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Recalcitrant Hypocalcemia after Thyroidectomy in Patients with Previous Roux-en-Y Gastric Bypass

Travis J. McKenzie, MD¹, Yufei Chen, MD¹, Richard A. Hodin, MD¹, Scott A. Shikora, MD², Matthew M. Hutter, MD¹, Randall D. Gaz, MD¹, Francis D. Moore Jr., MD², and Carrie C. Lubitz, MD, MPH¹

¹ Massachusetts General Hospital, Department of Surgery

² Brigham and Women's Hospital, Department of Surgery

Abstract

Background—Hypocalcemia is a potential complication after thyroidectomy. Patients with previous roux-en-Y gastric bypass (RYGBP) may be at increased risk for recalcitrant symptomatic hypocalcemia after thyroidectomy. This complication is poorly described and there is no current consensus on optimal management in this unique population.

Methods—All patients from 2000-2012 who underwent thyroidectomy with history of preceding RYGBP were identified retrospectively. Each of the 19 patients meeting inclusion criteria were matched 2:1 for age, gender, and BMI to a cohort who underwent thyroidectomy without previous RYGBP. The study cohort and matched controls were compared for incidence of symptomatic post-operative hypocalcemia, requirement of intravenous (IV) calcium supplementation, and length of hospital stay (LOS).

Results—Age, proportion of female patients, and BMI were equivalent between cases (n=19) and controls (n=38). Comparison of primary outcomes demonstrated that the study group had a significantly higher incidence of symptomatic hypocalcemia (42% vs. 0%, p<0.01), administration of IV calcium (21% vs. 0%, p<0.01), and LOS (2.2 vs. 1.2 days, p=0.02).

Conclusions—Patients with previous RYGBP have higher incidence of recalcitrant symptomatic hypocalcemia after thyroidectomy resulting in prolonged LOS. In this patient population calcium levels should be closely monitored and early calcium and vitamin D supplementation preemptively initiated.

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Corresponding Author Travis J. McKenzie, MD Wang Ambulatory Care Center, 460 15 Parkman Street Boston, MA 02114 Work Phone: 617-643-7869 Home Phone (Cell): 507-254-3895 tjmckenzie@partners.org.

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Introduction

Obesity is a worldwide epidemic, with over 500 million individuals meeting criteria for clinical obesity.¹ In the United States 124,838 bariatric operations were performed in 2008 of which 69% were RYGBP.² As the post-gastric bypass patient population grows, many will be diagnosed with thyroid disease necessitating thyroidectomy.

Transient hypoparathyroidism leading to hypocalcemia is a common complication following thyroidectomy, occurring in approximately 20% of patients.³ This complication may be symptomatic in approximately 10% of patients and presents most commonly with mild peri-oral or digital paresthesias.⁴ Mild symptomatic hypocalcemia is often adequately treated in the outpatient setting with oral calcium and vitamin D supplementation. However, patients with previous RYGBP may be at increased risk for the development of recalcitrant symptomatic hypocalcemia secondary to their malabsorptive enteric anatomy and underlying metabolic bone disease in the setting of secondary hyperparathyroidism.

This complication has been previously described only in case reports.^{5,6,7} There is currently no accepted standard of care regarding the peri-operative evaluation and management of the RYGBP patient in need of thyroidectomy. Herein we describe the incidence of clinically relevant symptomatic hypocalcemia after thyroidectomy in the setting of previous RYGBP and discuss the associated pathophysiology.

Methods

All patients from the years 2000-2012 who underwent thyroidectomy with a history of preceding RYGBP were identified from the Research Patient Data Registry (RPDR), a clinical care data registry capturing all data from the Partners HealthCare System, which includes two primary hospitals, Brigham and Women's Hospital and Massachusetts General Hospital. All patients who underwent total, near total, sub-total, or completion thyroidectomy with preceding RYGBP were included. Patients who underwent isolated thyroid lobectomy were excluded. Patients with history of a preceding bariatric operation other than RYGBP were also excluded. A control group was identified from all patients who underwent thyroidectomy without preceding bariatric procedure using the same database. Controls were matched 2:1 for age, gender, and BMI at time of initial operation. Case matching was done with the gmatch SAS macro (Developed by Erik Bergstralh and Jon Kosanke, 2003, Mayo Clinic). All three variables were weighted evenly. Primary endpoints included the incidence of symptomatic post-operative hypocalcemia, need for IV calcium replacement, and length of hospital stay (LOS). Secondary endpoints included post-operative uncorrected total calcium (Ca) and parathyroid hormone (PTH) levels. Analysis was performed using Statistical Analysis Software (SAS® v.9.2). Continuous variables were compared using the Wilcoxon Rank-Sum test and categorical variables with Fisher's exact test. A univariate analysis was conducted with a p-value of <0.05 considered statistically significant.

