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Do Adverse Childhood Experiences Affect Surgical Weight Loss Outcomes?

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Abstract Bariatric surgery is an effective and enduring treatment for obesity; however, variation in weight loss may occur following surgery. Many factors beyond technical considerations may influence postoperative outcomes. A better understanding of the influence of adverse childhood experiences (ACE) on surgical weight loss may improve preoperative care. Demographic and preoperative and postoperative data were prospectively obtained for 223 patients undergoing bariatric surgery. All cases were completed laparoscopically without serious complication. Patients completed the ACE questionnaire, which assesses childhood maltreatment. Patients had an average age of 48 years and 77 % were female. There was a significant reduction from preoperative to 12-month postoperative BMI (45 to 31 kg/m^2, $p \leq 0.01$). The average ACE score was 2.9 and these patients were more likely than population norms to have an ACE score ≥4 (35.9 vs. 12.5 %, $p < 0.001$). There was a positive correlation between the number of preoperative comorbidities and preoperative ACE score ($R = 0.112$, $p = 0.09$). Patients with a high ACE score (≥6) vs. patients low ACE scores had a higher postoperative BMI at 6-months (36.9 vs. 33.4 kg/m^2, $p = 0.03$) and 12-months postoperatively (34.5 vs. 30.5 kg/m^2, $p = 0.07$). High ACE patients had higher total cholesterol (191 vs. 169 mg/dL, $p = 0.02$) and LDL cholesterol (116 vs. 94 mg/dL, $p = 0.02$) than low ACE patients 12-months postoperatively. A high preoperative ACE score decreases weight loss following bariatric surgery and may warrant an increased preoperative counseling.

Keywords Obesity · Bariatric surgery · Adverse childhood experiences

Introduction

In the USA, the average adult is overweight with a body mass index (BMI) of 28.7 kg/m^2, and at least one third of Americans are obese.[1] Among Americans, 35.5 % has grade I obesity (≥30 kg/m^2), 15.5 % has grade II (≥35 kg/m^2), and 6.3 % has grade III (≥40 kg/m^2).[1] While the etiology of obesity is multi-factorial, one common risk factor for adult obesity is childhood trauma. Over half of all adults experienced some form of neglect, abuse, or a traumatic stressor during their childhood.[2] These are collectively termed adverse childhood experiences (ACE) and are known social determinants for numerous health outcomes including depression, obesity, cardiovascular disease, and diabetes.[2–9] However, given the high prevalence of obesity and ACE, little work has gone into studying the influence of ACE on obesity and its treatment outcomes.

It is difficult to elucidate the relationship between obesity and ACE given the multi-factorial etiology of the disease. While the literature on this topic is limited, one study suggests

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that patients with a history of sexual abuse lost significantly less weight on a multidisciplinary outpatient very-low-calorie diet (VLCD) weight-management program when compared to patients without a history of sexual abuse.[10]

While behavioral modification, exercise, and dietary restriction are important components in the treatment and management of obesity, studies have shown that weight loss surgery is significantly more likely to be successful in achieving long-term results than non-surgical treatment modalities based on lifestyle alone.[11] Bariatric surgery is the most effective and enduring treatment for morbid obesity.[11–16] However, data examining the relationship between weight loss surgery outcomes and ACE is limited as well. One study looking at an extremely obese patient population undergoing gastric bypass surgery suggests that a history of childhood maltreatment is not a negative prognostic factor for gastric bypass surgery.[17]

Given the limited data currently available, there is no reliable method of predicting which patients will be most successful in accomplishing their short- and long-term weight loss goals after bariatric surgery. Therefore, the purpose of this study is to determine if patients' ACE scores affect bariatric surgery outcomes in an adult population. Our study hypothesis is that those patients with greater childhood challenges will have poorer surgical weight loss outcomes than those who did not suffer an ACE.

Materials and Methods

Patient Population

Patients at a single academic institution seeking one of three weight loss surgeries, laparoscopic Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG), or adjustable gastric band (AGB) were prospectively recruited for this study. Inclusion criteria for patients were those required for bariatric surgery: age 18 years and over, BMI >40 or >35 kg/m^2 with two or more comorbid conditions, and have undergone RYGB, SG, or AGB.

