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Metabolic Effects of Roux-en-Y Gastric Bypass in Obese Adolescents and Young Adults

Manasi Sinha, MD, MPH[1,*], **Takara L. Stanley, MD**[1,2,*], **Jessica Webb**[1], **Christina Scirica, MD, MPH**[3], **Kathleen Corey, MD, MPH**[3], **Janey Pratt, MD**[3], **Paul A. Boepple, MD**[1,3], **Alison Hoppin, MD**[3], and **Madhusmita Misra, MD, MPH**[1,2]

[1]Pediatric Endocrine Unit, Massachusetts General Hospital and Harvard Medical School, Boston, MA

[2]Neuroendocrine Unit, Massachusetts General Hospital and Harvard Medical School, Boston, MA

[3]Weight Center, Massachusetts General Hospital and Harvard Medical School, Boston, MA

Abstract

Weight loss surgery is an increasingly common treatment option for obese adolescents, but data are limited regarding the metabolic effects of surgical weight loss procedures. We performed retrospective review of the electronic medical record to determine metabolic outcomes for 24 adolescents and young adults age 15–22y undergoing Roux-en-Y gastric bypass (RYGB) from 2009–2011 as well as 24 age-, gender-, and BMI-matched controls. Over a median follow-up of 6 months after RYGB, fasting glucose, HbA1c, LDL, triglyceride, and hsCRP decreased significantly. Changes in these measures were not significantly associated with age or extent of weight loss.

Keywords

Obesity; Adolescence; Roux-en-Y Gastric Bypass; Glucose; hsCRP

Introduction

Weight loss surgery (WLS) is increasingly used in severely obese adolescents who have failed attempts at lifestyle modification or pharmacologic therapy. In adults, WLS is a highly effective treatment for comorbidities of obesity (1–3). In contrast, less is known about outcomes of WLS in adolescents and young adults, and few studies compare post-surgical metabolic changes with metabolic changes in non-surgical controls. The objectives of this study were to evaluate metabolic changes in mature adolescents and young adults 15–22yo undergoing Roux-en-Y gastric bypass (RYGB) and to compare results to a non-surgical cohort. Our hypothesis was that RYGB would lead to improvement in body mass index (BMI), glucose homeostasis, lipids, and pro-inflammatory markers as compared to matched non-surgical controls.

Address for Correspondence: Takara Stanley, MD, LON5-207, Massachusetts General Hospital, Boston, MA 02114, Phone: 617-726-9209, Fax: 617-724-8998, : tstanley@partners.org.
*indicates co-first authorship

Conflicts of Interest: none to disclose

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Methods

This retrospective electronic medical record review was approved by the Partners Health Care Institutional Review Board (IRB). Requirement for informed consent was waived by the IRB based on the minimal risk to subjects and impracticability of obtaining consent for this retrospective review. We reviewed data on all patients age 22 years or less who were referred to the Weight Center at Massachusetts General Hospital (MGH) and underwent an RYGB procedure from 2009–2011. Adolescent eligibility criteria for WLS at the MGH Weight Center include BMI≥35kg/m^2 with severe comorbidities or BMI≥40kg/m^2 with minor comorbidities, completion of statural growth, demonstration of previous sustained efforts at non-surgical weight loss (i.e., lifestyle changes including nutritional changes and physical activity), and determination by a physician, psychologist, and nutritionist that sufficient maturity exists to recognize the risks and benefits of the procedure and to implement required post-operative behavioral changes. A control subject between the ages of 15–23y was selected to match each RYGB subject using a patient database that included only gender, age, and BMI information. These control subjects were also evaluated at the MGH Weight Center for obesity, but were managed with lifestyle intervention. Median [IQR] of BMI difference between weight center patients and controls was 0.9kg/m^2 [−0.1 – 3.1]. Information collected included height and weight measured at clinical visits by clinical staff as well as laboratory values obtained at MGH and its affiliates. Excess BMI was determined as the difference between a subject's BMI and a BMI of 25kg/m^2, and percent excess BMI loss (%EBMIL) was calculated as [BMI loss/(pre-operative BMI – 25)] × 100 (4, 5). Pre-operative data were collected within 1 year of surgery. When possible, follow-up data were collected between 6 and 12 months post-operatively. To maximize available data, some laboratory values outside this time frame were included. Not all data were available for all patients during the follow-up period. Statistical analysis was performed using the statistical software package JMP 9.0 (SAS Institute, Inc.). The majority of data were not normally distributed, and results are presented as median (Interquartile Range [IQR]) unless otherwise indicated. Wilcoxon Rank Sum test was used to assess differences between groups. To assess differences within groups between baseline and follow-up, paired t-test was used when differences were normally distributed, and paired Wilcoxon signed rank test when differences were not normally distributed.