Results

A total of 19 patients were identified for the study group with a corresponding 38 matched controls. There was no significant difference between the two groups in terms of age, gender and initial BMI, validating appropriate matching (**Table 1**). In the study cohort the average age was 49.7 years at thyroidectomy, 94% of patients were female, and average BMI was 45.3 at time of bariatric operation.

The average interval between RYGBP and thyroidectomy was 52.6 months (range 4 – 109). The average reduction in BMI (kg/m^2) during this time was 10.4 (± 8.1). Ten patients (53%) had their RYGBP done laparoscopically. Roux limb length was reported in 16 patients with a median of 100 cm (range 80-150 cm).

There was no significant difference between the study group and the control group in the extent of thyroidectomy performed (i.e. near-total vs. total thyroidectomy) or rate of malignancy. Seventeen patients (90%) in the study group and 36 patients (95%) in the control group underwent total thyroidectomy. Three patients (16%) in the study group had a concomitant intentional parathyroidectomy (all due to primary hyperparathyroidism) compared with 5 patients (13%) in the control group (4 had primary hyperparathyroidism and 1 had secondary hyperparathyroidism from renal failure). There were no inadvertent parathyroidectomies identified on final pathology.

There were also no significant differences between the study and control groups in regard to final pathology. Thyroid malignancy was identified in ten patients (53%) within the study group and 21 patients (55%) within the control group. All ten malignant cases in the study group were papillary thyroid carcinoma. In the control group, one patient had medullary thyroid carcinoma and the remaining 20 had papillary thyroid carcinoma. No patients in the study group underwent central neck dissection compared to five in the control group. Regarding benign pathologies, eight patients had multinodular goiter and one had a solitary benign nodule in the study group compared with 12 and five respectively in the control group. No patients in the study group had Graves disease. One patient in the study group had Hashimoto's thyroiditis but did not develop post-operative hypocalcemia. One patient in the control group had Hashimoto's and two patients had Graves disease.

A comparison of primary outcomes on univariate analysis (**Table 2**) demonstrates that the study group had a significantly higher incidence of symptomatic hypocalcemia (42% vs. 0%, $p < 0.01$), administration of IV calcium (21% vs. 0%, $p < 0.01$) and LOS (2.2 vs. 1.2 days, $p = 0.02$). The increased LOS in all cases within the study group was attributable to symptomatic hypocalcemia. One patient in the study group required readmission on post-operative day four due to muscle spasm secondary to hypocalcemia. Median duration of follow-up was 26.5 months (range 0.3-115) in the study population compared with 15 months (range 0.3-129) in the control group. Follow-up exceeded 6 months in 16 patients (85%) in the study group and 28 patients (74%) in the control group. Of the three patients in the study cohort with less than six month follow-up, two patients had short interval follow up given their recent date of surgery and one patient was lost to follow-up. The single

patient that was lost to follow-up had benign disease with no evidence of symptomatic hypocalcemia upon hospital discharge.

The study group had a significantly higher proportion of patients taking both oral calcium and vitamin D supplementation prior to thyroid surgery compared to the control group (26% vs. 5%, $p=0.04$) (**Table 3**). The pre-operative (those drawn nearest to the time of surgery) and post-operative serum calcium, vitamin D, and PTH levels were not significantly different between patients in the study and control groups (**Table 4**). The postoperative nadir calcium level was 7.9mg/dl in the study group and 8.3mg/dl in the control group ($p=0.11$) (normal 8.5-10.5mg/dl). 15 (39%) patients in the control group were found to have hypocalcemia (defined as calcium $<8.5\text{mg/dL}$) on the first post-operative day, none of whom developed symptoms.

