Comparative study between sleeve gastrectomy and gastric bypass regarding postoperative hyperparathyroidism

Original Article

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ABSTRACT

Background: Laparoscopic sleeve gastrectomy (LSG) is the most common bariatric procedure followed by Roux-en-Y Gastric Bypass(RYGB).

Aim: To illustrate the effect of bariatric surgery on serum calcium levels and serum vitamin D (vit D) levels, demonstrate the secondary hyperparathyroidism in patients undergoing bariatric surgeries, and compare between the outcome of RYGB and LSG regarding secondary hyperparathyroidism.

Patients and Methods: This prospective cross-sectional cohort study was conducted on 100 obese patients divided into two groups: group I: 50 patients who underwent LSG and group II: 50 patients who underwent RYGB at General Surgery Department, Faculty of Medicine, Beni-Suef University Hospital during the period between January 2019 and March 2022.

Results: Regarding blood calcium level, LSG group elaborated less proportion of patients with low blood calcium levels, compared with RYGB group, after 6 months and after 1 year ($P<0.05$). In the LSG group the mean±SD preoperative vit. D was 14.01±6.39, after 6 months was 18.05±3.20 and after 1 year was 22.07±2.03. In RYGB group the mean±SD preoperative vit. D was 14.05±6.13, after 6 months was 17.04±5.1 and after 1 year was 18.02±4.6.

Conclusion: The prevalence of secondary hyperparathyroidism is high in morbidly obese patients before bariatric surgery which is related to vit D deficiency and calcium deficiency. This prevalence increased continually along with the time after both LSG and RYGB surgery and more apparent after RYGB.

Key Words: Hyperparathyroidism, LSG, RYGB.

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INTRODUCTION

Laparoscopic sleeve gastrectomy (LSG) is the most common bariatric surgical procedure worldwide followed by Roux-en-Y Gastric Bypass (RYGB)[1].

Resection of the gastric fundus is required for LSG because it secretes ghrelin, which is known to stimulate osteoblasts. In contrast, skipping the small intestine during RYGB results in malabsorption and other hormonal abnormalities that can hurt bone directly and indirectly[2].

The effects of RYGB versus LSG on human bone architecture have only been evaluated in a small number of research[3,4], and the results have been mixed, with some suggesting that RYGB causes more bone loss than LSG, while other studies revealed equal rates of bone loss following both procedures.

The primary site of calcium absorption is the duodenum. It is bypassed during malabsorptive surgical operations, which partially justifies a calcium deficiency[5].

Furthermore, the duodenum and jejunum are the two segments that absorb vitamin D (vit D)from the diet; malabsorptive techniques avoid both of these areas. As a result, following these procedures, parathyroid hormone (PTH) levels rise secondary to vit D deficiency[6].

The hormone PTH is secreted by the parathyroid glands and is dependent on the amount of calcium in the body. The kidneys increase the excretion of phosphorus and calcitriol and decrease the excretion of calcium in an attempt to boost blood calcium levels when there is a low concentration of circulating calcium. This results in increased PTH and a decrease in bone mass, specifically a depletion of calcium and phosphorus[7]. Calcium and vitamin D should be used to treat secondary hyperparathyroidism, which is caused by this entire pathway[8].

Aim

This study aimed to show how bariatric surgery affected serum calcium and vit D levels, show how patients undergoing bariatric surgery experienced

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secondary hyperparathyroidism, and compare the results of laparoscopic sleeve gastrectomy and RYGB surgery in terms of secondary hyperparathyroidism.

PATIENTS AND METHODS:

This prospective cross-sectional cohort study was conducted on 100 obese patients divided into two groups. The choice of surgery type was to the patient after discussing the pro and cons of each procedure with a surgical team if no contraindication for the procedure.

Group I: 50 patients who underwent Laparscopic Sleeve Gastrectomy and **Group II:** 50 patients who underwent RYGB at General Surgery Department, Faculty of Medicine, Beni-Suef University Hospital during the period between January 2019 and March 2022.

Inclusion criteria

Male and female patients with BMI greater than 40, or greater than 35 with obesity-related comorbidities.

Exclusion criteria

Any patient with known coagulopathy, pregnancy, malignancy, severe psychiatric disease, and unfit for general anesthesia.

