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Research Article

Pre and Early Post-operative Iron Assessment in Obese Patients Underwent Laparoscopic Sleeve Gastrectomy

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ABSTRACT

Obesity is a chronic disease associated with mortality and morbidity. Bariatric surgery as a long-term weight reduction treatment has been increased. This study investigated the early state of iron storage and deficiency in patients underwent laparoscopic sleeve gastrectomy (LSG). Thirty patients were selected as a prospective study underwent LSG according to specialized inclusion and exclusion criteria at Soran Private Hospital in Erbil, from January 01, 2021, to September 01, 2021, after signing a consent form. All selected patients underwent preoperative and 3 months' post-operative hemoglobin (Hb), mean corpuscular volume (MCV), and serum ferritin (SF) assessments. They were instructed to follow specialized diet regimen for 3 months' post-operative and not to take any drugs and supplements. Results showed a strong positive correlation between pre-operative and post-operative assessment for both Hb and MCV respectively (r = 0.72; $P < 0.001$), (r = 0.76; $P < 0.001$), and a moderate correlation for SF (r = 0.41; $P < 0.024$). Significant difference ($P < 0.05$) was found between pre-operative and post-operative for the three markers (Hb, MCV, and SF). Their values were decreased from pre-operative to post-operative for the majority of the cases, but they were still within the normal range. The finding demonstrated that after 3 months from LSG, no patients showed iron deficiency anemia. However, there was decrease in SF level which indicated that the storage capacity of iron was decreasing. This suggests that the iron supplement has to be started since the food regime followed in by the patients was not sufficient to maintain normal iron level.

Keywords: Severe obesity, sleeve gastrectomy, iron deficiency, regime follow-up, weight reduction

INTRODUCTION

Obesity as a chronic disease is considered as a major threaten to the public health,[1] reaching a pandemic state.[2] Factors leading to obesity consist of association of genetic, metabolic, food habits, behavioral, social, cultural, and other aspects.[3] Recent data by the World Health Organization (WHO) demonstrated that worldwide obesity has been increased.[4] Over six-hundred million adults globally are suffering from obesity, and more than 1.9 billion adults were overweight.[5]

The association among obesity and accelerated mortality is a fact.[6] For example, an average increase in mortality by 30% is resulted by each 5 kg/m^2 increase in body mass index (BMI) above 25 kg/m^2. This increasing rate of mortality is mainly due to vascular diseases and diabetes.[7] Furthermore, the existence expectancy is decreased around 5–20 years in obese patient with a BMI higher than 35.[8]

Bariatric surgery (BS) reduces weight for obese patients and keeps their weight loss by limiting the consumption and/or induce mal-absorption of food. It is often used when other treatments such diet, exercise and drugs have failed.[9] Decreasing the size of the stomach is due to the restraining strategies, and hence restrict the energetic intake and initiate satiety.[10] laparoscopic sleeve gastrectomy (LSG) method is rapidly gaining popularity inside academic medical centers of the USA and worldwide.[11,12]

Despite the benefit of BS, many complications and the nutritional deficiencies are a worrying trend that need attention.[13] The deficiencies develop because of the change inside the physiology and anatomy of the gastrointestinal

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tract.[14] The most obvious nutrients deficiency is the risk of iron deficiency anemia (IDA). Restricted dietary intake, reduced appetite, increased satiety, inadequate intake of iron, and reduced secretion of hydrochloric acid are substantially caused to the development of iron deficiency after LSG.[15,16] In general, different factors contributed to iron deficiency such as poor adherence to dietary guidelines, recommended supplementation, and insufficient professional guidance.[17]

Therefore, it is advocated that patients underwent LSG ought to acquire postoperative follow-up according to the accreditation and standards from the "American Society for Metabolic and BS (ASMBS)" and the "International federation for the surgery of obesity and metabolic disorders."[18] However, it has been revealed that 47–90% of patients do not acquire dietary intervention following surgery treatment.[19]