A subgroup analysis was performed excluding patients with intentional parathyroidectomy as part of the thyroidectomy. This left a study cohort of 16 patients and control group of 33 patients with thyroidectomy alone (**Table 5**). Demographics, operative indications, and pathology were similar between groups. Both symptomatic hypocalcemia 38% vs. 0% ($p<0.01$) and the need for IV calcium 19% vs. 0% ($p=0.03$) remained statistically significant between study and control groups. LOS lost statistical significance (2.0 days $\pm$ 2.1 vs 1.2 $\pm$ 0.7) ($p=0.16$). The calcium and PTH levels immediately post-operatively and at 6 months were otherwise not different between groups.

A second subgroup analysis was performed among patients in the study cohort, comparing symptomatic and asymptomatic patients (**Table 6**). There was no significant difference between the two groups in terms of age at initial operation, extent of thyroidectomy performed, BMI or final thyroid pathology. Of the eight symptomatic patients, one patient (13%) was on pre-operative calcium and vitamin D supplementation compared with five (46%) from the asymptomatic group, although this was not statistically significant ($p=0.18$). Laboratory values showed a significantly lower post-operative total calcium mg/dL (6.9 vs. 8.6, $p<0.01$), PTH pg/mL (34.0 vs. 70.7, $p=0.04$), and 6 month calcium levels mg/dL (8.5 vs. 9.4, $p<0.01$) in the symptomatic group. Notably, no patients developed permanent hypoparathyroidism. The patients in the symptomatic group had a significantly increased length of hospital stay (3.6 vs. 1.1 days, $p<0.01$).

A final subgroup analysis of study group patients comparing those that were on both calcium and vitamin D prethyroidectomy to those that were not on calcium/vitamin D was performed. This analysis demonstrated that 58% of patients not taking calcium and vitamin D preoperatively were symptomatically hypocalcemic compared to 20% of those patients taking calcium and vitamin D ($p=0.18$). There was no significant difference in need for IV calcium (20% vs. 25% $p=0.67$) or LOS (2.2 vs. 2.3 days $p=0.80$) between these groups.

Discussion

Given the trend towards surgical management of obesity and the common finding of thyroid disease necessitating thyroidectomy in this population, we sought to determine if these patients are at increased risk for clinically relevant postoperative symptomatic

hypocalcemia. This study demonstrates that patients with a previous RYGBP are at greater risk of symptomatic hypocalcemia after thyroidectomy. In this patient population hypocalcemia can be recalcitrant to oral calcium supplementation necessitating supplemental IV calcium with prolonged hospitalization. In our study group, 21% of patients required IV calcium supplementation for symptomatic hypocalcemia. None of the control patients in our study required IV calcium, consistent with previous studies. In a study by Cayo et al, 3% of patients after thyroidectomy required IV calcium for symptomatic hypocalcemia.⁴ Furthermore, symptomatic hypocalcemia can lead to prolonged hospitalization.

This study has significant limitations. Most notably are the small numbers and retrospective nature of the study. Therefore, this analysis cannot, nor does it aim to draw definitive conclusions regarding the causative pathophysiology of recalcitrant hypocalcemia in this population. Nor does it aim to make conclusive recommendations regarding the best strategy for peri-operative management. Furthermore, conclusions cannot be drawn regarding long-term complications after thyroidectomy in this population. It is notable that calcium in this study is reported as total serum calcium, uncorrected for albumin. Albumin levels were not readily available in all patients, nor were ionized calcium levels. A further limitation is that BMI in the study group at time of RYGBP is matched to BMI at time of thyroidectomy in the control group. This was done in attempt to compensate for obesity as a determinant of altered calcium homeostasis. However, this inevitably results in the BMI being lower in the study group at time of thyroidectomy.