Study Design

Preoperatively and 3, 6, and 12 months postoperatively, patients were weighed, biochemical cardiac risk factors (BCRFs) were measured, and the ACE questionnaire was administered at preoperative visit to elicit its effect on postoperative outcomes. All blood samples were analyzed at our institution unless prohibited by the patient's insurance.

No patient enrolled in the study received statin, fibrate, or niacin therapy postoperatively. All patients in the study were required to take a daily multivitamin, per bariatric standard of care, to prevent deficiencies in folic acid, vitamin B_{12}, iron, calcium, and thiamine.

Measures

Primary outcome measures evaluated at baseline and follow-up visits included ACE questionnaire and weight loss outcomes. Secondary outcomes included biochemical cardiac risk factors such as total cholesterol, LDL, HDL, triglycerides, and high-sensitivity C-reactive protein (hs-CRP).

In the ACE questionnaire, adverse experiences are defined in three broad categories: abuse (emotional, physical, or sexual), neglect (emotional or physical), and household dysfunction (domestic violence, substance abuse, mental illness, parental separation/divorce, and incarceration). Responses to the ten forms of maltreatment were recorded as positive (+1 point) or negative (0 points). All responses were summated to give a total score ranging from 0 to 10 with higher scores indicating greater childhood maltreatment. This questionnaire had been previously validated among 334 women and 324 men in a single Health Maintenance Organization (HMO) in San Diego, CA.[18]

Changes in weight were measured as changes in BMI and as percent excess weight loss (%EWL). BMI, %EWL, and triglyceride/HDL cholesterol ratio (TG/HDL) were calculated using primary data.

Statistical Analysis

Patients were compared on the basis of age, gender, BMI, metabolic syndrome, ACE score, and %EWL. Triglyceride/HDL ratio (TG/HDL) was calculated as a surrogate for metabolic syndrome.[19] Patients with a preoperative TG/HDL ≥3.5 were considered to have metabolic syndrome and those <3.5 who did not have metabolic syndrome. ACE scores were divided as low ACE scores (<6) or high scores (≥6). The ACE score of 6 as a cut-off was chosen, as it was double the norm mean. Postoperative outcomes for the low and high ACE score groups were compared by Student's t test of equal variance with $p \leq 0.05$ as significant. Dichotomous and continuous variables were examined by chi-square analysis and Student's t test, respectively. Linear correlation analyses were conducted to compare ACE scores with outcomes in weight and cardiac risk factors. Subgroup analysis was performed on the basis of procedure type.

All analyses were performed using GraphPad Prism 6. Power analysis indicated sufficient sample size was present to detect significant differences between the two groups.

This study was approved by the Stanford University Institutional Review Board (IRB Protocol 17288).

Results

A total of 223 patients were enrolled in this study, and 12-month postoperative follow-up was 78.5 %. The demographic

distribution of patients in this study was representative of the overall patient population undergoing bariatric surgery (Table 1). Patients had an average age of 47 years, 77 % were female, and 50.2 % of these patients were white. Patients began with an average BMI of 45 kg/m^2, lost a significant amount of their weight as early as 3 months postoperatively, and maintained weight loss at 6 and 12 months postoperatively (37.2, 34.1, 31.3 kg/m^2, respectively, $p \leq 0.001$). The weight loss observed in patients was typical for patients undergoing bariatric surgery at this institution. Table 1 also compares preoperative demographic data of patients with low ACE scores (<6) ($n=179$) and high ACE scores (≥6) ($n=44$). Patients with a high ACE score had a statistically longer operative time (174 vs. 135 min, $p=0.01$) and higher rates of depression (54.8 vs. 38.5 %, $p=0.05$).

