RESEARCH ARTICLE

Effect of laparoscopic sleeve gastrectomy on vitamin D, parathormone hormone, and serum calcium levels

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Abstract

Objective: To evaluate the effect of laparoscopic sleeve gastrectomy on vitamin D status, parathyroid hormone, serum calcium and the effectiveness of vitamin D supplementation.

Method: The prospective study was conducted at the General Surgery Department of Kafrelsheikh University Hospital, Egypt, in November 2019, and comprised morbidly obese patients of either gender who were managed with laparoscopic sleeve gastrectomy. Serum levels of vitamin D, calcium and parathyroid hormone were assessed at baseline and at 6 and 12 months after the surgery. All subjects were given 400 IU/day of vitamin D. If the level of vitamin D was <30ng/ml, further doses of calcifediol 200,000 IU were added every two weeks. Data was analysed using SPSS 22.

Results: Of the 40 patients, 28(70%) were females and 12(30%) were males. The overall mean age was 33.9±10.8, mean weight was 136±18.29kg and mean body mass index was 50±4.9kg/m^2. The mean operative time was 64.5±13.6 minutes, and the mean hospital stay was 1.8±1.1 days. There was significant reduction in body mass index values after the surgery (p<0.05). Vitamin D level was 19.2±3.2 ng/ml at baseline, which rose to 21.4±2.7 ng/ml at 6 months and 26.6±2.8 ng/ml at 12 months post-surgery (p<0.05). Preoperative parathyroid hormone level was 58.3±7.8 pg/ml , which went down to 48.6±7.4 pg/ml at 6 months, and 41.3±6.5 pg/ml at 12 months postoperatively (p<0.05). The mean serum calcium level at baseline was 9±0.4mg/dL, which rose to 9.2 ±0.3mg/dL and 9.5±0.4 mg/dL at 6 and 12 months post-surgery (p<0.05).

Conclusion: Low vitamin D complications could be decreased postoperatively by administering vitamin D as a routine treatment. Postoperative monitoring of vitamin D, parathyroid hormone and serum calcium levels is essential.

Keywords: Obesity, Morbid, Parathyroid hormone, Gastrectomy, Laparoscopy, Bariatrics.

Registration: RCT registered at: clinicaltrials.gov (NCT05430932) **DOI: 10.47391/JPMA.EGY-S4-35**

Introduction

Obesity is likely to be the disease of the 21st century as it continues to grow significantly worldwide, and is linked to many health problems, like diabetes mellitus (DM), hypertension (HTN), heart disease, infertility and cancer.[1] Laparoscopic sleeve gastrectomy (LSG) is the most common operation in bariatric surgery worldwide due to its potential weight-loss achievements, safety profile and comorbidity reduction.[2]

Decreased vitamin D level has a higher incidence in obese subjects than in healthy non-obese people. Many patients undergoing bariatric surgery have decreased 25-hydroxyvitamin D (25[OH]D) levels. Vit D3 levels have an inverse relationship with body mass index (BMI) >30 kg/m2.[3]

Although the aetiology of low vitamin D in obese subjects is not clear, some studies have attributed this deficiency to reduced exposure to sunlight, increased usage of sunscreen, decreased ingestion in multiple tried diets, and an inverse relationship between serum 25(OH)D and multiple markers of inflammation.[4] Other studies added the presence of hepatic and renal diseases, such as fatty liver and diabetic or hypertensive chronic renal diseases, to the factors causing vitamin D deficiency.[5] Furthermore, the vitamin D binding protein and vitamin D receptor may have genetic variations, leading to phenotypic changes in the protein that may affect the affinity, activity and concentration of the vitamin.[6]

In non-obese subjects, the decreased vitamin D levels are related to reduced calcium (Ca) absorption, osteoporosis and osteomalacia. The increased parathyroid hormone (PTH) in persons with persistently low levels of vitamin D was observed in many studies, especially in groups with levels of 25(OH)D <30ng/m, as adequate calcium absorption requires a vitamin D level of >30ng/mL.[7]

The current study was planned to evaluate the effect of LSG on levels of 25(OH)D, PTH, serum Ca and the effectiveness of vitamin D supplementation.

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Patients and Methods

The prospective study was conducted at the General Surgery Department of Kafrelsheikh University Hospital, Egypt, in November 2019. After approval from the institutional ethics review committee and registration with the clinicaltrials.gov (NCT05430932), the sample size was calculated in line with a previous study[8], with power 80% and alpha (α) level 0.05.

