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RESEARCH ARTICLE

Vitamin D Status Before Roux-en-Y and Efficacy of Prophylactic and Therapeutic Doses of Vitamin D in Patients After Roux-en-Y Gastric Bypass Surgery

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Abstract
Background Literature regarding the effect of Roux-en-Y gastric bypass (RYGBP) on vitamin D level shows contradictory findings. Our goal was to determine preoperatively vitamin D levels, to evaluate the efficacy of therapeutic and prophylactic doses of vitamin D and to assess the relationship of 25-OH vitamin D level and body mass index (BMI).
Methods We conducted a retrospective cross-sectional study of 72 patients who underwent RYGBP from April 2007 to October 2007 in Bariatric Surgery Department at Saint Vincent Charity Hospital.
Results Our study demonstrated that 80% of the obese patients undergoing RYGBP had serum 25-OH vitamin D levels of less than 32 ng/ml. Postoperative data show that 45% of these patients continue being vitamin D insufficient despite the treatment. We demonstrated that a statistically significant inverse correlation between BMI and 25-OH vitamin D levels (r=0.464, p=0.01) exists.
Conclusion Our finding strongly supports the need for aggressive monitoring of vitamin D levels for long-term prevention of complications of vitamin D deficiency in gastric bypass patients. Identifying the factors that predict patient's responses to vitamin D supplementation requires larger-scale studies and further analysis of these tendencies suggested by our findings.

Keywords Vitamin D deficiency · Anastomosis Roux-en-Y · Morbid obesity

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Introduction

Obesity has become an increasing health problem in the US and worldwide.

The rate of obesity has doubled from 15% to more than 30% over the past 25 years [1]. As the prevalence of obesity increases, it was estimated that the number of obesity procedures may exceed 200,000 by 2010 [2]. It is also known that vitamin D is a major public health problem, as 21% to 58% of the American adults are vitamin D deficient [6]. Research indicates that there is an inverse relationship between serum 25-OH vitamin D and body mass index (BMI) and that obesity increases the risk of vitamin D deficiency and secondary hyperparathyroidism [7–14].

The exact mechanism for vitamin D deficiency in morbid obesity is not known. One possible cause is the sequestration of vitamin D in adipose tissue, resulting thus in a decrease of its bioavailability [13]. Reviewed literature regarding the effect of gastric bypass on vitamin D levels is contradictory. Even though gastric bypass does not affect the sites of the vitamin D absorption in jejunum and ileum, it was suggested that Roux-en-Y anastomosis decreases absorption of fat-soluble vitamins due to poor mixing with the bile salts [4, 19]. On the other hand, some postulated that surgery-related decrease in adiposity should, in theory, increase the bioavailability of vitamin D.

Bariatric surgery carries certain risks for nutritional complications including impairment of calcium metabolism and bone health. Calcium absorption takes place primarily in the duodenum and jejunum and is dependent on vitamin D levels. Bariatric patients are at an increased risk of hypocalcemia [3, 20]. Also, an increase in intraluminal fat and steatorrhea may further impair calcium absorption [4, 5]. Coates and colleagues [25] found evidence of bone resorption

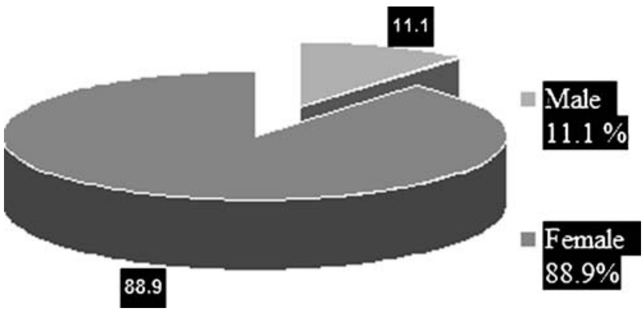

Fig. 1 Demographic characteristics of the study population—gender

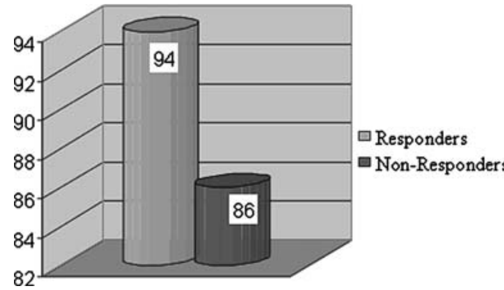

Fig. 3 Compliance with 50,000 IU D2 in patients with low preop vitamin D levels

as early as 3 months after RYGBP, despite calcium and vitamin D supplementation.

