number of anatomical areas operated. Group 1 – BCPS in one anatomical area (0.44 ± 1.4 kg/m^2/year); Group 2 – BCPS in two anatomical areas (0.03 ± 1.2 kg/m^2/year); Group 3 – BCPS in three or more anatomical areas (−0.11 ± 1.0 kg/m^2/year). $p = 0.03$.

Interpretation

Parallel to the increased rate of bariatric surgery, BCPS is being increasingly employed and the population of patients who desire BCPS is constantly growing.[6,12,14,15] It has been demonstrated repeatedly that BCPS following MWL improves quality of life, body image, and physical function.[5,6,9,11–14,16] Recent studies have also demonstrated better weight control over time after BCPS in MWL patients following bariatric surgery. Balague et al. demonstrated that patients who underwent BCPS following Roux-en-Y gastric bypass demonstrated better long-term weight control after 7 years of follow-up than patients who underwent Roux-en-Y gastric bypass alone.[10] Similarly, a study conducted at our institute demonstrated lower endpoint BMI and lower BMI regain percentage in patients who underwent BCPS after laparoscopic adjustable gastric banding (LAGB) than those who underwent LAGB alone.[8] These findings imply that a link may exist between the improved quality of life, patient motivation, and physical function achieved by BCPS and better ability to maintain normal BMI after MWL.

BCPS is a wide term that includes several different body contouring procedures involving various anatomical areas.[17] Song et al. classified MWL contour deformities and presented the Pittsburgh Rating Scale.[7] Ten anatomical areas were included, and a scale was created to define the severity of each deformity. The preferred body contouring procedure was defined accordingly. In practice, the decision regarding which anatomical areas shall be contoured and the number of anatomical areas to be contoured is multifactorial and depends, among others, on patient preference and general medical condition, surgeon experience, financial considerations, and limitations of the medical facility. To our knowledge, there are no studies to date that assessed the effect of the number of anatomical areas contoured on the trend of BMI and on other clinical and operative data. The decision regarding the number of anatomical areas to be contoured is therefore not based on its possible effect on BMI.

Our current study examined this association in a large cohort of MWL patients, regardless of the method of weight

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loss. Our findings suggest that BCPS in three or more anatomical areas is associated with a higher chance of long-term weight loss than BCPS in one anatomical area only. This may be an appropriate approach for patients who desire additional weight loss and should be considered when designing the surgical plan in MWL patients.

Study limitations

Our study has several limitations. First, the data regarding BMI at the end of follow-up are subject to report bias as these values were collected by telephone interview and not measured by a qualified medical nurse or physician. Moreover, measurements were not controlled using a standardized weight and height measuring tools. In case of report bias, one may presume that BMI values reported are probably lower than the objective measurement. To minimize this, it was highlighted to the patients that these data are anonymous and for academic use only. Sampling bias may also occur as patients who seek plastic surgery following weight loss may represent a healthier patient population than the general MWL patient population. The maximum follow-up period was 6 years (range 13–59 months), and hence, conclusions on BMI maintenance or BMI velocity may be drawn regarding this period of time alone. Our study did not include quality of life and patient satisfaction questionnaires, and further studies assessing the association between the number of anatomical areas operated and patient satisfaction are required. Finally, our data were not controlled for the weight of excess skin removed at BPCS, a factor that may by itself explain some of the results in regard to BMI velocity. With that said, we believe that the contribution of the removed excess skin's weight on long-term weight control is minimal.

Conclusions

The findings of this study suggest that in patients following MWL, BCPS in three or more anatomical areas is associated with a higher chance of long-term weight loss than surgery in one area only. This is to be considered when tailoring patient-specific body contouring surgical plan in MWL patients.

Conflict of interest statement

The authors have no commercial associations or financial disclosures that might pose or create a conflict of interest with any of the information presented in the article.

Acknowledgments

There were no contributors who do not meet the criteria for authorship. The study was not funded by any organization or grant.

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