Evaluation of Nutritional Deficiency-5 Years and More Outcomes Post Laparoscopic Sleeve Gastrectomy

Elif Çırak
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
Seda Sancak
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
Ali Özdemir
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
Aziz Bora Karip
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
özgen çeler (ozgenceler1981@gmail.com)
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi https://orcid.org/0000-0001-8167-6392
Nalan Okuroğlu
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
M. Mahir Fersahoğlu
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
M. Timuçin Aydın
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
Nuriye Esen Bulut
Fatih Sultan Mehmet Eğitim ve Araştırma Hastanesi: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
Hasan Altun
Liv Hospital
Hüseyin Çiğiltepe
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi
Kemal Memişoğlu
Fatih Sultan Mehmet Training and Research Hospital: Fatih Sultan Mehmet Egitim ve Arastirma Hastanesi

Research

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Abstract

Introduction

Nowadays one of the most popular surgical method for treatment of obesity is laparoscopic sleeve gastrectomy (LSG). Data regarding long-term nutritional deficiencies following LSG are scare. We aim to assess the prevalence of nutritional deficiencies 5 years post-LSG.

Methods

We retrospectively reviewed the files of 338 patients who had LSG surgery between June 2012 and June 2019 and had preoperative data and had at least 1 year of surgery. Serum iron, ferritin, folic acid, hemoglobin and vitamin B12 levels during annual visits for six years after LSG were compared with preoperative data. Patients with missing data during follow-up were evaluated as dropout and assessments were made on patients with available data.

Results

A total of 338 patients (83% women), with a baseline BMI 46,87±6,17 kg/m2 were included. In baseline, hypoferritinemia was detected in 19.16% for <15 ng/mL cutoff and in 43.11% for <30 ng/ml cutoff value. Serum iron, vitamin B12 and folate deficiencies were exist in 37.62%, 18.64% and 4.14% of the patients, respectively. We compared this prevalances with postoperative datas and found that ferritin deficiency in follow-up visits was significantly more frequent than the baseline (p<0.001), conversely vitamin B12 deficiency was significantly less common (p<0,05).

Conclusion

Despite the supplement, our results show that the prevalence of patients with hypoferritinemia after LSG is higher than before surgery. This high prevalence may be associated with factors such as insufficient supplementation, insufficient absorption of oral preparations, and insufficient compliance to treatment.

Introduction

Bariatric surgery (BS) is currently regarded as the most effective long-term therapy for the management of patients with obesity (1). The number of bariatric procedures performed annually is rapidly increasing worldwide (1) and LSG has recently emerged as the preferred surgical option (1–3).Although LSG isconsidered as a restrictive, “food limiting” procedure due to the reduction in stomach size,restriction of distention, increase sensation of fullnessand observing the small intestine (3, 4),even so patients are at increased risk for micronutrient deficiencies postoperatively due todecreased hydrochloric acid and intrinsic factor secretion, accelerated of gastric emptying, reduced food intake because of nausea and vomitinig, poor food choices, food intolerance and changed gut hormones (5, 6).

Obesity is associated with nutritional deficiencies (7–9). Recent studies showed that detect of deficient nutrient status before surgery is important because after LSG these nutrient deficiencies can exacerbate or occur de novo, and they may result into long-term complication (10–13). Therefore correction of nutritional deficiency before surgery ensures optimal nutritional status and outcomes postoperatively (14, 15–17).

The different results after BS are depending on the duration of the study, the specific micronutrients evaluation and the vitamin supplementation program or the different type of surgery procedure (10, 13, 17–19).And there are scarce studies have investigated the nutritional status of LSG patients during a long-term follow-up of more than 5 years postsurgery (13, 17, 18, 20–25).

It has not really been determined whether standard vitamin supplementation is sufficient or whether assessment of nutritional parameters is required to adjust supplementation. The Endocrine Society has published recommendations concerning screening and supplementation of nutritional deficiencies after BS (26, 27).

The aim of this retrospective follow-up study was to determine pre-and post operative LSGnutritional deficiencies.

Materials And Methods

Subjects

This retrospective, cohort study was approved by the …………ethics board. The data of 740 patients who had LSG surgery between June 2012 and June 2019 were obtained from their records. Preoperative nutritional parameters were examined and those with a follow-up period of 1 year or more were included in the study. Only those with LSG surgery were included in the study.Patients with chronic infectious disease, malignancy or renal or hepatic dysfunction and women who were pregnant and patients receiving steroids or other immunosuppressive therapies were excluded from the study. In finale, 338 of 740 patients met the study criteria.