Vitamin D and calcium should be given in quantities sufficient to keep the serum PTH below 100 ng/ml. Many recommend that RYGBP patients should be given 1,200–1,500 mg of elemental calcium per day. Recently, it was recognized that vitamin D concentration of 30 ng/ml or higher is optimal for bone health. In our research, we did not find vitamin D dose recommendation for treatment of vitamin D deficiency in bariatric patients. However, to determine whether patients respond to vitamin D, literature shows that some authors remeasured 25-OH vitamin D after a 12-week treatment course [21–23].

Methods

We collected preoperative and postoperative data on 72 patients who underwent Roux-en-Y gastric bypass surgery between April 2007 and October 2007 at St. Vincent's Bariatric Surgery Department (Figs. 1 and 2). We analyzed preoperative and at 6 months postoperative data for 25-OH Vitamin D levels, BMI, and the percentage of weight loss. Personal information was coded for confidentiality purposes.

25-OH vitamin D level was determined by serum immunoassay (Labcorp, Burlington, NC, USA) with the reference range of normal level 32–100 ng/dl. Vitamin D deficiency was defined as 25-OH vitamin D serum level of less than 32 ng/ml.

Preoperative values were examined and the prevalence of 25-OH Vitamin D deficiency in patients was noted. Correlation between BMI and 25-OH vitamin D level was analyzed. Statistical analysis was performed by using Statistical Package for the Social Sciences, version 14, 2005.

Patients were divided in two groups based on preoperative vitamin D levels. Thirty-two patients who missed follow-up or who lacked 6-month laboratory data were excluded from subsequent analysis.

The first group was composed of patients whose 25-OH vitamin D level was equal to or greater than 32 ng/ml. These patients received postoperatively 800 IU vitamin D3 and 1,200 mg of calcium daily for a period of 6 months.

The second group was composed of patients with 25-OH vitamin D level of less than 32 ng/ml. Starting in the sixth week after the surgery, patients in the second group received 50,000 IU vitamin D2 weekly for a period of 12 consecutive weeks followed by 800 IU vitamin D3 daily. Also, they received 1,200 mg calcium daily for 6 months.

Both groups were evaluated at 6 months after the surgery with a follow-up examination including vitamin D level, BMI, and percentage of weight loss.

St. Vincent's IRB committee approved the protocol. Statistical significance was defined as $p<0.05$.

Results

Seventy-two patients (mean age 44±9 years) were included in data analysis. Fifty-two patients were women (88.9%) and 20 were men (11.1%).The mean preoperative BMI was 48±7.

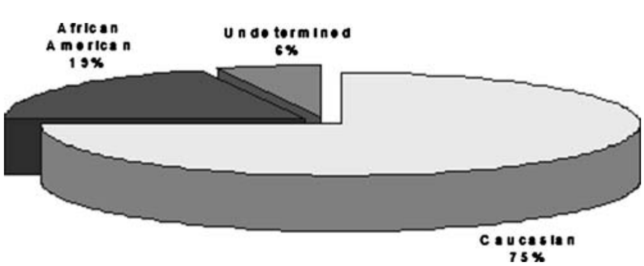

Fig. 2 Demographic characteristics of the study population—race

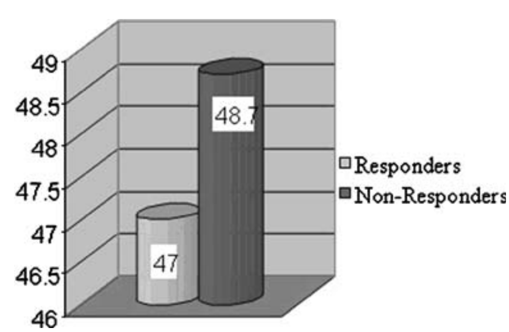

Fig. 4 BMI in the group with low preop vitamin D levels

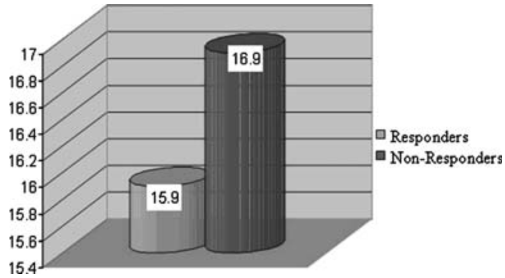

Fig. 5 Baseline 25-OHD levels in the group with low preop values

Prevalence of vitamin D deficiency in preoperative patients was estimated to be 83%. We found a negative correlation between BMI and vitamin D level. Correlation coefficient (r−0.464) was determined to be statistically significant (p=0.01). The follow-up group of 40 patients (54.7%) was included in subsequent analysis. Out of these 40 patients, 32 (80%) had 25-OH vitamin D level less than 32 ng/ml. Seventeen of them (53%) responded to the intervention with 25-OH vitamin D increasing the serum vitamin D level from the mean value of 15.9 ng/ml to the mean value of 42.5 ng/ml.