The sample was raised using consecutive sampling technique. Those included were morbidly obese patient of either gender aged 18-60 years, having BMI >40kg/m^2 or >35 kg/m^2, comorbidities, such as HTN and type 2 DM (T2DM), and an unsuccessful supervised conservative treatment of obesity for at least two years. Those excluded were patients with BMI >60kg/m^2, history of bariatric surgery, reflux oesophagitis with symptoms, stomach cancer, active peptic ulcer disease, alcohol or drug abuse, major psychological disturbance, or major eating troubles.

After taking written informed consent from all the patients, they were subjected to detailed history and a thorough clinical and pathological examination, cardiopulmonary evaluation, abdominal ultrasound, and upper gastrointestinal (GIT) endoscopy/series to exclude any upper GIT lesions in symptomatic cases. A standardised five-port technique was followed for all the subjects.[9]

Postoperative follow-up was tracked by a multidisciplinary team, including endocrinologist, surgeon, psychologist and dietitian, and was scheduled at 1, 3, 6 months, and one year postoperatively. Follow-up included weight-loss data, vitamin D, Ca, and PTH levels at 6 and 12 months, amelioration of comorbidities, and complications.

Normal serum level of 25(OH)D was taken as >30 ng/mL, vit D insufficiency 21-30ng/m, deficiency <20ng/mL, and severe deficiency <10ng/mL. PTH normal level was 10-65pg/mL and normal serum calcium was 8.6-10.3mg/dL.[10]

All subjects were given 400 IU/day of 25(OH)D.. If the levels were <30ng/ml, further doses of calcifediol (200,000IU) were added every two weeks.

Data was analysed using SPSS 22. It was expressed as mean, standard deviation (SD) and range, or as frequencies and percentages as appropriate. Analysis of variance (ANOVA) with paired t-test was done for comparison between the different time points after Bonferroni adjustment of multiple comparisons. Two-sided p<0.05 was considered statistically significant.

Results

Of the 40 patients, 28(70%) were females and 12(30%) were males. The overall mean age was 33.9±10.8, mean weight was 136±18.29kg and mean body mass index was 50±4.9kg/m^2. The mean operative time was 64.5±13.6 minutes, and the mean hospital stay was 1.8±1.1 days (Table 1).

There was significant reduction in BMI values after the surgery (p<0.05) (Figure 1A). Vit D level was 19.2±3.2 ng/ml at baseline, which rose to 21.4±2.7 ng/ml at 6 months and 26.6±2.8 ng/ml at 12 months post-surgery (p<0.05). Preoperative PTH level was 58.3±7.8 pg/ml, which went down to 48.6±7.4 pg/ml at 6 months, and 41.3±6.5 pg/ml at 12 months postoperatively (p<0.05) (Figure 1B). The mean serum calcium level at baseline was 9+0.4mg/dL, which rose to 9.2+0.3 mg/dL and 9.5+0.4 mg/dL at 6 and 12 months post-surgery (p<0.05) (Table 2).

Table-1: Patent characteristics (n = 40).

	n (%)
Gender	
Male	12 (30%)
Female	28 (70%)
Age (years)	
Mean ± SD.	33.9 ± 10.8
Median (Min. – Max.)	32.5 (18 – 55)
Onset of obesity	
Childhood	21 (52.5%)
Teenage/childhood	3 (7.5%)
Adulthood	16 (40%)
Family history	24 (60%)
Preoperative Height (cm)	
Mean ± SD.	164.4 ± 7.1
Median (Min. – Max.)	165 (150 – 183)
Preoperative Ideal weight (kg)	
Mean ± SD.	59.5 ± 5.3
Median (Min. – Max.)	59 (50 – 74.8)
Preoperative Excess weight (kg)	
Mean ± SD.	76.55 ± 15.1
Median (Min. – Max.)	78 (46 – 105.3)
Preoperative weight (kg)	
Mean ± SD.	136 ± 18.29
Median (Min. – Max.)	136 (105 – 180)
Preoperative Vitamin D level	
Deficiency < 20 (ng/ml)	16 (40%)
Insufficiency < 20-30 (ng/ml)	24 (60 %)
Preoperative Parathormone level	
Hyperparathyroidism	4 (10 %)
Normal	36 (90%)
Preoperative Calcium level	
Normal	40 (100%)
Operative time (min.)	
Mean ± SD.	64.5 ± 13.6
Median (Min. – Max.)	60 (45 – 120)
Hospital stay (day)	
Mean ± SD.	1.8 ± 1.1
Early post operation complication	3 (7.5%)
Late post operation complication	4 (10%)

SD: Standard deviation.