Results

Baseline characteristics are shown in Table 1 and Table 2. HbA1c was higher in the RYGB group compared to controls (P = 0.01), but there were no other differences between the groups at baseline. The median [IQR] for BMI follow-up was 191d [141–294], and for postoperative labs 198d [155–312] (P=0.62 for difference). Follow-up intervals for both labs and BMI tended to be 1–2 months longer in controls compared to RYGB but this was not statistically significant (P = 0.09 for labs, P = 0.11 for BMI). As expected, RYGB led to significant weight loss. Subjects undergoing RYGB lost 44% (33–55) excess BMI, with a range of 20–90% EBMIL. Of note, there was no difference in EBMIL between those RYGB subjects who had follow-up labs available and those who did not (P = 0.79).

As shown in Table 2, fasting glucose and HbA1c decreased significantly in the RYGB group. In the limited subset of subjects (N=9) who had fasting insulin available, fasting insulin changed by −22 μU/mL [(−31 – −11), P = 0.003], and HOMA-IR changed by −4.7 [(−7.0 – −2.3), P = 0.004]. In the two patients who had type 2 diabetes prior to surgery, diabetes was noted to be resolved at follow-up. Total cholesterol, LDL, and triglycerides also significantly decreased (Table 2).

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In the RYGB group as a whole, AST and ALT did not significantly change following surgery (Table 2). Among the sub-group (N=6) of patients who had elevated ALT or AST at baseline, however, RYGB resulted in a significant decline in AST [−12 U/L (−23 – −3), P = 0.03] and ALT [−27 U/L (−46 – −11), P = 0.03]. Serum creatinine showed a small but significant decrease following RYGB (Table 2, P = 0.03).

High sensitivity CRP changed by −6 mg/L (−13 – −2) following RYGB (P = 0.0007). Although sample size was limited, the decrease in CRP in females was greater than in males (P = 0.03). Sedimentation rate changed by −9 mm/hr (−18 – −6) in the RYGB group during follow-up (P = 0.0001). WBC count [−2.2 th/mm^3(−4.0 – −0.8), P = 0.001] and platelet count [−41 th/mm^3 (−81 – −2), P = 0.004] also decreased. In univariate analysis within the RYGB group, age at surgery was not associated with changes in weight or changes in metabolic variables. Of note, post-surgical changes in body weight were not significantly associated with changes in fasting glucose, HbA1c, lipid, or systemic inflammatory markers (hsCRP, ESR), P > 0.2 for all.

Changes in controls during the follow-up period are shown in Table 2. The control group did not experience significant weight loss during the follow-up period, and, in comparison to controls, the %EBMIL in the RYGB group was highly significant (P < 0.0001). Changes in fasting glucose (P = 0.02) and HbA1c (P = 0.02) were also significant in RYGB vs. controls. There were not sufficient data in controls to compare changes in fasting insulin or HOMA-IR. The decrease in LDL after RYGB was significant (P = 0.03) compared to controls, whereas the change in TGL was not significant (P = 0.4). Declines in WBC count (P = 0.002) and platelets (P = 0.003) were significant in RYGB vs. controls, whereas there were not sufficient control data to compare changes in hsCRP or ESR. There was a small decrease in creatinine in the RYGB group that just reached statistical significance as compared with controls (P = 0.05).