Clinical and Biochemical Assessment

Follow-up visits were scheduled at 12, 36, 48, 60 and 72 months by the endocrinologist or the surgeon. At each follow-up visit, anthropometric measurements and vitamin-mineral supplementation were assessed and blood was drawn for the vitamin and micronutrient analyses. Serum iron, ferritin, folate, vitamin B12 levels and complete blood count were studied in the blood sample taken. If serum iron, folate and vitamin B12 levels were below the lower limit of normal reference range were considered to be deficient.Hemoglobin values below 13g/dL in men and 12g/dL in women was accepted as anemia (28).Low ferritin was evaluated according to 2 different cutoff values, <15 and <30 ng/mL (29).We compared the postoperative prevalances with preoperative nutritional deficiency prevalances.

Patients had been advised to take multivitamins for the first postoperative year. At each follow up visit we prescribed spesific supplements if a deficiency was detected on laboratory outcomes. We treated vitamin B12 deficieny with intramuscular(IM) supplement but iron and folat deficiencies were treated orally.

Percentexcess weight loss (%EWL) wascalculated by [(presurgery weight − weight at last follow-up (kg)/(presurgery weight-ideal weight)] × 100 with ideal weight based on body mass index (BMI) of 25 kg/m^2.*Percent total weight loss (%TWL)*was calculated by (presurgery weight-weight at last follow-up (kg) / presurgery weight) x 100.

Statistical analysis

All data were analyzed usingthe IBM SPSS Statistics 22 (IBM SPSS, Turkey) package. For all istatistical tests, a P value <0.05 was considered significant. Comparision between groups were performed using the Mann-Whitney U test, Student's unpaired or paired t-test as appropriate for continuous variablesand the chi-squared for categorical variables.

Results

The study included 283 (84%) female and 55 (16%) male patients. The mean age of patients was 40.38±10 years. Pre-operative mean weight was 126.41±19.51 kg and mean BMI was 46.87±6.17kg/m^2. Eighty seven of 338 patients completed the 6-year follow-up. The number of patients who completed the 5, 4, 3 and 1-year follow-up was 138, 205, 244 and 338, respectively.When patients with and without data are proportioned, the non-follow-up rate was 20% in the first postoperative year and this rate approached 50% in the following years(Fig.1).

Weight loss outcomes

The greatest %EWL was achieved at first year after LSG.After the first year, it was observed that the patients started to gain weight again at a statistically significant level(p<0.001)(Fig. 2).

Vitamin Status in Periods of Pre- and Post-LSG

Vitamin B12

The prevalence of vitamin B12 deficiency decreased from 18.64% pre-operatively to 16.91% at 12 months post-LSG and the trend was maintained thereafter with statistically significant (p<0,05). The rate of deficiency declined to 9.33%, 8.87%, 8.14% and 8.51% at 3rd, 4rd, 5rd and 6rdpostoperative years, respectively (Table 1).

Folate

The prevelance of folate deficiency significantly increased from 4.14% pre-operatively to 8.73% at 12 months post-LSG (p<0,05). After the first year, folate deficiency decreased to preoperative levels and continued as such(Table 1).

Ferritin

Due to uncertainty in cutoff value for lowness, in our study, we investigated the prevalance of hypoferrtinemia according to two different cutoff values (<15 and <30 ng / mL).When we received the cutoff value of <30 ng / mL for hypoferritinemia, we found deficiency in 43.11% of preopretative patients and we found that the rates of patients with hpoferritinemia increased significantly in the visits after the first postoperative year(Table 1) (Fig. 3).When we received the cutoff value of <15 ng / mL for hypoferritinemia, we found deficiency in 19.16% of preoperative patients and we found that the rates of patients with hypoferritinemia increased significantly in the follow-up visits (Table 1). (Fig. 3).The increase in the rate of patients with hypoferritinemia in the postoperative years was remarkable in both cutoff values.

Serum Iron

37.38% of the patients had low preoperative serum values, and there was a statistically insignificant decrease in prevalence in post-LSG period(Table 1) (Fig. 3).

Anemia

At baseline, no anemia was detected in any male patient according to hemoglobin value. At baseline, 29.68% of women were anemic and an increase in the frequency of anemia, which did not reach statistical significance, was detected in women during the 6-year follow-up. Women with anemia also had lower serum iron and ferritin levels (p<0.001).

Patients Adherence to Supplementations

Adherence to vitamin and mineral supplement intake assessed by self-report and our results showed that adherence was low,especially for iron and vitamin B12 (Table 2).