Table-2: Comparison of baseline and post-surgery values.

	Baseline Mean ± SD	6m after bariatric surgery Range	12m after bariatric surgery Mean ± SD	Range	Mean ± SD	Range	*p-value*
BMI (kg/m2)	50.1[a,b]±4.8	38-58	37[b]±3.7	30.8-44.5	31.6±3.0	27-38.8	< 0.001
Serum 25(OH)D (ng/ml)	19.2[a,b]±3.2	13-27	21.4[b]±2.7	15-27	26.6±2.8	20-31	< 0.001
Calcium (mg/dl)	9a,[b]±0.4	8.5-10	9.2[b]±0.3	8.8-10.2	9.5±0.4	9-10.5	< 0.001
PTH (ng/ml)	58.3a,[b]±7.8	41-73	48.6[b]±7.4	38-62	41.3±6.5	26-55	< 0.001

BMUI: Body mass index, PTH: Parathyroid hormone, a: statistically significant difference in comparison to 6m, b: statistically significant difference in comparison to 12m

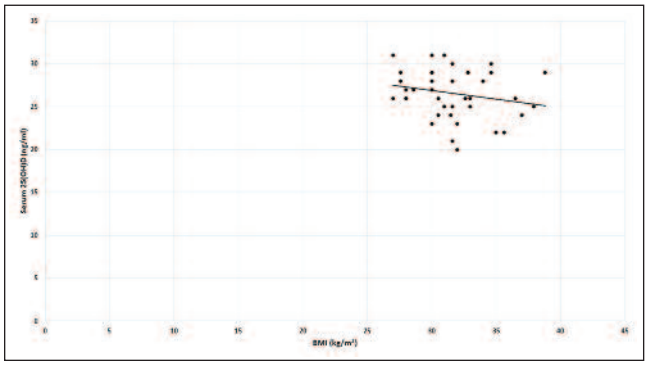

Figure (1A): Correlation between body mass index (BMI) (kg/m2) and serum 25-hydroxy vitamin D (25[OH]D) (ng/ml) at 12 months after bariatric surgery.

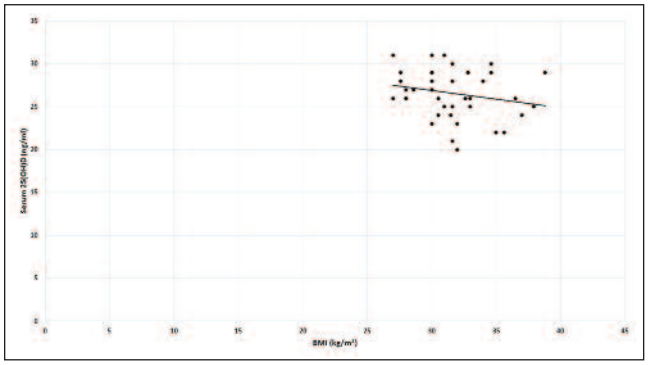

Figure (1B): Figure (1B): Correlation between parathyroid hormone (PTH) concentration (ng/ml) and serum 25-hydroxy vitamin D (25[OH]D) (ng/ml) at 12 months after bariatric surgery.

Discussion

Before LSG, 90% of morbidly obese patients had low vit D levels. Vit D deficiency is crucial for calcium homeostasis and bone metabolism to preserve bone health. Bariatric surgery is linked to a reduced bone mass and a high tendency to have bone fractures.[12]

Calcium homeostasis and bone metabolism require vitamin D. Some studies worried that bariatric surgery could harm bone health, and low vit D levels could be the main reason for this.[13] The ideal 25(OH)D levels are still up for debate. It has been suggested that 25(OH)D levels must be in the 30-35ng/mL range, or possibly higher, to achieve optimal calcium absorption and to avoid non-skeletal consequences. Nonetheless, concentrations >20ng/mL are widely accepted.[13]

Low vit D levels were discovered during the preoperative screening of subjects who are going to have bariatric surgery.[3,4] All patients in the current study had low 25(OH)D levels preoperatively; 40% presented with vit D deficiency, while 60% presented with insufficiency. This may be explained by sequestration of vitamins and their storage in fat tissues, decreased outdoor activities, increased sunscreen use, inadequate intake, and repeated trials of failed weight-loss. Although additional calcifediol supplement was administered, when needed, vit D slightly improved, and most patients remained <30ng/ml.