Discussion

Our data demonstrate improvements in multiple metabolic parameters following RYGB in adolescents and young adults, many of which were highly significant compared to controls. Age was not significantly associated with outcomes. Moreover, the magnitude of metabolic improvement was not significantly associated with the degree of weight loss, supporting recent research that RYGB alters critical endocrine and metabolic pathways independent of caloric restriction and weight loss (6–8). However, our small sample size may have limited our ability to detect associations between magnitude of weight loss and improvement in metabolic variables.

As shown in previous studies in adolescents, glucose homeostasis improved in our cohort following RYGB (9, 10). In the 2 of 24 RYGB subjects who had T2DM at baseline, T2DM resolved post-surgically, consistent with previous reports in adolescents and adults (10). Although the majority of our cohort was non-diabetic, significant improvements were seen in HbA1c (−0.4%), and fasting glucose (−9mg/dL), insulin (−22μU/mL) and HOMA-IR (−4.7). The magnitude of these changes is similar to changes reported in other RYGB cohorts (9, 11).

Markers of chronic inflammation, including CRP and ESR, decreased significantly in RYGB subjects. Reduction in CRP has been reported in adult WLS cohorts (12, 13), but, to our knowledge, this is the first report of reductions in CRP and ESR in adolescents and young adults following RYGB. We also noted reductions in leukocyte and platelet counts after RYGB. Prior to the widespread use of hsCRP as a marker of inflammation, population studies showed strong positive associations between leukocyte count and future

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cardiovascular (CV) disease risk (14, 15). Thrombocytosis is also associated with systemic inflammation (16) and obesity (17), and relatively higher platelet counts predict future CV disease (18). To our knowledge, the small but significant decrease in serum creatinine after RYGB has not yet been reported in adolescents and young adults but is consistent with data in adults showing a 0.1mg/dL decrease in creatinine 6 months after RYGB (19).

There are important limitations to the current study. This was a retrospective study dependent on clinical data, which was not consistently collected in all patients. RYGB patients and controls were matched only on the basis of gender, age, and BMI, and we were not able to match on other potentially important factors such as prior weight history and follow-up interval. Height and weight were collected by multiple clinical staff rather than a single evaluator. In addition, we have a relatively small sample size and limited time frame for evaluation of postoperative changes. Importantly, previous studies have shown a modest decline in success rates 2–3 years post-operatively in patients after gastric bypass, and it will be necessary to follow adolescents undergoing RYGB further to assess this issue. However, given the relatively limited data on outcomes of WLS in adolescents and young adults, we believe our data, in combination with reports from other relatively small cohorts, contribute to our knowledge of metabolic outcomes of RYGB in this age group. Consistent with other studies, we demonstrate significant improvements in glucose homeostasis and lipid measures, and, for the first time in this age group, we show significant changes in markers of inflammation, including CRP, as well as improvements in creatinine. Further studies are necessary to elucidate the mechanisms of these changes.