The responder group (Fig. 3) had 100% compliance to treatment with standard calcium, vitamin D, and multivitamin (MVI) supplementation and 94% compliance to the therapeutic dose of 50,000 IU of vitamin D2. In 15 of these patients (47%) with low 25-OH vitamin D level, treatment had no effect. The nonresponders had a compliance rate of 86% for the treatment with 50,000 IU of vitamin D2 and 93% compliance for the standard calcium–vitamin D–MVI dosage, respectively.

The nonresponders (Fig. 4) also had a higher BMI of 48.7 vs. 47 in the responder group.

Table 1 Summary of data analysis for patients with preoperative 25OHD levels<32 ng/ml

	Responders	Nonresponders	p value
Mean age (years)	47.63	44.47	0.289
Race			0.026
AA	0	9	
Caucasian	15	4	
Gender			0.865
Female	15	13	
Male	3	3	
Mean BMI	47.00	48.67	0.463
Preoperative 25OHD level (ng/ml)	15.94	16.97	0.660
Compliance 50,000 IU D2 (%)	94	86	0.082
Compliance 800 IU D3 (%)	100	86	0.808

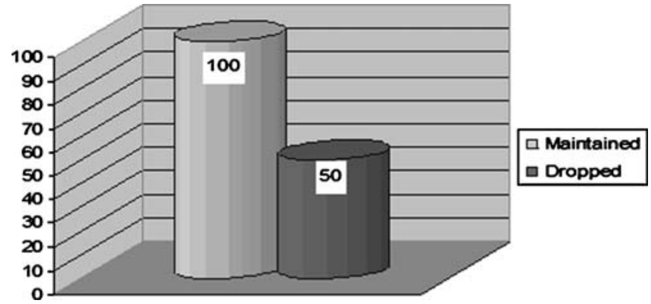

Fig. 6 Compliance with 50,000 IU D2 in patients with normal vitamin D levels

Nonresponders (Fig. 5) also had a higher baseline vitamin D level of 16.9 vs. 15.9 ng/ml compared to the responders.

According to Table 1, differences between groups were not statistically significant.

Twenty percent of the total follow-up group of patients had 25-OH vitamin D level more than or equal to 32 ng/ml. The majority of the patients (75%) maintained normal level with standard supplementation of Ca–vitamin D and MVI. Among those who maintained normal vitamin D levels, 100% of the patients were compliant with the regimen (Fig. 6). In this group, 25-OH vitamin D level increased from the mean of 41.2 ng/ml preoperatively to 45.2 ng/ml at 6 months postsurgery (Fig. 7).

Twenty-five percent of the patients having normal preoperative 25-OH vitamin D levels developed subnormal levels of 25-OHD postoperatively; in this group, compliance rate was 50%. Also, these patients (Fig. 7) tend to have higher preoperative BMI (mean of 48 vs. 45.8 in those who maintained their vitamin D levels) and (Fig. 8) lower baseline 25-OH vitamin D levels (37.1 vs 41.2 ng/ml). However, these differences between the two groups were not found to be statistically significant (Table 2).

The overall prevalence of vitamin D deficiency in the patients with available postoperative data decreased from 80% to 47% (Fig. 9).