The frequency of nutritional deficiency was not different in those who received and did not take supplements.

Discussion

The results of this study confirms the effect of LSG in weight reduction, as similarly reported in previous literature (13,17,18,20,22,24,25). Our results show that nutritional deficiencies,especially iron, are very common in the post-LSG period.Another remarkable outcome of the current study is that the rates of not coming for follow-ups of patients are very high.

According to our data, as similar to the previous literature, 18.64% of the individuals had vitamin B12 deficiency in the preoperative period (12,14,16,24,30). The frequency of vitamin B12 deficiency started to decrease from the first year and it was significantly less common in the following years compared to preoperative values, but it was still more frequent than some other studies (10,16,19,24,31). Also some studies showed an acceleration in percantage of deficiency at first year post-LSG contrast to our study (14,16,19). We thought that in the postoperative period, vitamin B12 deficiency is seen less frequently than baseline may be related to the parenteral administration of vitamin B12 replacement.Because the cause of post LSG vitamin B12 deficiency is probably the decrease of intrinsic factor and this can be overcome with parenteral administration.Our post LSG vitamin B12 deficiency rates were also lower than the literature(13,18,23-25,30).On the contrary, there are studies showing that there is no vitamin B12 deficiency in a long-term period in post-LSG patients(17,20,32).

Folic acid deficiency is mainly caused by insufficient consumption of green leafy vegetables (14).We did not observe a noticeable folate deficiency neither at the beginning nor any follow up, similar to other mediterranen countries' studies (23,24) but our percantages were lower than most of the studies (12,16,20,21,33). Only at first year after LSG we found that 8.73% of the individuals had folate deficiency and it was statistically significant increase compared to baseline.We thought that the increase in folate deficiency in the first year was related to poor food preferences rather and depleted stores than the procedure, because the proximal small intestine, the main absorption site of folic acid, is preserved in LSG surgery(10,14,31).This increase in the first year has been reported in other studies (14,20,21), but not all (12,16,33).We observed that the prevalence of folate deficiency in the visits after the first year was at preoperative levels. There are also studies reporting that folate deficiency decreases (13,20) or is never seen in long-term follow-up (17,20,23,24,32).

Serum Iron and Ferritin (storage iron) Deficiency

In LSG patients iron deficiency can be attributed to several reasons such as the decreased secretion of gastric hydrocloric acid because of the procedure (10,14,18), preoperative low ferritin levels (10), too much weight loss (10), not preffering oral iron supplements due to their gastrointestinal side effects and possible impact on weight regain, intolerances to red meat consumption and reduced appetite (18,34).Female sex and menstrual cycle are also risk factors for iron deficiency (10,12,16).

Iron deficiency is prevalent among individuals presenting for BS due to inadequate of iron intake,more iron requirement because of high blood volumes and low iron absorption due to low levels of chronic inflammation(35).In literature there is a conflict on iron deficiency definition in LSG patients. Both serum iron and ferritin levels are used to identify iron deficiency. It is still uncertain which ferritin level should be considered as a cutoff. Most of the studies were used low serum iron levels for defining iron deficiency (10,13,14,32,34).The prevalence of iron deficiency has been reported at rates ranging from 6.6% to 50.5%.Our results were consistent with the literature with a rate of 37.68%(12-14,17,23,24). We also observed a downward trend in patients with low serum iron during follow-up visits.This may be explained by taking supplements postoperatively (36).

The other studies in literature were used serum ferritin levels to identify iron deficiency (21,25,32,37,38). Ferritin is an indicator forstorage iron so it will be a better parameter for iron deficiency (29). But because of the low grade chronic inflammation in patients with obesity ferritin levels could be found false high (29,39-41). Due to postoperative weigt loss inflammation disappears and ferritin levels drop as expected (41). Inflamation affects the diagnostic value of ferritin(29,39,40). As a acute phase reactant ferritin level <40 ng/ml should be considered as a deficiency (42). If cut off take as 12-15 ng/ml spesifite is 99% but sensitivite is 57%, when it takes as 30 ng/ml sensitivite rises 92% (43). Because of these wide cutoff range, study results were all different in literature (12,17,18,21,23-25,32,37,38,44).