Iron deficiency prevalence ranged between 1% and 54.1% for the duration of a follow-up of maximal 5 years following LSG and the prevalence of anemia varies between 3.6% and 52.7%.[20]

Affected patients rate by iron deficiency rely on the suggested iron status markers and their standard ranges. None of the iron marker is an ideal determinant. Consequently, the desired screening technique is the combination of markers. Therefore, hemoglobin (Hb), mean corpuscular volume (MCV), and serum ferritin (SF) levels are the markers that should be included for investigation of iron deficiency.[21,22]

This study aimed to evaluate the early state of iron storage and iron deficiency in patients who underwent LSG for weight reduction at pre- and post-operative using three markers (Hb, MCV, and SF levels), and to find out the effectiveness of the diet follow-up plan.

PATIENTS AND METHODS

This research is a prospective study that included 30 patients, selected from 55 patients undergoing LSG for managing their weight loss that held at Soran Private Hospital in Erbil, Kurdistan Region of Iraq from January 01, 2021, to September 01, 2021, using the most updated surgical technique.

All surgeries were performed by single laparoscopic and bariatric after taking and signing patients written consent form. Clinical reassessment was carried out each month postoperatively during the period of the study. All patients under went preoperative and 3 months post-operative Hb, MCV, and SF assessments at the same laboratory.

A deficiency was described as a serum plasma level determined under the regular reference range. While, excess level was defined as a serum plasma level over the reference range for normal standard. The values of the tests were measured to compare with the described values from the references records as follows: The normal value of Hb in men is 13.8–18.0 g/dl and in women is 12.1–15.1 g/dl. The normal reference range of MCV is 80–100 fl. While, the value of SF ranged between 30 and 300 ng/ml for males, and 30–160 ng/ml for females, and a value <50 ng/ml is considered as iron deficiency.[23]

All selected patients were instructed to follow the specialized diet regimen for 3 months' post-operative and not to take any drug or herbal supplements during the study time.

The Inclusion Standard for the Patients in this Study Include

1. Age between 18 and 40 years
2. Both male and female were included
3. BMI from 35 to 45 kg/m^2
4. Normal preoperative blood test value (Hb, MCV, and SF)
5. No comorbid conditions (HT, DM, and blood disease)
6. Accept the procedure, follow-up, and signed the consent form.

The Exclusion Criteria for the Patients in this Study were as Follows

1. Patient with abnormal pre-operative blood tests
2. Patients who developed intra- or post-operative complications (bleeding, leak, and conversion of surgery)
3. Failure to follow the regimen given.

The food regime that followed by the patients for post-operative composed of 2 stages, stage one for the 1st month and stage two for the next 2 months: [24,25]

Stage One

Week 1: Clear Liquids to give stomach time to heal and help avoid post-operative implications. A clear liquid diet is often the preliminary regimen. The patients start with sips of clear liquid. The goal is to drink a minimum of 2.5 L each day.

The clear liquids include: Water, tea including herbal or de-caffeinated coffee, fruit, clear chicken, beef, vegetable broth, watery fruit juice such as apple, grape or cranberry, diluted free of sugar squash, and flavored water. Liquids to be avoided: Caffeine, sugary drinks, and carbonated drinks.

Week 2: Full Liquids: The patients should keep drinking more of clear fluids as well as incorporating into fuller liquids that are loaded in protein.

Full liquid choices include: Low fat milk, homemade smoothies, yogurt drinks, smooth soups including cream of tomato, chicken, meat, ice cream without sugar, and sorbet.

Foods to be avoided as follows: High-fat foods (whole-milk yogurt), sweets foods, and food that has any lumps, caffeine, sugary drinks, and carbonated drinks.

