



A Prospective Study on Short-Term Changes in Serum Nutrient Levels After Sleeve Gastrectomy and One Anastomosis Gastric Bypass (OAGB)

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Abstract: In Egypt, sleeve gastrectomy and one anastomosis gastric bypass (OAGB) are popular bariatric procedures. The current study was conducted to compare between these two procedures regarding short-term weight loss, comorbidity improvement, vitamin and micronutrient changes. This prospective study included 40 cases who were divided into two equal groups; sleeve gastrectomy and OAGB groups. All cases received the standard perioperative care. Our primary outcome was serum nutrient changes (hemoglobin, iron, calcium, vitamin D, and vitamin B 12), while secondary outcomes included weight loss parameters along with the improvement of obesity related comorbidities. These data were recorded 3, 6, and 12 months after operation, and then compared to the corresponding baseline values. Demographic criteria were comparable between the two groups, apart from diabetes which was more prevalent in the OAGB group. Both groups were followed by a significant and comparable weight loss at the short-term after operation. Both groups were associated with significant improvement in DM and hypertension at 12 months. Most evaluated vitamin and nutrient levels were comparable between the two groups except for hemoglobin, iron and vitamin B 12 levels, which were significantly higher with sleeve gastrectomy at 6- and 12-month follow up. Both sleeve gastrectomy and OAGB are effective bariatric procedures that could achieve satisfactory weight loss and improvement of comorbidities. However, OAGB carries higher risk of iron, hemoglobin and vitamin B 12 deficiency.

Keywords: Sleeve Gastrectomy, One Anastomosis, Gastric Bypass, Vitamin Deficiency, Malnutrition

1. Introduction

In the 21st century, obesity has become a global health epidemic, which has a significant negative impact on human well-being. It is associated with multiple comorbidities including diabetes, hypertension, dyslipidemia, obstructive sleep apnea and degenerative joint disease [1]. Obesity constitutes a major health challenge in both developing and developed countries [2].

Currently, bariatric surgical procedures are the only effective and durable solution for managing obesity. It leads to satisfactory weight loss with remission or improvement of

obesity-related comorbidities. Also, it improves long-term survival in such population [2, 3].

Among all bariatric procedures, both sleeve gastrectomy and OAGB represent two of the most popular bariatric procedures, especially in Egypt [4]. In 2018, the fourth IFSO global registry reported that sleeve gastrectomy accounted for 46% of all bariatric procedures, whereas OAGB accounted only for 7.6% [5].

Sleeve gastrectomy has become the commonest performed bariatric procedure worldwide [6]. This could be explained by the numerous advantages of such procedure. It is characterized by short learning curve and satisfactory

outcomes which are even comparable with Roux-en-Y gastric bypass [7, 8].

The OAGB procedure was introduced by Rutledge in 1997 [9, 10], and its popularity has increased since then as an effective and safe metabolic procedure, which is relatively easier compared to the Roux-en-Y procedure [11]. Some studies even reported better weight loss and comorbidity improvement results for the OAGB procedure [12, 13].

Although multiple studies have compared sleeve gastrectomy and OAGB procedures regarding weight loss and comorbidity outcomes [2, 14], there is obvious paucity of trials handling the impact of these two procedures on post-operative vitamin and micronutrient levels. Therefore, the current study was conducted to compare between these two procedures regarding short-term weight loss, comorbidity improvement, vitamin and micronutrient changes.

2. Patients and Methods

This prospective non-randomized study was conducted at the General Surgery Department, Mansoura University Hospitals during the period between August 2017 and August 2020. We included a total of 40 cases aged between 18 and 60 years, whose BMI > 40 kg/m² without obesity related comorbidity, or with BMI between 35 and 40 kg/m² with presence of any obesity related comorbidity. We excluded cases with previous upper GI surgeries, secondary obesity, major psychiatric illness or pregnancy.