Despite these limitations, our study does illustrate that patients with history of RYGBP may be at increased risk for recalcitrant symptomatic hypocalcemia and prolonged hospital stay after thyroidectomy. These patients, therefore, warrant careful preoperative planning and preparation, as well as postoperative monitoring, as no management guidelines currently exist. Our results suggest that the surgeon should anticipate recalcitrant postoperative hypocalcemia after thyroidectomy in the setting of a previous RYGBP. Although we cannot make definitive recommendations based on the results of this small retrospective analysis, we suggest several preventative steps in anticipation of complicated hypocalcemia. At our institutions, we are now more sensitive to this possible issue and are now following the below recommendations based on the results of this study. Vitamin D levels should be evaluated prior to thyroidectomy. In the setting of vitamin D deficiency, we recommend supplemental calcitriol (0.25mcg orally twice daily) for one week prior to thyroidectomy. In the absence of renal failure or hypoparathyroidism, vitamin D3 may be supplemented as an alternative to calcitriol pre-operatively. It is necessary to ensure that all patients with prior RYGBP are taking oral calcium supplements prior to thyroidectomy. Guidelines from the American Society for Metabolic and Bariatric Surgery (ASMBS) recommend supplementing 1.5-2mg/day of oral calcium with vitamin D.⁸ However, as illustrated in this study these recommendations are not always followed, as less than 30% of our study group was on supplemental calcium and vitamin D in the immediate pre-operative period leading up to thyroidectomy. Of those on neither calcium nor vitamin D, 58% developed symptomatic hypocalcemia. We recommend starting oral calcium as early as possible in the evaluation phase prior to thyroidectomy based on ASMBS recommendations. Specifically, we prefer calcium citrate as it has better bioavailability when compared to calcium carbonate after

RYGBP.⁹ In addition, post-bariatric surgical patients should be well educated on the prevention of micronutrient deficiencies.

Postoperative management is tailored to each individual patient's recovery and biochemical parameters after thyroidectomy. For the post-RYGBP patient, we now routinely check calcium levels at multiple time-points including the night of surgery, on the morning of the first postoperative day, and then as needed. Notably, one patient in our study group became symptomatic after discharge and was readmitted with muscle spasm secondary to hypocalcemia, illustrating the necessity of routinely checking calcium levels post-operatively in this patient population. Calcitriol (0.25mcg orally twice daily) is started on all patients postoperatively and continued for a minimum of one week. Calcitriol is discontinued if there is no evidence of symptomatic hypocalcemia upon follow-up. Calcium citrate with vitamin D3 (200mg elemental calcium per tab) two tabs orally four times daily is started immediately post-operatively and continued indefinitely, meeting ASMBS guidelines. We do not feel that higher dosing will increase efficacy as absorption is limited beyond these doses.

An argument has been made that PTH testing may allow early identification of patients at risk for hypocalcemia after thyroidectomy, prompting early initiation of calcium and calcitriol when PTH is <10pg/ml.^{10,4} This finding would not change our immediate management since all patients after thyroidectomy in the setting of previous RYGBP are now maintained on both calcium and calcitriol postoperatively. Furthermore, following PTH in this unique patient population may not be accurate because secondary hyperparathyroidism is frequently present after RYGBP.^{11,12} The recommendation by Cayo et al that patients with PTH >10 on post-operative day one after thyroidectomy can be discharged safely without supplementation clearly does not apply in the setting of previous gastric bypass. This is evident in that our study group of patients with symptomatic hypocalcemia had an average PTH of 34 pg/mL.

The pathophysiology responsible for recalcitrant hypocalcemia after thyroidectomy with previous RYGBP is likely multi-factorial including malabsorptive enteric anatomy leading to hypocalcemia and vitamin D deficiency, as well as metabolic bone disease due to secondary hyperparathyroidism. Enteric calcium absorption occurs by two distinct processes, both of which are adversely affected by RYGBP. Active transport of calcium across enterocytes occurs largely in the duodenum. Passive absorption of calcium occurs elsewhere in the small intestine and colon and is dependent upon upstream ionization of calcium which occurs in the low pH environment of the stomach.¹³ However, RYGBP surgery creates a very small gastric pouch that produces little acid. Therefore, calcium is not exposed to the low pH environment as it would be in a patient with normal enteric anatomy. Furthermore, the absorption of calcium is partially dependent on vitamin D. Dietary vitamin D is absorbed in the proximal jejunum after being incorporated into micelles. Therefore, the enteric bypass created during RYGBP can lead to malabsorption of vitamin D, thereby further hindering calcium absorption. This is evident in that patients with longer limb RYGBP have a more profound vitamin D deficiency when compared to shorter limb RYGBP patients.¹⁴ Multiple other studies have demonstrated that RYGBP is associated with vitamin D deficiency and altered calcium homeostasis.^{15,16,17} Furthermore, up to 60-90% of

obese patients have some level of vitamin D deficiency prior to bariatric surgery.^{18,19} This is postulated to be the result of poor diet, lack of sun exposure, and hepatic dysfunction.^{20,21} Notably, prethyroidectomy vitamin D levels were not different between symptomatic and asymptomatic patients within our study group.