Overall, patients had an average ACE score of 2.9. Figure 1 shows the percentage of patients with each form of childhood adverse events for published population norms and for high versus low ACE scoring patients.[20] The most common form of adverse event was household separation or divorce (45.7 %), followed by emotional abuse (40.4 %), household substance abuse (37.7 %), emotional neglect (31.8 %), physical abuse (30.5 %), and sexual abuse (26.9 %). When compared to data from population norms, published by a single Health Maintenance Organization (HMO) in California, surgical weight loss patients in this study were more likely to have an ACE score ≥4 ($p<0.001$) (Table 2).[2]

Patient outcomes were compared on the basis of high versus low scores as shown in Fig. 2. Patients with high ACE score had a significantly greater 6-month postoperative BMI when compared to patients with a low ACE score (36.9 vs. 33.4 kg/m^2, $p=0.03$). This trend was also found at 12 months postoperatively (34.5 vs. 30.5 kg/m^2, $p=0.07$). Similarly, patients with high ACE scores had worse markers of cardiovascular disease. At 12 months postoperatively, patients with high ACE scores had higher LDL cholesterol (116 vs. 94 mg/dL, $p=0.02$) and higher total cholesterol (191 vs. 168 mg/dL, $p=0.02$). Overall triglyceride/HDL ratios decreased for all patients, and patients with high ACE scores had significantly higher ratios 3 months postoperatively (4.61 vs. 2.58, $p=0.02$). No significant differences were found in postoperative HDL cholesterol, triglycerides, and hs-CRP protein values between the two groups.

Table 2 Comparison of percentage of patients with 1 to 4+ ACE score in the present study with previously published data at a single Health Maintenance Organization (HMO)[2]

	Present study ($n=223$)	Single HMO ($n=17,337$)	p value
0 ACE	24.2 %	36.1 %	<0.001
1 ACE	17.9 %	26.0 %	0.01
2 ACE	12.6 %	15.9 %	0.17
3 ACE	9.4 %	9.5 %	0.97
≥4 ACE	35.9 %	12.5 %	<0.001

Linear correlation analysis suggests a relationship between total ACE score and total number of preoperative comorbidities ($R=0.11$, $p=0.09$), 6-month postoperative BMI ($R=0.29$, $p=0.05$), 6-month postoperative C-reactive protein ($R=0.23$, $p=0.03$), and TG/HDL ratio 3 months postoperatively ($R=0.17$, $p=0.06$) (Fig. 3).

Subgroup analysis of RYGB patients demonstrated significant postoperative differences between high ($n=98$) and low ($n=28$) ACE score subgroups. Patients who underwent RYGB and had a high ACE score were more likely to have a higher 6-month (39.7 vs. 33.9 kg/m^2, $p=0.02$) and 12-month (37.5 vs. 30.5 kg/m^2, $p=0.04$) postoperative BMIs. These patients also had a higher TG/HDL ratio 3 months

Table 1 Patient demographics for all patients, low ACE scores (<6), high ACE scores (≥6), and p values. Reported as average (SE)

	All patients ($n=223$)	Low ACE ($n=179$)	High ACE ($n=44$)	p value
Age at surgery [years]	47.6 (11.8)	47 (1)	50 (2)	0.11
Female [%]	76.7	74.9	84.1	0.19
White race [%]	50.2	50.0	50.3	0.97
Income [k]	61.8 (25.9)	62.0 (2)	61.2 (4)	0.86
Private insurance [%]	65.5	67.6	59.1	0.29
BMI [kg/m^2]	45.0 (1.9)	44.8 (0.6)	45.9 (1.5)	0.67
Total preoperative comorbidities	4.0	4.0	4.3	0.36
RYGB [%]	57.0	54.7	63.6	0.29
Diabetes [%]	32.3	33.0	30.2	0.73
Hypertension [%]	57.0	58.1	53.5	0.58
Hyperlipidemia [%]	50.7	51.4	48.8	0.76
Depression [%]	41.0	38.5	54.8	0.05
Operative time [min]	142 (86)	135 (3)	174 (27)	0.01
Waist circumference [cm]	132 (18)	132 (1.3)	133 (3.1)	0.91