Recruitment of patients was initiated after gaining approval from the local ethical committee and Institutional Review Board (IRB). Additionally, an informed written consent was signed by all the participants after complete explanation of the benefits and drawbacks of each procedure.

All cases were performed laparoscopically under general anesthesia. The included cases were divided into two equal groups (20 patients in each), according to shared decision making between surgeon, physicians and patient, the sleeve gastrectomy group and OAGB group. A standardized 5 port technique was used in all cases.

In the sleeve gastrectomy group, we started devascularization of the greater gastric curve using harmonic or ligasure devices. Dissection started 4 cm proximal to pylorus till reaching the left diaphragmatic crus and identifying the angle of His. Dissection of posterior gastric adhesions was done, if found. After insertion of a 38-Fr bougie, the sleeve was created using an endostapler (4 – 6 cartridges). The bleeding points over the staple line were controlled by hemostatic clips.

For the OAGB group, we started dissection perpendicular to the lesser gastric curve, distal to the crow's foot. After reaching the lesser sac, the stomach was horizontally transected by an endostapler. A 50-ml gastric pouch was created over the bougie using additional two or three additional cartridges. A gastrojejunal anastomosis was created between the pouch and the jejunum about 2 meters

from the Treitz ligament. The anastomosis was created by the stapler, and the remaining defect was closed with continuous vicryl sutures.

In both groups, intraoperative methylene blue test was done to exclude leakage, and the operation was finished after adequate wash and hemostasis. All cases were kept NPO after operation till performing an oral gastrografin test. If no radiological leak was detected, oral fluids were initiated. Most patients were discharged on the first or second post-operative day. Vitamin supplementation was commenced for all cases in either group, and it included a daily oral supplementation iron (18 mg), calcium (700 mg), vitamin D (1000 IUs), and vitamin B12 (500 mcg). In addition, copper, selenium, and zinc were also added. Moreover, protein supplementation was provided for all patients in the first 6 months.

Regular follow up visits were scheduled for all cases, weekly for the first month then at 3, 6 and 12 months. We measured the serum levels of Hb, Iron, calcium, vitamin D and vitamin B12 within one month before surgery and at 6 and 12 months after surgery. The percentage of excess weight loss (%EWL), comorbidity improvement, and serum nutrient level were recorded. Comorbidity resolution and/or improvement was defined according to the Standardized outcomes reporting in metabolic and bariatric surgery [15].

Our primary outcome was serum nutrient changes (iron, calcium, vitamin D, and vitamin B 12), while secondary outcomes included weight loss parameters along with the improvement of obesity related comorbidities.

Our collected data were processed using statistical package of social science (SPSS 26.0, IBM/SPSS Inc., Chicago, IL) software. The quantitative data were tested for normality using Kolmogorov Smirnov-test and expressed as mean \pm standard deviation (SD) when parametric and as median (range) when non-parametric. The qualitative data were expressed as frequency and percent within groups. For comparing two groups with quantitative data, independent samples t-test was used for parametric data and Mann-Whitney U-test for non-parametric data. Comparison of two groups of qualitative data was conducted using Chi-square test (or Fischer's exact test as a correction). For all tests, the cutoff point of 0.05 was considered to be statistically significant.

3. Results

Both groups had comparable age, sex, weight, height and BMI with no significant differences. The mean age of the included patients was 34 \pm 9.1 years in the sleeve and 32.9 \pm 10 in OAGB group. Females represented 85% and 80% of the included patients in the same groups respectively. BMI had mean values of 52 and 49.7 kg/m² in the two groups respectively.

OAGB had significantly higher proportional of diabetes mellitus than sleeve gastrectomy 65% vs 10%. The prevalence of hypertension was comparable between the

two groups ($p = 0.288$). the previous data are summarized at table 1.

Table 1. Demographic data and obesity-related comorbidities in the study groups.