Secondary hyperparathyroidism is common following RYGBP and is likely the result of chronic calcium malabsorption and vitamin D deficiency, although the precise mechanism has yet to be fully explained.^{11, 12} In our study group, mean parathyroid hormone (PTH) was 77 pg/mL, which was not significantly different from the control group. This can be explained by two patients in the control group with PTH levels greater than 230. Prolonged secondary hyperparathyroidism can lead to bone demineralization resulting in osteopenia or osteoporosis, and ultimately leading to hungry bone syndrome after thyroidectomy. Despite these untoward effects, secondary hyperparathyroidism is a compensatory mechanism to maintain normal serum calcium levels in the setting of the above described alterations after RYGBP. In other words, the maintenance of eucalcemia after RYGBP is dependent on relatively high levels of PTH. During thyroidectomy, the parathyroids may be inadvertently injured leading to a loss of compensatory secondary hyperparathyroidism. This, in the setting of malabsorptive enteric anatomy and vitamin D deficiency can lead to symptomatic hypocalcemia. Within our study cohort, the PTH was significantly lower among those patients that developed symptomatic hypocalcemia. It is notable that three patients within the study cohort and five patients within the control group had concomitant parathyroidectomy. Upon subgroup analysis excluding these patients, endpoints of symptomatic hypocalcemia and need for IV calcium remained significantly different between groups.

This study demonstrates that patients with previous RYGBP may be subject to symptomatic hypocalcemia after thyroidectomy and that this hypocalcemia may be recalcitrant to oral calcium supplementation, requiring supplemental IV calcium with prolonged hospitalization. The pathophysiology is likely multifactorial including relative hypoparathyroidism after thyroidectomy in the setting of malabsorptive enteric anatomy and metabolic bone disease. In this patient population, recalcitrant postoperative hypocalcemia should be anticipated, calcium levels should be closely monitored and early calcium and vitamin D supplementation should be preemptively initiated.

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Table 1

Patient demographics. Study group of thyroidectomy in setting of previous RYGBP vs. control group of thyroidectomy alone.

	Study group (n=19)	Control group (n=38)	p-value
Age (years)	49.7 $\pm$ 10.7	49.7 $\pm$ 10.3	0.79
Females n (%)	18 (94%)	35 (92%)	0.40
Initial BMI (kg/m ²)	45.3 $\pm$ 6.2	44.5 $\pm$ 5.3	0.41
Concomitant parathyroidectomy n (%)	3 (16%)	5 (13%)	0.54
Malignant n (%)	10 (53%)	21 (55%)	0.54

Table 2

Primary endpoints

	Study group (n=19)	Control group (n=38)	p-value
Symptomatic hypocalcemia, n (%)	8 (42%)	0	< 0.01
Intravenous calcium replacement, n (%)	4 (21%)	0	< 0.01
LOS (days)	2.2 $\pm$ 2.1	1.2 $\pm$ 0.6	0.02

Table 3

Calcium and vitamin D supplementation

	Study group	Control group	p-value
Pre-operative, n (%)	5 (26%)	2 (5%)	0.04
Post-operative, n (%)	15 (79%)	20 (53%)	0.08

Table 4

Pre-op, post-op, and 6 month serum Calcium mg/dL (normal 8.5-10.5), 25-OH-Vitamin D ng/mL (normal 33-100), and PTH pg/mL (normal 10-60)

	Study group	Control group	p-value
Pre-op calcium	9.3 $\pm$ 0.6 (n=19)	9.6 $\pm$ 0.5 (n=36)	0.11
Pre-op vitamin D	29 $\pm$ 13.8 (n=15)	32 $\pm$ 12.0 (n=18)	0.38
Pre-op PTH	77 $\pm$ 24.5 (n=10)	76 $\pm$ 74.3 (n=15)	0.07
Post-op (nadir) calcium	7.9 $\pm$ 1.0 (n=19)	8.3 $\pm$ 0.7 (n=35)	0.11
Post-op vitamin D	24 $\pm$ 12.2 (n=14)	31 $\pm$ 9.0 (n=14)	0.25
Post-op PTH	47 $\pm$ 29.4 (n=11)	57 $\pm$ 46.8 (n=12)	0.88
6 month calcium	9.1 $\pm$ 0.7 (n=14)	9.2 $\pm$ 0.5 (n=22)	0.48
6 month vitamin D	30 $\pm$ 13.2 (n=10)	34 $\pm$ 9.2 (n=8)	0.46
6 month PTH	41 $\pm$ 15.7 (n=5)	88 $\pm$ 73.5 (n=5)	1.0