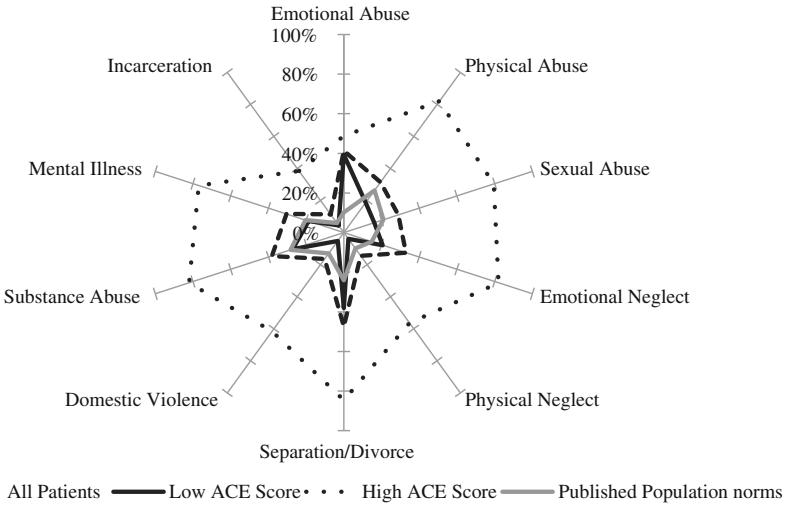

Fig. 1 Percentage of responders who answered positively to maltreatment and type of maltreatment for all patients, low and high ACE scorers, and published population norms

postoperatively (6.7 vs. 2.7, $p=0.01$). However, there was no significant difference in the total cholesterol, LDL cholesterol, triglycerides, or hs-CRP between RYGB patients with high versus low ACE scores.

Discussion

This study is the largest prospective study that evaluates adverse childhood experiences (ACE) in a surgical weight loss population using the validated ACE questionnaire. Our patient population had a significantly higher ACE score when compared to population norms, and, as shown in Fig. 1, the prevalence of each adverse childhood event in our patient population is consistent with previously published trends in household separation/divorce, household substance abuse, and sexual abuse.[2, 20] However, the patient population in the present study tended to have much higher rates of emotional abuse and neglect, which may be an effect of previously documented biases against obese individuals.[21, 22] If there are biases against obese individuals within a household, these bias may manifest as emotional abuse and neglect. In addition, obesity may be a reaction to these adverse events.

Consistent with published literature, patients in our study with a high ACE score tended to have higher rates of depression when compared to those with a low ACE score.[3, 4] Unlike previously published data, however, our study did not demonstrate a relationship between the prevalence of diabetes, hypertension, and hyperlipidemia.[7–9] This is likely due to the confounding effects of obesity in this patient population.

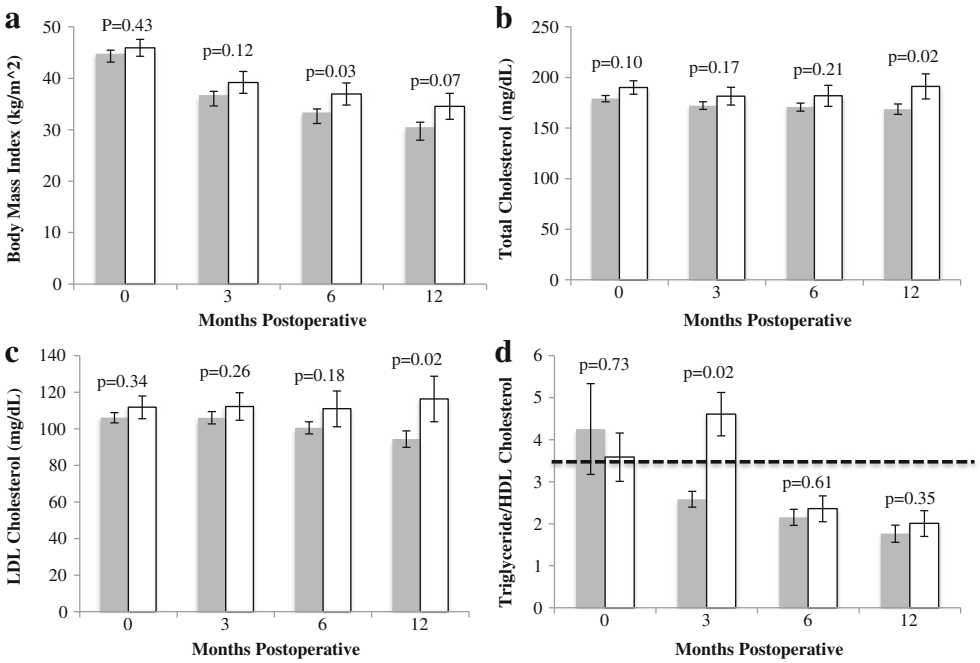

Fig. 2 Comparison of low ACE scores (<6) in *gray* and high ACE scores (≥6) in *white* over time in **a** body mass index, **b** total cholesterol, **c** LDL cholesterol, and **d** triglyceride/HDL ratio. Triglyceride/HDL ratio ≥3.5 (*dashed line*) was used as a surrogate for metabolic syndrome. *P* values compare low ACE scores to high ACE scores