	Sleeve gastrectomy (n = 20)	OAGB (n = 20)	P value
Age (years)	34 ± 9.1	32.9 ± 10	0.731
Gender			
Male	3 (15%)	4 (20%)	1.0
Female	17 (85%)	16 (80%)	
Weight (kg)	138.5 ± 27.2	131.0 ± 35.4	0.455
Height (cm)	163.4 ± 6.6	166.10 ± 10	0.321
BMI (Kg/m ²)	52.0 ± 9.4	49.75 ± 9	0.445
Diabetes	2 (10%)	13 (65%)	< 0.001
Hypertension	4 (20%)	7 (35%)	0.288

BMI: Body mass index.

Regarding the primary outcomes, there was no significant difference between the two groups before operation in term of serum nutrient changes. However, sleeve gastrectomy patients had significantly higher levels of hemoglobin, iron and

vitamin B12 after surgery compared to OAGB patients. Both calcium and vitamin D levels were comparable between the two groups after operation at 6 and 12 months. Table 2 illustrates these data.

Table 2. Vitamin and mineral changes in the study groups.

	Sleeve gastrectomy (n = 20)	OAGB (n= 20)	P value
Hemoglobin (gm/dl)			
Preoperatively	11.9 ± 1.4	12.7 ± 1.6	0.094
6 month	11.8 ± 1.2	10.4 ± 1.4	0.002
12 months	11.2 ± 1.2	10.1 ± 1.4	0.017
Iron (mcg/dL)			
Preoperatively	72 ± 19.8	85.8 ± 31.6	0.106
6 months	70.2 ± 28.2	51.5 ± 17.4	0.016
12 months	68.4 ± 25.6	48.5 ± 15.7	0.005
Calcium (mg/dl)			
Preoperatively	9 ± 0.7	9.1 ± 0.6	0.521
6 months	8.9 ± 0.6	8.9 ± 0.5	0.935
12 months	8.6 ± 0.6	8.7 ± 0.6	0.496
Vitamin D (ng/ml)			
Preoperatively	16.7 ± 6.5	13.6 ± 5.1	0.097
6 months	29.9 ± 8.4	25.2 ± 6.8	0.062
12 months	30.2 ± 8.1	27.3 ± 9	0.295
Vitamin B12 (ng/ml)			
Preoperatively	619.3 ± 170.4	437.2 ± 196.5	0.06
6 months	814.5 ± 414.7	574.5 ± 135.6	0.019
12 months	759.1 ± 304.2	451.2 ± 147	<0.001*

Table 3 shows that both groups were followed by a significant weight loss at 3, 6, and 12 months postoperatively. There were no significant differences between the two groups in terms of mean body weight and BMI at these time intervals.

Three-month %EWL was significantly higher after OAGB compared to sleeve gastrectomy (46.7 vs. 42.8, $p = 0.0007$); however, this statistically significant difference was not maintained at the subsequent visits ($p > 0.05$).

Table 3. Short-term weight loss parameters in the study groups.

	Sleeve gastrectomy (n = 20)	OAGB (n = 20)	P value
Weight (Kg)			
After 3 months	109.8 ± 22.8	110.4 ± 17.5	0.926
After 6 months	96.6 ± 20.5	96.9 ± 13.6	0.957
After 12 months	88.5 ± 19.6	88.8 ± 11.2	t0.961
BMI (kg/m ²)			
After 3 months	41 ± 7.7	40.3 ± 7.6	0.766
After 6 months	36 ± 7	35.4 ± 6.3	0.740
After 12 months	33 ± 6.7	32.4 ± 4.9	0.708
%EWL			
After 3 months	42.8 ± 2.8	46.7 ± 3.8	0.0007
After 6 months	61.7 ± 0.6	64.4 ± 9.8	0.22
After 12 months	73.5 ± 4.2	75.4 ± 21.4	0.69

%EWL: Percentage of excess weight loss. BMI: Body mass index.

Table 4 shows the comorbidities improvement among the two groups, the two patients with diabetes improved after sleeve gastrectomy were as twelve out of thirteen patients improved after OAGB. On the other hand, three patients with

hypertension out of four improved after sleeve gastrectomy as six out of seven improved after OAGB. there is no significant difference in the improvement of DM and hypertension ($p=0.99$).