Capoccia et al.[14] directed a group of 138 LSG patients to have a daily multivitamin (200 IU) for six months, followed by 2500 IU VitD3 for another 6 months. Over a year, 25(OH)D levels did not show significant alteration. Schollenberger et al. found no change in deficiency prevalence over 36 months, despite treatment with 1000 IU/day for deficient individuals.

Damms-Machado et al.[16] found no change in the incidence of low vit D levels over 12 months after LSG. Preoperative 25(OH)D was borderline adequate (49.1nmol/L) and fell to 42.1nmol/L 12 months after operation, with 79% subjects reporting taking multivitamins. Karefylakis et al.[17] found a significant frequency of vit D deficiency 10 years after laparoscopic roux en y gastric bypass (LRYGB) caused by a decrease in compliance with vit D administration in long-term research.

A marked rise in vit D levels in LSG subjects after 12 months of surgery has been reported in several studies without the use of any vitamin D treatment,[18,19] which can be explained mostly by weight-loss and increased bioavailability owing to reduced adipose tissue, as well as patient compliance with supplements in the early postoperative period.

A group of 106 people was investigated by Lanzarini et al.[10] (62 underwent LSG and 44 underwent LRYGB). Before the surgery, 49 patients had secondary hyperparathyroidism, although there were no significant variations in PTH levels between the two surgical methods. At 12 months, 18%

individuals had secondary hyperparathyroidism. In LRYGB individuals, serum 25(OH)D was significantly decreased, which could be explained by excluding a major portion of the stomach, duodenum, and proximal jejunum with these procedures; this did not occur in LSG case in which these parts of the digestive tract were kept intact .[10]

Fox et al.[8] found that vit D levels improved significantly after surgery. Rutte et al.[20] observed a significant reduction in vit D deficiency (from 81% to 36%) after LSG.

Secondary hyperparathyroidism was seen in 10% patients in the current study preoperatively and returned to normal post-surgery with vit D supplementations. Most of those who had vit D insufficiency were found to have secondary hyperparathyroidism. Surprisingly, nearly one-fifth of subjects with insufficient vit D had elevated PTH levels. A large number of the vit D-deficient subjects were found to have secondary hyperparathyroidism. Despite calcium supplementation and maintaining normocalcaemia, mean serum Ca dropped significantly after 12 months of bariatric surgery. Calcium shortage appears to be the main force behind secondary hyperparathyroidism in people with adequate vit D levels;[21] bone resorption may keep serum Ca at normal levels in these individuals. In a study, 60% patients had a major drop in bone mineral density (BMD) at 6 months and 70% at 12 months of the operation, with a strong correlation with more significant weight-loss.[22] It was found that T2DM patients managed by gastric bypass surgery had higher amounts of bone turnover markers with decreased bone strength and density compared to those without gastric bypass surgery.[23]

It is advised to give vit D and calcium as it benefits BMD in patients post-surgery. It has been suggested by many studies that any LSG patients ought to have large amounts of vit D after the operation, and a good vit D level can be maintained by 5000 IU/week and maintenance doses of multivitamins before and after the surgery.[7, 8]

The current study proposed administering vit D at higher doses after LSG. Secondary hyperparathyroidism could be prevented by assessment of PTH and vit D levels, so it could be possible to adjust the doses of vit D and avoid the bone loss caused by secondary hyperparathyroidism.

Although some studies used different doses of vit D, there were difficulties in adjusting serum vit D levels after the surgery. These difficulties were thought to be due to malabsorption, inadequate doses, and the presence of residual adiposity.[8]

On the other hand, some studies stated that vit D optimisation could be achieved in many patients having bariatric surgery. There was an immediate rapid increase in vit D after the operation. It has been thought that the fast decrease in weight after the operation facilitates the liberation of vit D stored in the visceral fat.[11-24]

Guidelines for perioperative support of individuals having bariatric surgery (nutritional, metabolic, and nonsurgical) recommended a minimum nutritional supplementation of at least 3000 IU of vit D per day (6000 IU per day is safe and essential for many subjects) for LRYGB and LSG patients.[25]

Conclusion

Low vit D is common in subjects having bariatric surgery. This deficiency and bone complications could be decreased postoperatively by administering vit D as a routine treatment. Postoperative continuous monitoring of vit D, PTH, and serum calcium levels is essential.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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