Sample size

100 patients; 50 for each group. By using the G power program for sample size calculation, setting power at 80%, alpha error at 5%, and after reviewing previous studies and assuming medium effect size difference (0.5).

Methods

Administrative design

The patients had been followed-up for 1 year following surgery with replacement therapy 1000 mg elemental calcium in the form of calcium citrate and 3000 IU vit. D3 daily for persons with normal levels of vit.D prior to surgery or 5000 IU–10000 IU vit D3 for persons with vit. D deficiency prior to surgery, to detect levels of (PTH, serum Ca, 25-hydroxy D3) at 6 months and 1 year postoperative.

Ethical committee approval

This study was approved by Institutional Review Board (IRB) at Beni-Suef University hospitals.

RESULTS:

There was no statistically significant difference between the two groups regarding age, sex (Table 1) and BMI (Table 2) (*P>0.05*) .

Regarding blood calcium level, the mean values of blood calcium levels of the study groups, at different follow-up points (preoperative, after 6 months and after 1 year) were formulated in (Table 3).

In LSG group, statistical studies elaborated a slight increase in the serum ionized calcium level after 6 months compared with preoperative levels. After one year, serum calcium levels were decreased below the baseline levels, collected preoperatively. However, these changes were statistically insignificant (Table 4).

In GB group, serum ionized calcium levels decreased after 6 months, and after one year. Compared with preoperative levels, these changes were statistically insignificant(Table 4).

Regarding vit.D levels, there was a significant increase in vit.D level after 6months and after 1 year, compared with preoperative levels, in both LSG group (P<0.05) and GB group (P<0.05) most properly due to postoperative vit.D replacement therapy.

Statistical analysis of the present work showed a statistically significant higher mean values of vit.D level in LSG group, compared with GB group, on the two follow-up points (Table 5).

Moreover, LSG group showed a statistically significant improvement in abnormal vitamin D levels, versus GB group, after 6 months and after 1 year (*P<0.05*) (Table 6).

Regarding PTH levels, in the LSG group, PTH level showed a significant elevation after 6 months but remains within normal range, and after 1 year it slightly decreased. This decline was statistically insignificant , while in GB group, PTH showed a significant increase after 6 months and after 1 year (Table 7).

By previous data elucidated in the study, statistical analysis revealed significantly higher PTH levels in the GB group, versus the LSG group, after 6 months and after 1 year (*P<0.05*) (Table 7).

Table 8 illustrated that regarding the presence of high PTH levels, GB group exhibited a significantly higher proportion of patients, after 6 months and after 1 year (*P<0.05*).

A highly significant positive correlation between baseline calcium level and vitamin D (r=0.760, *P<0.001*) was detected, while a highly significant negative correlation between baseline calcium level and PTH (r=-0.449, *P=0.001*) in LSG group. In the RYGB group, there was high significant positive correlation between baseline calcium level and vit.D (r=0.725, *P<0.001*) while there was a high significant negative correlation between baseline calcium level and PTH (r=-0.427, *P=0.002*) (Table 9).

Table 1: Demographic characteristics among the studied groups

	LSG group (No.=50) No. (%)	RYGB group (No.=50) No. (%)	Test value	*P* value
Sex				
Male	24 (48.0)	22 (44.0)	X^2=0.161	0.688
Female	26 (52.0)	28 (56.0)		
Age (years)				
Mean±SD	34.88±8.09	35.82±8.21	Z_MWU 0.659	0.510
Median	35.0	35.50		
Range	20.0–56.0	21.0–55.0		

P less than or equal to 0.05 is considered statistically significant.
P less than or equal to 0.01 is considered high statistically significant.
* Chi- Square test and Mann–Whitney U test.
SD, standard deviation.

Table 2: Comparison between the studied groups regarding BMI

	LSG group(No.=50)	GB group(No.=50)	Test value	*P* value
BMI (Kg/m^2)				
Mean±SD	39.66±1.83	44.60±1.96	Z_MWU 8.196	<0.001
Median	39.5	45.0		
Range	36.0–43.0	41.0–49.0		

P less than or equal to 0.05 is considered statistically significant.
P less than or equal to 0.01 is considered high statistically significant.
* Mann–Whitney U test.
SD, standard deviation.