Table 4. Comorbidity improvement in the study groups.

	Sleeve gastrectomy (n = 20)	OAGB (n = 20)	P value
Diabetes mellitus	2/2 (100%)	12/13 (92%)	0.99
Hypertension	3/4 (75%)	6/7 (85.7%)	0.99

Regarding post-operative complications, early post-operative vomiting was recorded in 20% and 15% of patients in the sleeve and OAGB groups respectively, while bleeding was recorded in 5% of patients in the both groups.

No leak was recorded in the current study. The incidence of post-operative complications was comparable between the two groups, as shown at table 5.

Table 5. Post-operative complications in the study groups.

	Sleeve gastrectomy (n = 20)	OAGB (n = 20)	P value
Early vomiting (%)	4 (20%)	3 (15%)	0.99
Early bleeding (%)	1 (5%)	1 (5%)	0.99
Leakage (%)	0	0	0.99

4. Discussion

The current study was conducted to evaluate the effect of bariatric surgical procedure either Sleeve gastrectomy or OAGB on serum vitamins and nutrients levels, weight loss as well as comorbidity resolution. Although the current literature is rich with studies comparing these two bariatric procedures regarding weight loss and comorbidity resolution outcomes, there is a paucity of studies comparing these two specific procedures regarding post-operative mineral and vitamin values.

When it comes to weight loss parameters in our study, no significant difference was noticed between the two procedures regarding six- or twelve-month % EWL. It had mean values of 73.5 and 75.4% in the sleeve and OAGB groups respectively ($p = 0.69$). Our results show that both procedures are effective and comparable in achieving adequate weight loss on the short term. Our outcomes at one year for % EWL are in accordance with large studies evaluating the same procedures. In the current literature, twelve-month % EWL after OAGB varies between 67% and 80% [16-18], while the same value for sleeve gastrectomy varies between 57% and 75.6% [19-21] and it may reach 40% in super-obese patients [22].

In our study, the rates of diabetes improvement and/or remission was comparable between the two procedure. It was experienced in 100% and 92% of diabetic cases in the sleeve and OAGB groups respectively ($p = 0.99$). Kansou and his associates also reported a non-significant difference in improvement of diabetes in 90.5% and 92.6% of patients one year after LSG and OAGB groups respectively [23]. The underlying mechanism of diabetes remission after either of the two procedures is still unclear. However, weight loss is a crucial factor for that improvement [24].

The improvement and/or remission of hypertension was detected in 75 and 57.1% of cases diagnosed with it in the sleeve and minigastric groups respectively, with no significant difference between the two groups ($p = 0.99$). We could notice that outcomes were slightly better in the sleeve group, but the affected cases with hypertension in the sleeve were only four, which makes this result not generalized. Kular *et al.* also reported that resolution of hypertension was achieved in 74% and 76% of cases in the sleeve and minigastric groups respectively, with no significant difference between the two groups [25].

In the current study, although there was no significant difference between the two groups regarding preoperative hemoglobin levels. On follow-up at 6 and 12 months postoperatively, the serum hemoglobin levels after OAGB were significantly lower than after LSG. In line with our findings, Bashas *et al.* reported a significant decrease in hemoglobin levels at one-year after OAGB [26]. Other authors confirmed the previous findings after OAGB [27]. Anemia is common after OAGB, similar to or less than the rates reported after RYGB [28]. Post-OAGB anemia is largely related to the bypass of the duodenum where most iron is absorbed as compared to LSG where no bypass is performed [29].

Parallel to the previous finding, there was no significant difference between the two groups regarding baseline serum iron levels. Significantly lower levels of serum iron were observed after OAGB as compared to LSG. There has always been a fear of iron deficiency anemia following OAGB. Kular *et al* reported five cases (6.9%) of iron deficiency anemia after OAGB [25]. Other studies showed similar incidence of iron deficiency anemia after OAGB [30-32].