We evaluated our data in both cutoffs. As expected, when <30 ng / mL was taken as cutoff, more patients had hypoferritinemia than <15 cutoff.Hypoferritinemic patients significantly increased in postoperative visits compared to preopretive in both cutoff values.While the effects of iron or iron supplements taken orally appear on serum iron level immediately, there is no acute effect on ferritin level.In the postoperative visits, while the rate of patients with low serum iron decreases, the increase ofthe rate of patients with hypoferritinemia may be due to oral iron or supplements containing iron.There was no significant difference in %EWLbetween patients with and without hypoferritinemia at follow-up.Therefore, we cannot say that the increase in the frequency of hypoferritinemia is a simple result of improvement in low-grade inflammation associated with obesity due to weight loss.Interestengly, there was a negative but statistically unsignificant relationship between ferritin and %EWL in follow-up visits. However, we also found that concurrently anemia ratio was also increased and anemic patients had hypoferritinemia and lower serum iron levels. Therefore, we can think that the change in the ferritin level reflects the change in the iron state rather than a simple result of the change in the inflammation state. When we consider that anemic and hypoferritinemic patients lose more weight, we can conclude that this group of patients pay more attention to their diets with fear of gaining weight again and do not use iron or iron supplements regularly or receive insufficient dose replacement. Considering that the majority of patients in our study are premenopausal women,it is possible that changes in weight loss and menstrual status may also play a role in the increase frequency of anemia and hypoferritinemi.

Anemia

Hemoglobine is the only indicator for defining anemia (28). In our study we found 24,85% of the patients had anemia and they were all women. In our study, no anemic male patient was detected in preoperative and postoperative follow-up visits.Although anemia is more common in women in the literature, in two studies preoperative anemia ratio was found higher in men (45,46). During our study we did not find any statistically significant changes in percanteges of anemic patients (10,24,41). Our ratio was mostly higher than other studies, especially at long- term period after LSG (17,18,20,21,23,38) but lower than two studies (24,41).

Compliance and Supplement Choices

The first year compliance rates, which were around 50-60% in our study, were consistent with the other study results, but this rate decreased further in the long-term follow-up(13,17,20-22,25).

There was no significant difference in terms of any vitamin deficiency or frequency of anemia in those who used or did not use supplements during follow-up visits.Although the rates of patients receiving vitamin B12 and iron replacement were similar, there was a decrease in vitamin B12 deficiency and an increase in iron deficiency in follow-up visits.As a consequence it seems reasonable to recommend higher doses or IM/IV modules for treating iron deficiency and compliance should be stimulated.In our study, the decrease in frequency after the increase in folate deficiency in the first year may be due to both the procedure applied and the nutritional properties of our country.In the Mediterranean country where fruits and greens are not missing from the kitchen, green vegetables and fruits cannot be consumed sufficiently in the first year due to the process applied.

Unfortunately there is no consensus on the optimal supplement levels and treatment duration in literature (10,14,16,17,21,30,47,48) but still IFSO and ASMBS recommend for a long term supplementation after BS (49,50).

Limitations

The retrospective nature of our study was the most important limitation. Especially in the patient population where there was a significant number of female patients, we did not know the menstruation scheme and supplement usage before operation. We did not follow other acute phase reactants in order to control hyperferritinemia due to inflammatory status.

We did not question the frequency of nausea and vomiting that caused folic acid deficiency in the first year. Also we did not analyze the PPI usage rates in terms of iron and vitamin B12 deficiency that may occur due to regular use. The fact that, deficiencies in the desired blood tests in the control visits, verbal evaluation based on patient compliance; it could contribute to results.

Conclusion

Micronutrient-related abnormalities are important to detect and treat before surgery because they can worsen postsurgery. Based on our results for supplement choices we can say that IM vitamin B12 is a better option for treating deficiency and oral iron supplements were not adequate to treat deficiency. Also we should consider that this available data for long term after LSG, belongs to 50% of the patients and that may be suggest that patients who do not come, do not apply because they have no complaints or perhaps there is a much higher level of nutritional deficiency.

The other important point was deciding which level of ferritin is correct for detecting iron store deficiency. Although at first we took ferritin below 15 ng/ml as a deficiency we have noticed that we missed many patients who had actually an iron store deficiency and because of this these patients had been left untreated. In patients with obesity we should not forget ferritin is an acute phase reactant and below 30 ng/ml must defined as a deficiency. Supplementation should be tailored for patient in every follow-up laboratory results and complaints.

Due to our retrospective designed study and compliance was asked only for verbal we could not detect which multivitamin dosage or period was adequate to treat or prevent deficiencies so this should be another study’s main point.