Week 3: Pureed Foods: The patients were guided to eat 60 g of protein daily. In addition, they are recommended to add milk to mixture foods, ensuring that it is free of lumps. patients are suggested to eat small portions, and introduce new foods slowly including mashed fruit like bananas, avocados, and canned fruit, blended steamed fish in a low-fat sauce, tuna and salmon, mashed potato, low-fat cheese and soft cheeses, liquidized meat, chicken or fish stew, steamed or boiled vegetables, thick blended soups, and scrambled eggs.

Foods not to eat include: meals rich in starch (pasta, rice, and bread), hard uncooked vegetables, skin and seeds from vegetables, fatty foods (oils and butter), and spicy food.

Week 4: Smooth meals: The patients can add soft foods and lumps to diet. Well-cooked chicken and turkey, soft fish, lean mince meats, vegetables cooked well, cheese with low-fat,

eggs, soups with lumps, soft fruit, sweet potatoes, rice, and cereal with low-sugar.

Foods not to consume: difficult digested foods including steak, tough vegetables, nuts, white potatoes, and meals with excessive fat.

Stage Two

On the week 5 the patients can consume solid food smoothly. After the 1st month following LSG surgery diet instructions for patient is to eat a healthy diet, high protein, and low fat. It is necessary to have three small meals a day, have protein in each meal. Plan the meals, drink lots of water, if feel hungry between meals try taking a drink first.

It is advised to wait for at least 30 min from the time of eating to drinking. Drinking fluids during meals may cause to an overfull stomach and vomiting. Stop eating when feel satisfied, overeating will stretch stomach pouch and can cause vomiting.

Foods not to eat: Food with empty calories, alcohol as it has high calories and absorption will steadily increase after surgery. Some drink cause bloating and can increase stomach size such as fizzy drinks. High fat foods may cause nausea and will not help to lose weight. Tough meats are difficult to chew and hard to digest.

The clinical follows-up assessment was done each month through the period of study (3 times evaluation). It included general examination, assessments of vital signs and searching for symptoms and signs of anemia concentrating on the following: Headaches, fatigue, weakness, shortness of breath, dizziness, pale skin, irregular heartbeats, cold hands and feet, hair loss, brittle nail, and glossitis.

Table 1: The pre- and post-operative values of Hb, MCV, and SF

Patient code	Age/year	Sex	Preoperative tests			3 months post-operative tests		
			Hb/g/dL	MCV/fl	SF/ng/mL	Hb/g/dL	MCV/fl	SF/ng/mL
1	21	F	12.5	80	85	11	75	45
2	33	F	14	90	92	12	90	56
3	25	M	16	80	120	14	80	45
4	40	F	14.5	85	43	14	80	51
5	22	F	12	82	60	11	75	60
6	45	F	15	86	50	12	85	66
7	30	F	14	83	45	13	78	45
8	18	F	12.5	87	100	12	80	80
9	30	F	12	80	66	11.5	75	54
10	22	M	12	84	65	11	82	50
11	40	F	14	90	80	13	85	76
12	18	F	13	86	55	12	80	50
13	22	F	15	82	100	14	75	65
14	40	M	14.5	88	96	14	82	58
15	45	F	12.5	80	100	13	80	84
16	33	F	12.5	87	130	12.5	80	55
17	20	F	14	92	105	12	85	67
18	25	M	15	90	110	14	82	55
19	30	F	14	89	120	14	80	64
20	32	F	13	90	94	12	85	80
21	35	F	13	86	90	11.5	82	43
22	18	F	13.5	88	86	13	85	60
23	40	F	12	81	65	12	75	55
24	25	F	15	85	140	13	80	93
25	30	M	14	87	97	12	83	55
26	28	M	12.5	86	100	12	78	80
27	40	F	13.5	90	152	11.5	80	77
28	45	F	14	92	140	13	85	60
29	32	M	12.5	80	105	12	78	58
30	40	F	14	90	80	12.5	85	60

Hb: Hemoglobin, MCV: Mean corpuscular volume, SF: Serum ferritin

Statistical Analysis

Statistical Package for the Social Sciences (IBM SPSS version 24) was used. A statistically significant was considered with $P \leq 0.05$. Measurements are provided as mean ± standard deviation. A number of descriptive methods were used such as frequency distributive and descriptive statistical for demographic variables. A few statistical tests such as t-test paired samples and t-test two independent samples were used to examine the differences in the average measurement before and after the operation for some studied variables. Pearson's test was used to find out the relationships between some relevant variables.