To compensate for lack of iron absorption from the duodenum after OAGB, all patients were prescribed iron

supplementation after surgery. However, non-compliance of some patients with the postoperative vitamin and mineral supplementation may explain the significant decrease in serum iron levels in these patients.

Of note, it is worth to mention that iron deficiency can also occur after LSG. It is probably due to an impaired transformation of iron from meals to an absorbable form by hydrochloric acid in the stomach, as its secretion is reduced by this kind of surgery [33-35].

In the current study, no significant difference was detected between the two procedures regarding preoperative and post-operative serum calcium values. Another study reported that OAGB was not associated with any significant impact on calcium levels [36]. Saif et al. reported that LSG was not associated with a significant change in calcium levels at one-year follow up visit. [37]. The previous studies confirmed the safe outcomes of both procedures regarding post-operative calcium levels. This lack of difference may be attributed to the concept that calcium absorption is not markedly affected after either procedure.

Similar to the changes in serum calcium levels, no significant differences between both procedures regarding preoperative and post-operative vitamin D levels were noted. Although we did not record significant reduction in serum calcium after either procedures, it has been suggested that bariatric surgery overall may intensify vitamin D deficiency [38, 39]. The main explanations for this hypothesis are related to a decreased oral intake following the surgical procedure, as well to its impact on the absorption of nutrients. Thereby, routine vitamin D supplementation is commonly advised after bariatric surgery [40]. Perhaps the prescribed vitamin D supplementation to our patients in the present study was sufficient to overcome the impact of bariatric surgery on vitamin D absorption.

Bashah et al. did not find any negative impact of OAGB on post-operative serum vitamin D levels at one year after surgery [26]. Other authors reported a significant increase in vitamin D level after OAGB, from 22.24 ng/ml before operation up to 35.52 ng/ml one year after it [27]. The same was also noticed for sleeve gastrectomy. Furthermore, a recent Egyptian study reported a significant increase in vitamin D levels after both LSG and OAGB [41]. In the study conducted by Pellitero and his associates, vitamin D level showed a significant increase one year after sleeve gastrectomy [42]. Other authors confirmed the previous findings regarding sleeve gastrectomy [37, 43].

In our study, follow up levels of vitamin B12 were significantly higher after both procedures than their baseline levels; perhaps because of the corrective effect of vitamin B supplementation prescribed after surgery. Postoperative Vitamin B12 levels were higher after LSG as compared to after OAGB, and this may be explained by the fact that LSG doesn't entail any bowel bypass, unlike OAGB. Other authors also reported a significant increase in the serum levels of vitamin B12 after OAGB. Zamaninour and Pellitero reported a significant rise in vitamin B12 levels one year after LSG [27, 42]. On the other hand, other authors didn't

record significant changes in vitamin B 12 levels after OAGB procedure [26]. Conversely, other authors reported that serum vitamin B 12 showed a significant decrease after sleeve gastrectomy [43].

When it comes to post-operative complications, we did not notice any significant difference between the two groups regarding complications such as vomiting, bleeding or leakage. Multiple previous studies have reported a comparable safe perioperative profile of both procedures [44, 45]. We did not encounter any cases with post-operative leakage in the current study. The incidence of leaks after OAGB in the literature is reported to be very low, varying between 0.1% and 1.5% [46]. In SG, leakage rates ranges between 1.5 to 3% [26].

Our study has some limitations. First of all, the small sample size that was collected from a single surgical center. Secondly, the medium- and long-term follow up data should have been collected. Additionally, other minerals and vitamins parameters should be collected and evaluated.

5. Conclusion

Based on the results of this study, both sleeve gastrectomy and OAGB achieved similar EWL and reduction in BMI at 6 and 12 months postoperatively, comparable improvement of comorbidities and similar complication rates. However, OAGB carries higher risk of nutritional deficiency mainly iron, hemoglobin and vitamin B 12.

Conflict of Interest

The authors have no conflict of interest.

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