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References

1. Sugerman HJ, Wolfe LG, Sica DA, et al. Diabetes and hypertension in severe obesity and effects of gastric bypass-induced weight loss. Ann Surg. 2003; 237(6):751–6. discussion 757–8. [PubMed: 12796570]
2. Mingrone G, Panunzi S, De Gaetano A, et al. Bariatric surgery versus conventional medical therapy for type 2 diabetes. N Engl J Med. 2012; 366(17):1577–85. [PubMed: 22449317]
3. Schauer PR, Kashyap SR, Wolski K, et al. Bariatric surgery versus intensive medical therapy in obese patients with diabetes. N Engl J Med. 2012; 366(17):1567–76. [PubMed: 22449319]
4. Deitel M, Greenstein RJ. Recommendations for reporting weight loss. Obes Surg. 2003; 13(2):159–60. [PubMed: 12760387]
5. Dixon JB, McPhail T, O'Brien PE. Minimal reporting requirements for weight loss: current methods not ideal. Obes Surg. 2005; 15(7):1034–9. [PubMed: 16105403]
6. Korner J, Bessler M, Cirilo LJ, et al. Effects of Roux-en-Y gastric bypass surgery on fasting and postprandial concentrations of plasma ghrelin, peptide YY, and insulin. J Clin Endocrinol Metab. 2005; 90(1):359–65. [PubMed: 15483088]
7. Peterli R, Steinert RE, Woelnerhanssen B, et al. Metabolic and hormonal changes after laparoscopic Roux-en-Y gastric bypass and sleeve gastrectomy: a randomized, prospective trial. Obes Surg. 2012; 22(5):740–8. [PubMed: 22354457]
8. Bayham BE, Greenway FL, Bellanger DE, et al. Early resolution of type 2 diabetes seen after Roux-en-Y gastric bypass and vertical sleeve gastrectomy. Diabetes Technol Ther. 2012; 14(1):30–4. [PubMed: 21933001]
9. Lawson ML, Kirk S, Mitchell T, et al. One-year outcomes of Roux-en-Y gastric bypass for morbidly obese adolescents: a multicenter study from the Pediatric Bariatric Study Group. J Pediatr Surg. 2006; 41(1):137–43. discussion 137–43. [PubMed: 16410123]

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10. Inge TH, Miyano G, Bean J, et al. Reversal of type 2 diabetes mellitus and improvements in cardiovascular risk factors after surgical weight loss in adolescents. Pediatrics. 2009; 123(1):214–22. [PubMed: 19117885]
11. Teeple EA, Teich S, Schuster DP, et al. Early metabolic improvement following bariatric surgery in morbidly obese adolescents. Pediatr Blood Cancer. 2012; 58(1):112–6. [PubMed: 22021118]
12. Illan-Gomez F, Gonzalvez-Ortega M, Orea-Soler I, et al. Obesity and inflammation: change in adiponectin, C-reactive protein, tumour necrosis factor-alpha and interleukin-6 after bariatric surgery. Obes Surg. 2012; 22(6):950–5. [PubMed: 22527592]
13. Miller GD, Nicklas BJ, Fernandez A. Serial changes in inflammatory biomarkers after Roux-en-Y gastric bypass surgery. Surg Obes Relat Dis. 2011; 7(5):618–24. [PubMed: 21546319]
14. Kannel WB, Anderson K, Wilson PW. White blood cell count and cardiovascular disease. Insights from the Framingham Study. JAMA. 1992; 267(9):1253–6. [PubMed: 1538564]
15. Margolis KL, Manson JE, Greenland P, et al. Leukocyte count as a predictor of cardiovascular events and mortality in postmenopausal women: the Women's Health Initiative Observational Study. Arch Intern Med. 2005; 165(5):500–8. [PubMed: 15767524]
16. Santimone I, Di Castelnuovo A, De Curtis A, et al. White blood cell count, sex and age are major determinants of heterogeneity of platelet indices in an adult general population: results from the MOLI-SANI project. Haematologica. 2011; 96(8):1180–8. [PubMed: 21546503]
17. Samocha-Bonet D, Justo D, Rogowski O, et al. Platelet counts and platelet activation markers in obese subjects. Mediators Inflamm. 2008; 2008:834153. [PubMed: 18385810]
18. Thaulow E, Erikssen J, Sandvik L, et al. Blood platelet count and function are related to total and cardiovascular death in apparently healthy men. Circulation. 1991; 84(2):613–7. [PubMed: 1860204]
19. Getty JL, Hamdallah IN, Shamseddeen HN, et al. Changes in renal function following Roux-en-Y gastric bypass: a prospective study. Obes Surg. 2012; 22(7):1055–9. [PubMed: 22318447]