Table 2: The mean, median, and mode of pre and post-operative results

Iron markers	Pre-operative			Post-operative		
	Mean	Median	Mode	Mean	Median	Mode
Hb	13.5	13.75	14	12.4	12	12
MCV	85.8	86	90	80.8	80	80
SF	92.3	95	100	61.5	59	60

Hb: Hemoglobin, MCV: Mean corpuscular volume, SF: Serum ferritin

Table 3: t-test of two Paired Samples for three variables Hb, MCV, and SF

Paired samples descriptive statistics	Mean	SD	Std. error mean
Pair 1			
Pre Hb	13.533	1.0981	0.2005
Post Hb	12.483	0.9692	0.1770
Pair 2			
Pre MCV	85.87	3.893	0.711
Post MCV	80.83	3.788	0.692
Pair 3			
Pre SF	92.37	28.440	5.192
Post SF	61.57	12.955	2.365

Hb: Hemoglobin, MCV: Mean corpuscular volume, SF: Serum ferritin

Table 4: Paired samples correlations

Pearson's correlation		*n*	Correlation	Sig.
Pair 1	Pre Hb and Post Hb	30	0.721	0.000
Pair 2	Pre MCV and Post MCV	30	0.765	0.000
Pair 3	Pre SF and Post SF	30	0.411	0.024

Hb: Hemoglobin, MCV: Mean corpuscular volume, SF: Serum ferritin

Table 5: *t*-test for independent two samples. Descriptive statistics of Hb

Descriptive statistics of Hb	Sex	N	Mean	SD	Std. error mean
Pre Hb	Male	7	13.786	1.4960	0.5654
	Female	23	13.457	0.9760	0.2035
Post Hb	Male	7	12.714	1.2536	0.4738
	Female	23	12.413	0.8874	0.1850

Hb: Hemoglobin

RESULTS AND DISCUSSION

This study aimed to assess the pre and early post-operative iron assessment in obese patients underwent LSG. This is due to the fact that LSG is one of the most widely used techniques and is account for about 37% of all range of bariatric methods achieved across the world in 2013. However, to ensure that the procedure is success, patients should adhere to comprehensive lifestyle changes. Therefore, the follow-ups practice is very important. For this purpose, a multidisciplinary team is necessary that should involve a surgeon, dietitian, psychologist, and family physician or endocrinologist.[25] Dietitians in particular have a vital role in this group before and after BS.[26] For instance, loss of medical and nutritional follow-up's patients did not achieve considerable weight reduction and they were at higher risk of developing nutritional deficiency according to several studies.[27,28]

The present study was a prospective, follow up study that included 30 patients after selection to eliminate bias, there were 23 female (76.5%) and 7 male (23.5%) patients. The median age was 30 and their age ranged from 18 to 40 years old [Table 1]. Their BMI ranged from 35 to 45 kg/m^2. All patients underwent smooth recovery without any considerable post-operative complications.

Table 1 presented the results of pre- and post-operative tests of the three markers (Hb, MCV and SF) for all patients, and the mean, median and mode of the results are presented in Table 2. The significant levels between pre-operative and post-operative for the three markers were statistically analyzed [Tables 3-5], and the Pearson correlation coefficient between pre-operative and post-operative of the three markers were calculated [Table 4].