Table 3: Comparison between the two studied groups regarding number of patients at different follow up periods regarding calcium levels

Ca+2	LSG group (No.=50) No. (%)	RYGB group (No.=50) No. (%)	Test value	*P* value
Preoperative				
Normal	48 (96.0)	49 (98.0)	X^2=0.00	0.8
Low	2 (4.0)	1 (2.0)		
After 6 months				
Normal	45 (90.0)	42 (84.0)	X^2=0.088	0.05
Low	5 (10.0)	8 (16.0)		
After 1 year				
Normal	46 (92.0)	39 (78.0)	X^2=0.088	0.04
Low	4 (8.0%)	11 (22.0%)		

P less than or equal to 0.05 is considered statistically significant.
P less than or equal to 0.01 is considered high statistically significant.
* Chi- Square test and Mann–Whitney U test.
SD, standard deviation.

Table 4: Comparison between the studied groups regarding calcium level at different follow-up periods

	LSG group (No.=50) Mmol/L		GB group (No.=50) Mmol/L			
Ca. (2.2–2.7 mmol/L)	Mean±SD	Median	Mean±SD	Median	Test value*	*P* value
Preoperative	2.27±0.25	2.27	2.28±0.23	2.29	0.666	0.8
After 6 months.	2.28±0.18	2.29	2.27±0.19	2.27	0.626	0.8
After 1 year	2.26±0.18	2.25	2.25±0.19	2.25	0.626	0.7
Test value#	16.0		14.0			
P value	**0.8**		**0.7**			

P less than or equal to 0.05 is considered statistically significant.
P less than or equal to 0.051 is considered highly statistically significant.
Comparison between group done by Mann–Whitney U Test and inside the same group indifferent period by Friedman's Two-Way analysis of variance.
SD, standard deviation.

Table 5: Comparison between the studied groups regarding levels of vitamin D at different follow-up periods

	LSG group (No.=50) nmol/L		RYGB group (No.=50) nmol/L			
Vit. D (30–100nmol/L)	Mean±SD	Median	Mean±SD	Median	Test value*	*P* value
Preoperative	14.01±6.39	14.00	14.05±6.13	14.26	0.768	0.9
After 6 months	18.05±3.20	18.50	17.04±5.1	16.94	0.318	0.01*
After 1 year	22.07±2.03	22.04	18.02±4.6	18.64	0.707	0.001*
Test value#	42.26		27.07			
P value	0.001		0.001			

P less than or equal to 0.05 is considered statistically significant.
P less than or equal to 0.051 is considered highly statistically significant.
Comparison between group done by Mann–Whitney U Test and inside the same group in different period by Friedman's two-way analysis of variance.
SD, standard deviation.

Table 6: Comparison between the two studied groups regarding number of patients regarding vitamin D levels at different follow-up periods

Vit. D	LSG group (No.=50) No. (%)	RYGB group (No.=50) No. (%)	Test value	*P* value
Preoperative				
Normal	2 (4.0%)	1 (2.0%)	X^2=2.041	0.153
Low	48 (96.0)	49 (98.0)		
After 6 months				
Normal	7 (14.0)	5 (10.0)	X^2=0.298	0.03*
Low	43 (86.0)	45 (90.0)		
After 1 year				
Normal	8 (16.0)	6 (12.0)	X^2=0.271	0.03*
Low	42 (84.0)	44 (88.0)		

P less than or equal to 0.05 is considered statistically significant.
P less than or equal to 0.01 is considered high statistically significant.
* Chi- Square test and Mann–Whitney U test.
SD, standard deviation.

Table 7: Comparison between the studied groups regarding levels of PTH at different follow-up periods

	LSG group(No.=50) pmol/L		GB group(No.=50) pmol/L			
PTH (1.6 to 6.9 pmol/L)	Mean±SD	Median	Mean±SD	Median	Test value*	*P* value
Preoperative	4.71±1.77	4.40	4.88±1.41	4.95	0.932[a]	0.7
After 6 months	5.58±2.10	5.49	6.83±1.93	6.72	0.497[b]	0.001*
After 1 year	5.48±2.10	5.51	7.21±1.93	7.24	0.497 [b]	0.001*
Test value#	21.43		22.53			
P value	0.01		0.01			

P≤ less than or equal to 0.05 is considered statistically significant.
P less than or equal to0.051 is considered highly statistically significant.
Comparison between group done by Student T testbMann–Whitney U Test and inside the same group in different period by Friedman's two-way analysis of variance.
SD, standard deviation.

