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Original article

Prospective evaluation of urinary metabolic indices in severely obese adolescents after weight loss surgery

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Abstract

Background: Observational studies in obese adults have found abnormal urinary metabolic indices that predispose to nephrolithiasis. Few studies have been performed in severely obese adolescents.
Objectives: To assess urinary stone risk factors in severely obese adolescents and in those undergoing 2 types of weight loss surgery.
Setting: Children's hospital, United States.
Methods: A prospective cross-sectional study was performed to assess urinary metabolic profiles in severely obese adolescents who either have not undergone any gastrointestinal surgery or who have undergone Roux-en-Y gastric bypass (RYGB) or vertical sleeve gastrectomy (SG). Twenty-four-hour urine collections were performed at home and evaluated at a central laboratory. Established normal reference ranges for adults were used in the analysis. A linear regression analysis was performed assessing the relationship of the study group with each of the outcomes.
Results: A total of 55 samples were analyzed from 14 severely obese adolescents and from 17 severely obese adolescents after bariatric surgery (RYGB, 10; SG, 7). Median body mass index was similar between the RYGB and SG groups. The median 24-hour excretion of oxalate was significantly elevated in the RYGB group. Calcium and uric acid excretion and the median supersaturation of calcium oxalate, calcium phosphate, and uric acid were similar among all groups.
Conclusions: Elevated excretion of oxalate in the urine of severely obese adolescents and in those who have undergone RYGB may portend increased risk for kidney stone formation. Larger longitudinal studies are needed to verify these findings and to determine the clinical risk of developing stone disease in these patient populations. (Surg Obes Relat Dis 2015;▮:00–00.)

Keywords: Urinary metabolic indices; Obesity; Nephrolithiasis

The prevalence of nephrolithiasis in adults is increasing in parallel with the obesity epidemic, and epidemiologic studies have found a significant association between obesity and increased nephrolithiasis risk. Kidney stones previously were thought to be uncommon in children and adolescents, but the incidence appears to be increasing in the younger age group [1,2]. Previous observational studies in obese

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adults have shown abnormal urinary metabolic indices that predispose to crystal aggregation and calculus formation [3,4]. In addition, gastric bypass procedures have been implicated in the development of enteric hyperoxaluria [5]. Few studies have been performed in severely obese children and adolescents. The purpose of this study was to assess urinary chemistry in severely obese adolescents and to determine whether alterations in lithogenic salt excretion might be expected after weight loss surgery.

Materials and methods

After obtaining institutional review board approval, a prospective cohort study was performed to assess urinary metabolic profiles in severely obese adolescents presenting to the Surgical Weight Loss Program for Teens at the Cincinnati Children's Hospital Medical Center. The project was conducted as an ancillary study to the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS, U01 DK072493), National Institute of Diabetes and Digestive and Kidney Diseases-funded multicenter consortium studying the health benefits and risks in adolescents undergoing weight loss surgery.

Adolescents and young adults (up to age 21) who were being evaluated either before or after bariatric surgery were eligible for this study, unless they met any of the following exclusion criteria: history of urologic (urethral, bladder, ureteral, or renal) surgery, renal insufficiency, or a previous known personal history of nephrolithiasis. After enrollment, a general medical history and physical was performed in the clinic. Because nephrolithiasis can be familial, a family history of kidney stone disease was elicited and recorded. A basic metabolic panel performed for clinical indications was reviewed to assess for renal insufficiency. All patients were studied using a standard protocol (two 24-hour urine collections performed at home and sent directly for evaluation at a central laboratory (Litholink Corporation, Chicago, IL). Internal quality assurance controls were performed in the laboratory to assess for undercollection and to validate the volume measurement. Patients were offered a $25 incentive for participation.

The 24-hour urinary metabolic evaluation was a standard urinary panel that included pH and 24-hour urine volume, as well as the excretion of creatinine, calcium, oxalate, citrate, uric acid, magnesium, phosphorus, sodium, potassium, chloride, sulfate, ammonium, and urea nitrogen. Data from 2 consecutive urine samples were averaged if available and included as one data point in the final analysis. Urinary supersaturation or the proximate free energy to crystallization was defined as the ratio of the concentration of a dissolved salt to its solubility in water. The urinary supersaturation ratios of calcium oxalate, calcium phosphate, and uric acid were calculated using the iterative computer program EQUIL II (SAS Institute Inc, Cary, NC). Established reference ranges for adults were used in the analysis of specimens from these older adolescents. No samples were excluded for undercollection.

Severely obese adolescents who were enrolled in a 6 month preparatory program before bariatric surgery were recruited as nonoperative controls. They had not previously undergone any gastrointestinal operation. The postoperative patients previously had undergone either a Roux-en-Y gastric bypass (RYGB) or vertical sleeve gastrectomy (SG) procedure. The RYGB procedure was performed using a standard 100–150 cm Roux limb length [6]. The SG was performed by resection of most of the gastric body and fundus along a 34F intraluminal bougie, starting 6 cm proximal to the distal end of the pylorus. All postoperative patients were maintained on a standard protocol of vitamin supplements.

Standard descriptive statistics were calculated to summarize subject characteristics. Frequencies and percentages were reported for categorical measures. Medians and interquartile ranges were calculated for continuous variables. Fisher's exact and Kruskal-Wallis tests were used to compare characteristics across study groups. Linear regression modeling analyses were performed, adjusting for age, sex, and body mass index (BMI) to evaluate the relationship between surgical (RYBG, SG)/nonsurgical groups and urinary metabolic indices. Statistical analysis was performed using SAS version 9.3 (generalized linear model procedure). All reported P values were 2-sided and considered statistically significant at $P \leq .05$.

Results

A total of 31 patients were enrolled and completed the urinary collection (Table 1). Overall, 55 samples were submitted for analysis. Seven patients were able to complete only 1 specimen collection. There were 6 males and 8 females in the nonoperative group, and their median age

Table 1
Patient demographic characteristics

Demographic characteristics	Nonoperative (n = 14)	RYGB (n = 10)	SG (n = 7)	P
Sex, n				.02
Male	6	0	1	
Female	8	10	6	
Age (yr), median	17.9	18.6	17.6	.07
Current weight (kg), median	133	105	94	<.01
Current BMI (kg/m^2), median	50	36	32	<.01
Preoperative BMI (kg/m^2), median	N/A	52	51	.37
Time since surgery (mo), median	N/A	12.7	10.0	.38
Family history of nephrolithiasis, n	5	3	2	.99

RYGB = Roux-en-Y gastric bypass; SG = vertical sleeve gastrectomy; BMI = body mass index; N/A = not applicable.