In our study, Hb level was not significantly changed after 3 months' post-operative which means that no patient has anemia, the MCV showed insignificant decrease, while SF showed significant decrease which means that mild deficiency has been occurred. The normal ranges of Hb according to the WHO guidelines should not be <13 g/dL in men and not <12 g/dL in women.[29]

A positive correlation (r = 0.76; $P < 0.05$) was found between Hb level at pre and post-operative assessment tests. Although these values of Hb were dropped from pre-operative (mean value 13.5) to postoperative (12.4) as shown on Tables 1-4, the values were still within the normal range. This decrease may be due to the implication of the BS that often decrease the level of Hb. For example, according to the study conducted by Santos *et al*., the Hb levels were slightly decreased from pre-operative to post-operative after 3 months of surgery and were significantly decreased after 1 year of surgery.[30,31]

Similarly, the mean value of MCV showed a significant ($P < 0.05$) decrease from 85.5 at pre-operative tests to 80.8 at post-operative tests, while the normal value ranged from 80 to 100 fl. Furthermore, the mean value of SF showed a significant

Table 6: *t*-test for two independent samples with respect to sex variable and Hb

t-test for sex and Hb variables	Pre Hb		Pos Hb	
	Equal variances assumed	Equal variance not assumed	Equal variances assumed	Equal variance not assumed
Levene's test for equality of variances				
F	3.364		3.474	
Sig.	0.077		0.073	
t-test for equality of means				
T	0.688	0.548	0.714	0.592
Df	28	7.620	28	7.920
P-value	0.497	0.600	0.481	0.570
Mean difference	0.3292	0.3292	0.3012	0.3012
SE difference	0.4784	0.6010	0.4220	0.5087
95% confidence interval of the difference				
Lower	−0.6507	−1.0687	−0.5631	−0.8738
Upper	1.3091	1.7271	1.1656	1.4763

Hb: Hemoglobin

Table 7: t-test for independent two samples. Descriptive statistics of MCV

Descriptive statistics of MCV	Sex	*n*	Mean	SD	SE mean
Pre MCV	Male	7	85.00	3.873	1.464
	Female	23	86.13	3.946	0.823
Post MCV	Male	7	80.71	2.059	0.778
	Female	23	80.87	4.214	0.879

Hb: Hemoglobin, MCV: Mean corpuscular volume

($P < 0.05$) decrease from 92.3 at pre-operative tests to 61.5 in post-operative tests (Normal value 30–300 ng/mL for males, and 30–160 ng/mL for females), the statistical analyses are shown in Tables 3-7.

Recommendation of iron intake and other nutrients are available within the "Dietary Reference Intakes (DRIs)" set by the "food and nutrition board" at the "Institute of Medicine of the National Academies". DRI is the general term for a set of reference values used for planning and assessing nutrient intakes of healthy people.[31] According to the practice guidelines of the ASMBS, iron status have to be assessed at every follow-up visit following BS. In case of ID, a daily iron dosage of 150–200 mg should be provided via supplements.[24] This because of the fact that patients with BS are at high risk of suffering from ID before and after surgery.[32]

A study revealed an estimation of 15% of the prevalence of iron deficiency 1 year after sleeve gastrectomy.[33] Therefore, preoperative education is essential for better understanding the complication of LSG. In both pre-operative and post-operative, the coordination between expertise in medicine, surgery, psychology, and nutrition is required.[10]

Although the impact of variable sex on the three markers at pre-and post-operative assessment were not effective [Tables 6-10], Hb value at pre-operative for all female cases was at normal range. Whereas for seven male cases, only three cases had lower value at pre-operative assessment compared to normal range. In addition, there was a significant decrease on post-operative of the most patients. There were no significant differences in the mean value of Hb between male and female neither at pre nor at post-operative assessment. This refers that sex variable has no effect on the Hb vale.

Similarly, the results of MCV of preoperative in all case were within the normal range. However, there was a significant decrease on MCV at post-operative compared to preoperative. At preoperative assessment test, only two female cases had a value <50 ng/ml which is considered as iron deficiency. While, at postoperative assessment 4 patients had lower value than normal range.

In addition, there was a significant decrease on the value of SF for most cases from pre-operative to post-operative assessment.