Table 5

Comparison of study group and control group excluding patients who had concomitant parathyroidectomy. BMI kg/m², serum total calcium mg/dL (normal 8.5-10.5), 25-OH-Vitamin D ng/mL (normal 33-100), PTH pg/mL (normal 10-60)

	Study group (n=16)		Control group (n=33)		
	n	%/±SD	n	%/±SD	p-value
Age	49.3	±11.0	49.1	±10.5	0.95
Females	15	93.8%	30	90.9%	1.00
Initial BMI	45.8	±6.7	44.1	±4.8	0.38
Total thyroidectomy	14	87.5%	31	93.9%	0.59
Malignant	7	43.8%	19	57.6%	0.54
Symptomatic hypocalcemia	6	37.5%	0	0%	<0.01
IV Calcium replacement	3	18.8%	0	0%	0.03
LOS (days)	2.0	±2.1	1.2	±0.7	0.16
Pre-op Ca	9.2	±0.5	9.5	±0.4	0.06
Pre-op vitamin D	27.5	±13.8	31.7	±11.8	0.42
Pre-op PTH	78.4	±15.5	44.2	±13.2	<0.01
Post-op Ca	7.9	±0.9	8.2	±0.7	0.21
Post-op vitamin D	22.3	±11.7	29.4	±8.3	0.10
Post-op PTH	51.9	±32.0	66.5	±49.9	0.48
6 month Ca	8.9	±0.8	9.2	±0.5	0.27
6 month vitamin D	31.9	±11.2	40.1	±12.7	0.10
6 month PTH	82.9	±68.3	82.1	±109.0	0.16

Table 6

Patients with symptomatic versus asymptomatic hypocalcemia in the study group. BMI kg/m², serum total calcium mg/dL (normal 8.5-10.5), 25-OH-Vitamin D ng/mL (normal 33-100), PTH pg/mL (normal 10-60)

	Symptomatic (n=8)	Asymptomatic (n=11)	p-value
Age at thyroidectomy	43.8 (± 12.0)	54 (± 7.6)	0.11
Age at RYGBP	40.5 (± 12.1)	48.4 (± 8.0)	0.18
Operation interval (months)	39.6 (± 29.1)	62.1 (± 25.4)	0.08
Roux length	100 (± 23.8)	106 (± 21.9)	0.47
BMI at RYGBP	44.0 (± 5.9)	46.3 (± 6.6)	0.40
BMI at thyroidectomy	33.9 (± 5.8)	35.7 (± 9.1)	0.90
BMI change	10.0 (± 4.3)	10.6 (± 10.2)	0.78
Parathyroidectomy	2 (25%)	1 (9%)	0.55
Malignancy	6 (75%)	4 (36%)	0.17
Pre-op Calcium and vitamin D supplementation	1 (13%)	5 (46%)	0.18
Post-op calcium and vitamin D supplementation	8 (100%)	7 (64%)	0.10
Pre-op calcium	9.2 (± 0.5)	9.5 (± 0.7)	0.40
Pre-op vitamin D	33.8 (± 10.4)	26.6 (± 15.2)	0.44
Pre-op PTH	82.1 (± 34.9)	73.3 (± 17.5)	0.61
Post-op calcium	6.9 (± 0.3)	8.6 (± 0.7)	< 0.01
Post-op vitamin D	24.3 (± 10.8)	24.6 (± 14.3)	1.00
Post-op PTH	34 (± 18.5)	70.7 (± 32.3)	0.04
6 month calcium	8.5 (± 0.5)	9.4 (± 0.5)	< 0.01
6 month vitamin D	30.3 (± 9.7)	29.3 (± 16.0)	0.78
6 month PTH	36 (± 17.7)	49 (± 12.7)	0.40
LOS	3.6 (± 2.7)	1.1 (± 0.3)	< 0.01