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Table 1

Baseline Characteristics

	RYGB Cohort (N=24)	Controls (N=24)	p-value for comparison*
Age (y)	19.0 (16.3 – 21.8)	18.5 (16.0 – 21.0)	0.52
Gender	4M/20F	4M/20F	1.00
Race/Ethnicity			0.87
Asian	2 (8%)	1 (4%)	
Black	3 (13%)	2 (8%)	
Hispanic	6 (25%)	6 (25%)	
White	11 (46%)	14 (58%)	
Other	2 (8%)	1 (4%)	
Weight (kg)	139.3 (122.5 – 163.6)	133.6 (122.3 – 156.2)	0.46
BMI (kg/m^2)	49.5 (46.4 – 58.6)	48.3 (43.4 – 56.3)	0.53
hsCRP (mg/L)	7.2 (3.2 – 16.1)	11.8 (6.0 – 17.8)	0.30
ESR (mm/hr)	21 (13 – 45)	28 (18 – 39)	0.83
WBC (th/mm^3)	8.3 (6.8 – 12.0)	9.1 (7 – 9.8)	0.92
PLT (th/mm^3)	339 (289 – 410)	329 (288 – 378)	0.50

Values are median (IQR).

*P-value using Wilcoxon Rank-Sum Test for continuous variables and the Chi-Square test for discrete variables.

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Table 2

Body Composition and Metabolic Changes during follow-up for RYGB and Controls

	Baseline		Follow-up					
	RYGB	Control	RYGB			Control		
			N[a]	Change	P [b]	N[a]	Change	P [b]
Body Composition								
Weight (kg)	139.3 (122.5 – 163.6)	133.6 (122.3 – 156.2)	23	−32.3 (−38.1 – −25.3)	<0.0001	23	1.1 (−2.2 – 6.5)	0.38
BMI (kg/m^2)	49.5 (46.4 – 58.6)	48.3 (43.4 – 56.3)	23	−10.9 (−13.3 – −8.1)	<0.0001	23	0.4 (−0.8 – 2.5)	0.29
Glucose Homeostasis								
Fasting Glucose (mg/dL)	84 (80 – 101)	89 (83 – 95)	14	−9 (−18 – −3)	0.0007	8	1 (−10 – 4)	0.55
HbA1c (%)[c]	5.7 (5.3 – 5.9)	5.3 (5.2 – 5.5)	12	−0.4 (−0.8 – −0.2)	0.001	9	0.0 (−0.3 – 0.2)	0.75
Lipids								
Total Cholesterol (mg/dL)	159 (141 – 193)	164 (145 – 206)	12	−38 (−55 – −6)	0.002	8	−14 (−21 – 11)	0.21
LDL-cholesterol (mg/dL)	95 (82 – 111)	108 (85 – 130)	12	−34 (−39 – −18)	0.0005	8	−9 (−23 – 5)	0.10
HDL-cholesterol (mg/dL)	39 (34 – 46)	42 (35 – 46)	12	0 (−9 – 12)	0.55	8	2 (−2 – 5)	0.30
Triglyceride (mg/dL)	93 (66 – 182)	105 (76 – 126)	12	−33 (−55 – 8)	0.03	8	−4 (−19 – 6)	0.55
Transaminases								
ALT (U/L)	22 (16 – 33)	25 (19 – 48)	21	−3 (−16 – −1)	0.06	13	−4 (−14 – 1)	0.12
AST (U/L)	21 (17 – 30)	24 (21 – 36)	21	−2 (−7 – 5)	0.41	13	−5 (−14 – −2)	0.12
Creatinine (mg/dL)	0.7 (0.6 – 0.8)	0.7 (0.7 – 0.9)	22	−0.1 (−0.2 – 0.0)	0.03	12	0.0 (−0.1 – 0.2)	0.25

Baseline and change values are median (IQR).

[a] N shows sample sizes available for paired testing in each group.

[b] P-value performed using within group two-tailed paired testing (paired t-test for normally distributed differences and paired Wilcoxon signed rank test for non-normally distributed differences).

[c] HbA1c significantly different between RYGB and controls at baseline. All other values not different between groups.

HOMA-IR: Homeostatic Model Assessment - Insulin Resistance. HbA1c: hemoglobin A1c. PTH: parathyroid hormone. ALT: alanine aminotransferase. AST: aspartate aminotransferase. hsCRP: high sensitivity c-reactive protein. ESR: erythrocyte sedimentation rate.