Several studies have documented that iron intake after LSG is reduced below the minimal daily requirement (8.7 mg a day for men over 18. 14.8 mg a day for women).[34] In addition, some others factors make contribution to the high occurrence of iron deficiency after LSG such as failure to provide supplements consistently,[34] lack of patient adherence to supplementation,[35] the link of iron supplement with troublesome gastrointestinal side effects,[24] large gaps in dietary follow-up, and the absence of specialized nutritional care after surgery. Hence, led to iron deficiency progresses from mild iron deficiency, to iron-deficiency erythropoiesis (erythrocyte production), and finally to IDA.[36,37]

For iron supplementation following LSG, there are two phenomena of thought. Few bariatric surgeons choose to monitor laboratory levels of iron and then have patients start iron once their iron levels begin to decrease. On the other hand, others bariatric surgeons prefer to have patients start a daily

Table 8: t-test for two independent samples with respect to Sex variable and MCV

t-test for sex and MCV variables	*t*	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
				Lower	Upper
Pre MCV					
Equal variances assumed	−0.666	28	0.511	−4.606	2.345
Equal variances not assumed	−0.673	10.115	0.516	−4.866	2.605
Pos MCV					
Equal variances assumed	−0.093	28	0.926	−3.564	3.253
Equal variances not assumed	−0.132	21.515	0.896	−2.592	2.282

MCV: Mean corpuscular volume

Table 9: t-test for independent two samples. Descriptive statistics of SF

Descriptive statistics of SF	Sex	*n*	Mean	SD	Std. error mean
Pre SF	Male	7	99.00	17.166	6.488
	Female	23	90.35	31.106	6.486
Post SF	Male	7	57.29	11.041	4.173
	Female	23	62.87	13.431	2.801

Table 10: *t*-test for two independent samples w. r. to sex variable and SF

t-test for sex and SF variables	*t*	df	Sig. (2-tailed)	95% confidence interval of the difference	
				Lower	Upper
Pre MCV					
Equal variances assumed	0.699	28	0.491	−16.721	34.025
Equal variances not assumed	0.943	18.851	0.358	−10.560	27.864
Pos MCV					
Equal variances assumed	−0.998	28	0.327	−17.040	5.872
Equal variances not assumed	−1.111	11.960	0.288	−16.538	5.370

dose of iron soon after their operation to be able to prevent levels from declining. The most important thing is to continue to get blood work done as advised so iron supplementation can be adjusted as needed and can keep normal iron levels. However, sometimes patients' loss to follow-up. If there is a more effective and evidence-based guideline for repletion of iron deficiency, patients are more likely to be participated. Therefore, it is preferable to give patients who are not serious about follow-up for any reason iron treatment, since our study supported a decrease in iron stores in patients after the 3rd month of the operation.[38]

CONCLUSION

The finding data of patients participated in this study showed decrease in their SF after 3 months from operation even with adequate nutritional support but not to a level of causing IDA.

Therefore, patients undertaken LSG should start iron supplements at 3 months or earlier as the patient can tolerate the supplements. Follow-up is mandatory to detect early iron deficiency. Further assessments are needed on iron state after 6 months and 1 year and then annually to have more information about the quality of nutrition state of patients after sleeve gastrectomy.

It is suggested that iron supplements should not be used until patients have been evaluated by their primary health-care provider such as nutritionists, dietitian or their surgical team. This is to ensure that supplementations were taken appropriate and under their supervision. When patients are counseled about iron supplementation, it is important to remind them that iron supplements may be associated with GI irritation, nausea, constipation, dark stools, and abdominal pain. To prevent iron toxicities, patients using iron supplements should be reminded not to take multivitamin supplements that contain iron. Patients should be encouraged to contact their primary health-care provider if they experience any adverse effects or their symptoms worsen. To monitor their iron level, patients should be advised to maintain routine checkups.

CONFLICTS OF INTEREST

The authors confirmed that they have no conflicts of interest of the research submitted.

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