Table 8: Comparison between the two studied groups regarding number of patients regarding parathyroid hormone levels at different follow-up periods

PTH	LSG group (No.=50) No. (%)	RYGB group (No.=50) No. (%)	Test value	*P* value
Preoperative				
Normal	48 (96.0)	49 (98.0)	X^2=0.706	0.4
High	2 (4.0)	1 (2.0)		
After 6 months				
Normal	48 (96.0)	40 (80.0)	X^2=1.563	0.001
High	2 (4.0)	10 (20.0)		

After 1 year				
Normal	46 (92.0)	39 (78.0)	X^2=1.563	0.001
High	4 (8.0)	11 (22.0)		

P less than or equal to 0.05 is considered statistically significant.
P less than or equal to 0.01 is considered high statistically significant.
* Chi- Square test and Mann–Whitney U test.
SD, standard deviation.

Table 9: Correlation between baseline calcium level and different parameters

	Calcium level			
	LSG group (No.=50)		RYGB group (No.=50)	
	r	*P* value	r	*P* value
Age	–0.130-	0.366	0.220	0.125
BMI	–0.217-	0.129	–0.053-	0.716
Preop. Vitamin D	0.760	**<0.001**	0.725	**<0.001**
Preop. PTH	–0.449-	**0.001**	–0.427-	**0.002**

DISCUSSION

There was no statistically significant difference between the two groups regarding age, sex and BMI (*P>0.05*).

Regarding blood calcium level, SG group elaborated less proportion of subjects with low blood calcium levels, compared with GB group, after 6 months and after 1 year (*P<0.05*). In this study, statistical analysis revealed a significant difference between the two studied groups regarding the prevalence of low calcium level after 6 months and after 1 year; GB group had a larger proportion of subjects with low blood calcium levels (22%) versus SG group (only 8%) after one year. Tian *et al*., agreed with the findings of the current work[9].

In agreement with this results, a prospective study of Gehrer *et al*. has concluded that fewer deficiencies are seen after SG, compared with the RYGB[10].

In SG group the mean±SD preoperative vit. D was 14.01±6.39, after 6 months was 18.05±3.20 and after 1 year was 22.07±2.03. In GB group the mean±SD preoperative vit. D was 14.05±6.13, after 6 months was 17.04±5.1 and after 1 year was 18.02±4.6

In accordance with this results, a meta-analysis of Tian *et al*. that was published on 2020, revealed more prevalence of deficiency of 25-hydroxyvitamin D in patients undergoing gastric bypass[9].

Also, in agreement with this study, Vix *et al*., reported that vit.D values were statistically significantly higher after SG compared with RYGB[11].

A meta-analysis that was published on 2017 stated that individuals with obesity are already shown to be vit.D deficient at baseline, moreover, bariatric surgeries circumventing the proximal small bowel bypasses the preferential-dependent active transport, a transcellular pathway responsible for ~80% of oral vit.D absorption[12].

In SG group, the PTH level showed a significant elevation after 6 months but remains within the normal range, and after 1 year it slightly decreased. This decline was statistically insignificant, while in GB group, PTH showed a significant increase after 6 months and after 1 year. In accordance with previous data elucidated in the study, statistical analysis revealed significantly higher PTH levels in GB group, versus SG group, after 6 months and after 1 year (*P<0.05*). Regarding the presence of high PTH level, GB group exhibited a significantly higher proportion of patients, after 6 months and after 1 year (*P<0.05*).

According to Vix *et al*., the SG group had lower serum parathyroid hormone (SHPT) levels than the GB group, which is consistent with these findings. The SG and RYGB groups had a secondary hyperparathyroidism rate of 20.83% and 24%, respectively, according to the later publication[11]. Furthermore, Altawil *et al*. clarified that 15.4% of patients had hyperparathyroidism at baseline and 36.4% had it after surgery (*P<0.001*). Low vit. D levels, which were very common before surgery, were reported to have a dramatic decrease (66.4% preoperative and 28.0% at follow-up after surgery, *P=0.032*)[13].

Contrary to this conclusion, Tian *et al*. reported that patients receiving GB and SG surgery had comparable circulating levels of parathyroid hormone[9].