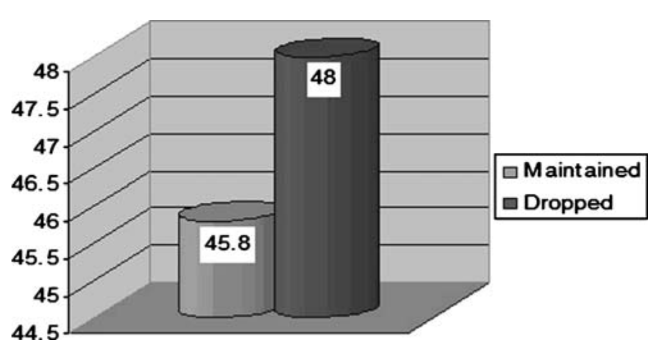

Fig. 7 BMI in patients with normal vitamin D levels

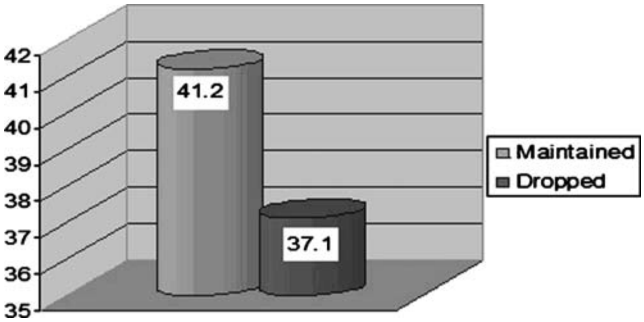

Fig. 8 Baseline 25-OHD levels in patients with normal preop values

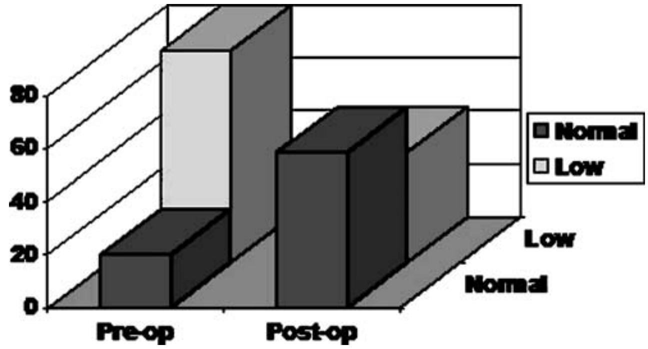

Fig. 9 Prevalence of 25-OH vitamin D deficiency in preoperative and postoperative period

Discussion

Vitamin D status and its role in predicting bone health and risk of cancers and certain chronic conditions recently became a focus of scientific interest [24]. Concerns on treatment and prevention are growing in parallel. The evidence suggests that obesity itself can be associated with vitamin D deficiency [8–14]. The evidence in our study suggests that there is an inverse correlation between BMI and 25-OH vitamin D levels.

Vitamin D deficiency is defined by the majority of specialists as a 25-OH vitamin D level less than 20 ng/ml. Some authors suggest that vitamin D insufficiency can reach values as a high as 29 ng/ml. However, growing evidence suggests that levels more than 30 ng/ml should be considered to be sufficient [24]. Prevalence of vitamin D deficiency varies between 21.1% and 84% [14–18]. Our study demonstrates that about every four out of five patients undergoing Roux-en-Y gastric bypass have 25-OH vitamin D level of less than 32 ng/ml.

This study demonstrates several important points.

First, therapy with 50,000 IU of vitamin D2 every week for 12 weeks and subsequent supplementation with 800 IU of D3 daily did not reveal significant difference between responders and nonresponders in terms of age, gender, preoperative BMI, baseline 25-OH vitamin D levels, and medication compliance in patients having preoperatively low levels of 25-OH vitamin D. The only statistically significant difference was higher number of African–American patients among nonresponders. The significant proportion of nonresponders may be a result of an inadequate dose or duration of the treatment with vitamin D.

Second, our study shows that prevalence of vitamin D deficiency decreases to 47% in the postoperative period; however, significant numbers of patients continue to have low vitamin D levels. This finding emphasizes the need for defining the optimal therapeutic dose of vitamin D and the length of treatment in the obese population.

Recently published data suggest that obese patients need treatment in the length of 8 to 12 weeks. Patients maintaining a level of 25-OH vitamin D lower than 30 ng/ml need course repetition. In order to prevent further vitamin D depletion and to maintain its normal levels, obese patients may need higher doses of vitamin D3 ranging from 1,000 to 2,000 IU a day with a possible beneficial role of 50,000 IU of vitamin D2 every 1, 2, or 4 weeks [24]. The relationship between vitamin D supplementation and weight loss changes after RYGBP is yet to be determined; therefore, it underlines the need for close postoperative follow-up.

Third, our study suggests the importance of compliance with vitamin D supplementation. Higher number of noncompliant

Table 2 Summary of data analysis for patients with preoperative 25OHD levels≥32 ng/ml

	Patients with postoperative 25OHD≥32	Patients with postoperative 25OHD<32	*p* value
Mean age (years)	39.83	42.00	0.00
Race			NA
AA	0	0	
Caucasian	5	2	
Gender			0.064
Female	5	1	
Male	0	1	
Mean BMI	45.83	48.00	1.414
Preoperative 25-OHD level (ng/ml)	41.20	37.10	0.660
Compliance 800 IU D3 (%)	100	86	0.088

patients were found among those who failed to respond to the vitamin D.

Fourth, there is poor follow-up in post-RYGBP patient population. Over 45% of our subjects failed to properly follow-up by missing appointments or had appointments with their private physicians who did not check their vitamin D levels.

Our data strongly support the need for aggressive monitoring and proper follow-up of vitamin D levels in RYGBP patients and customized treatment in order to prevent "long-term" complications of vitamin D deficiency.

Baseline BMI, preoperative 25-OH vitamin D levels, and factors predicting the response to treatment with vitamin D need to be further evaluated in a larger-scale study in order to determine an effective treatment, the frequency, and the required dosage of vitamin D in order to maintain normal blood values of vitamin D.

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