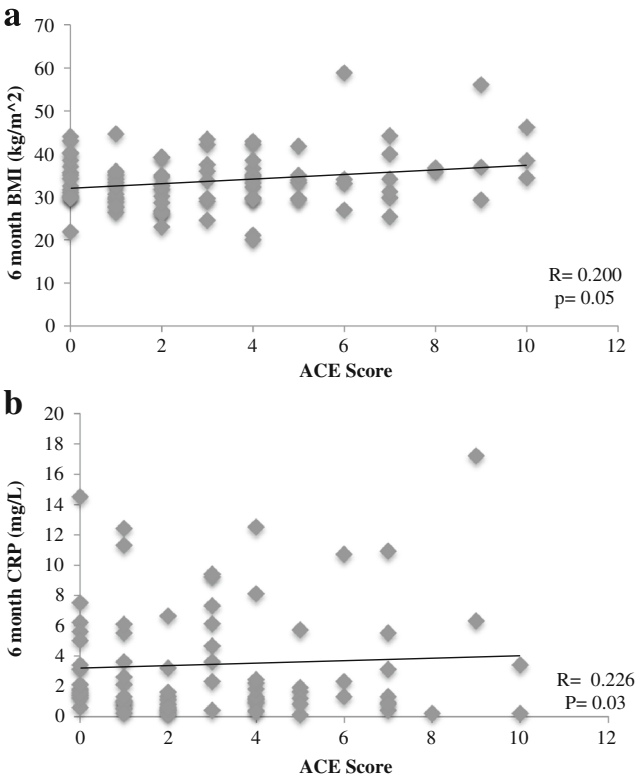

Fig. 3 Correlation analysis of ACE score with number of **a** 6-month postoperative body mass index (BMI) and **b** C-reactive protein (CRP)

The significantly longer operative time in patients with a high ACE score can be explained by the larger percentage of patients who had RYGB, which is a longer surgery than the SG or AGB.

ACE may help explain, in part, heterogeneity in weight loss outcomes after bariatric surgery. We have demonstrated that bariatric surgery patients with high ACE scores (≥6) have worse outcomes in regard to postoperative BMI, total cholesterol, and LDL cholesterol. Although all patient's BMIs improved significantly by 12 months postoperatively, patients with a high ACE score had less improvement in BMI than those with a low ACE score. We saw similar trends for LDL cholesterol, HDL cholesterol, triglycerides, and TG/HDL.

The trends observed in this study are likely multi-factorial. First, patients with high ACE scores had lower improvements in their BMI, which may affect the improvements seen in biochemical cardiac risk factors. Second, patients with high ACE scores may have less support in their households given the cyclic nature of abuse.[23, 24] Our group has previously shown the positive effects of surgical weight loss in family members; however, we believe these effects could negatively impact patient outcomes if a family support network is not available to patients.[25] One of the hallmarks of long-term weight loss is persistence and resiliency when confronted with setbacks in adherence to diet. Prior history of adverse childhood events may blunt the resiliency needed to maintain weight loss.

Conclusion

The data presented here are consistent with previous research showing that obesity is associated with higher ACE scores.[5, 6] However, the present study also indicates that a high number of adverse childhood experiences may negatively influence outcomes after bariatric surgery. While bariatric surgery helps patients lose significant amounts of weight and allows for resolution of obesity-related comorbidities, those bariatric patients with a history of childhood abuse, neglect, and household dysfunction may not experience the full benefits of these procedures. This study warrants further research into the relationship between adverse childhood experiences and surgical weight loss outcomes particularly in implementing cognitive therapy to improve coping resiliency.

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