In the SG group, there was a highly significant negative connection (r=□0.449, *P=0.001*) between

baseline calcium level and PTH, and a highly significant positive correlation (r=0.760, *P<0.001*) between baseline calcium level and vitD. Within the GB group, there was a highly significant negative connection (r=-0.427, *P=0.002*) between baseline calcium level and PTH, and a highly significant positive correlation (r=0.725, *P<0.001*) between baseline calcium level and vit.D. The findings about the relationships between serum calcium, vit.D, and parathyroid hormone levels were validated by earlier research[14].

For example, a cohort study conducted by Jalali *et al*. on 120 patients who had multiple bariatric procedures discovered a substantial correlation between less weight loss and postoperative hyperparathyroidism, as well as deficits in calcium and vit.D. They came to the same conclusion as us[15]: sleeve gastrectomy is linked to a notably decreased incidence of hyperparathyroidism patients. Additionally, it has been shown by Salman *et al*. that the incidence of hyperparathyroidism peaked 6 months following surgery and thereafter declined[16].

CONCLUSION

The prevalence of secondary hyperparathyroidism is high in morbidly obese patients before bariatric surgery which is related to vitamin D deficiency and calcium deficiency. This prevalence increased continually along with the time after both LSG and RYGB surgery and more apparent after RYGB (Fig. 1).

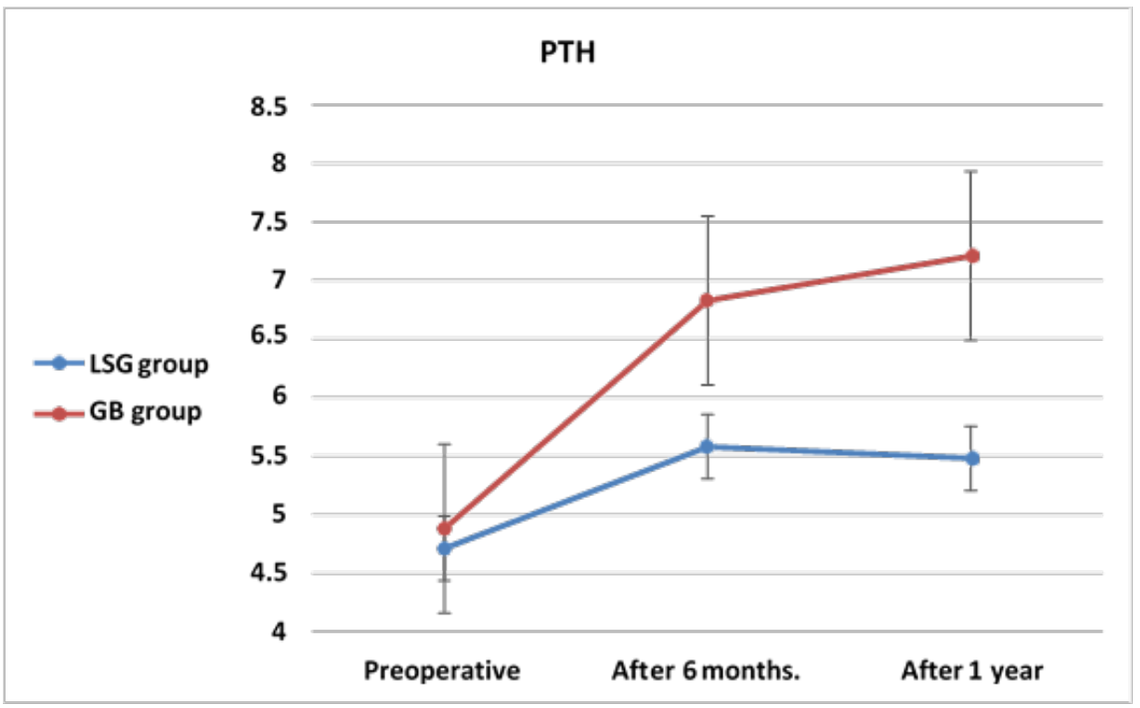

Fig. 1: Comparison between the studied groups regarding parathyroid hormone level at different follow-up periods. LSG, laparoscopic sleeve gastrectomy; GB, Gastric Bypass

CONFLICT OF INTEREST

There are no conflicts of interest.

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