Abbreviations

Laparoscopic sleeve gastrectomy (LSG)

Body mass index (BMI)

Bariatric surgery (BS)

Intramuscular (IM)

Percentexcess weight loss (%EWL)

Percent total weight loss (%TWL)

Intravascular (IV)

International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO)

American Society for Metabolic and Bariatric Surgery (ASMBS)

Proton-pump Inhibitors (PPI)

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Consent was obtained from all individual participants included in the study.

Consent for publication

The authors all consent for publication of all the data, materials, tables and figures from this article.

Availability of data and materials

Data and materials are available with the permission of all the authors.

Competing interests

The authors state that they have no conflict of interest.

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Authors' Contributions

Elif Çırak Data collection, writing the article

Seda Sancak Conception and design of the work, analysis and interpretation of data, statistical analysis, overall responsibility

Ali Özdemir Final approval of the article, statistical analysis

Aziz Bora Karip Critical revision of the article, statistical analysis

Özgen Çeler Writing the article

Nalan Okuroğlu Conception and design of the work, analysis and interpretation of data, Timuçin Aydın Data collection

Nuriye Esen Bulut Data collection

M. Mahir Fersahoğlu Data collection

Hasan Altun Critical revision of the article

Hüseyin Çiğiltepe Critical revision of the article

Kemal Memişoğlu Final approval of the article

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Seda Sancak, as principal investigator, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Authors' information

Elif Çırak https://orcid.org/0000-0002-8697-4011,cirakelif@hotmail.com

Seda Sancak https://orcid.org/0000-0003-0072-5901, drsedasancak@gmail.com

Ali Özdemir: https://orcid.org/0000-0002-8087-9654 alemoz2004@yahoo.com

Aziz Bora Karip https://orcid.org/0000-0001-9396-6055, borakarip@gmail.com

Özgen Çeler https://orcid.org/0000-0001-8167-6392,ozgenceler1981@gmail.com

Nalan Okuroğlu: https://orcid.org/0000-0002-0814-2359nokuroglu@yahoo.com

M. Mahir Fersahoğlu https://orcid.org/0000-0003-2526-1832,fersahoglu@yahoo.com

Timuçin Aydın https://orcid.org/0000-0003-2835-5308, mtimucina@gmail.com

Nuriye Esen Bulut https://orcid.org/0000-0002-4845-8964,nuriyeesenbulut@hotmail.com

Hasan Altun https://orcid.org/0000-0003-4978-5585,haltun@hotmail.com.tr

Hüseyin Çiğiltepe https://orcid.org/0000-0003-3048-1784, drciyiltepe@hotmail.com

Kemal Memişoğlu https://orcid.org/0000-0002-9486-4648,cerrah@gmail.com

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Tables

Table 1 Prevalence of deficiency (%) of nutritionalparameterspre-operationandover 6 years post LSG

	Pre-operation		1 year			3 years			4 years			5 Years		
	n/N	Def (%)	n/N	Def (%)	P	n/N	Def (%)	P	n/N	Def (%)	P	n/N	Def (%)	P
Ferritin≤15 ng/ml	64/334	19,16	96/273	35,16	<0.001	69/147	46,94	<0.001	73/124	58,87	<0.001	45/85	52,94	<0.
Ferritin≤30 ng/ml	144/334	43,11	135/273	49,45	0,119	101/147	68,71	<0.05	92/124	74,19	<0.05	59/85	69,41	<0.
Vitamin B12	63/338	18,64	47/278	16,91	ns	14/150	9,33	<0.05	11/124	8,87	<0.05	7/86	8,14	<0.
Folate	14/338	4,14	24/275	8,73	<0.05	8/149	5,37	ns	4/124	3,23	ns	3/85	3,53	ns
Serum Iron	79/210	37,62	50/220	22,73	ns	20/96	20,33	ns	27/86	31,40	ns	12/64	18,75	ns

P valuederivedfromChi-square test

ns: nonsignificant

n: number of patientswho had deficiency

N: total number of patientswho had laboutcomes

Table 2 Adherencetosupplement

	1year (n/N)	3year (n/N)	4year	5year	6year
Iron	48,72% (115/273)	39,46% (62/147)	37,9% (51/124)	29,41% (27/85)	35,56% (16/45)
Vitamin B12	60,43% (168/278)	39,33% (64/150)	29,84% (39/124)	33,72% (31/86)	42,55% (20/47)
Folate	25,09% (69/275)	14,09% (21/149)	11,29% (14/120)	14,12% (12/85)	13,04% (6/46)

n: number of supplementusers

N: number of total patientswho had beenreached

Figures

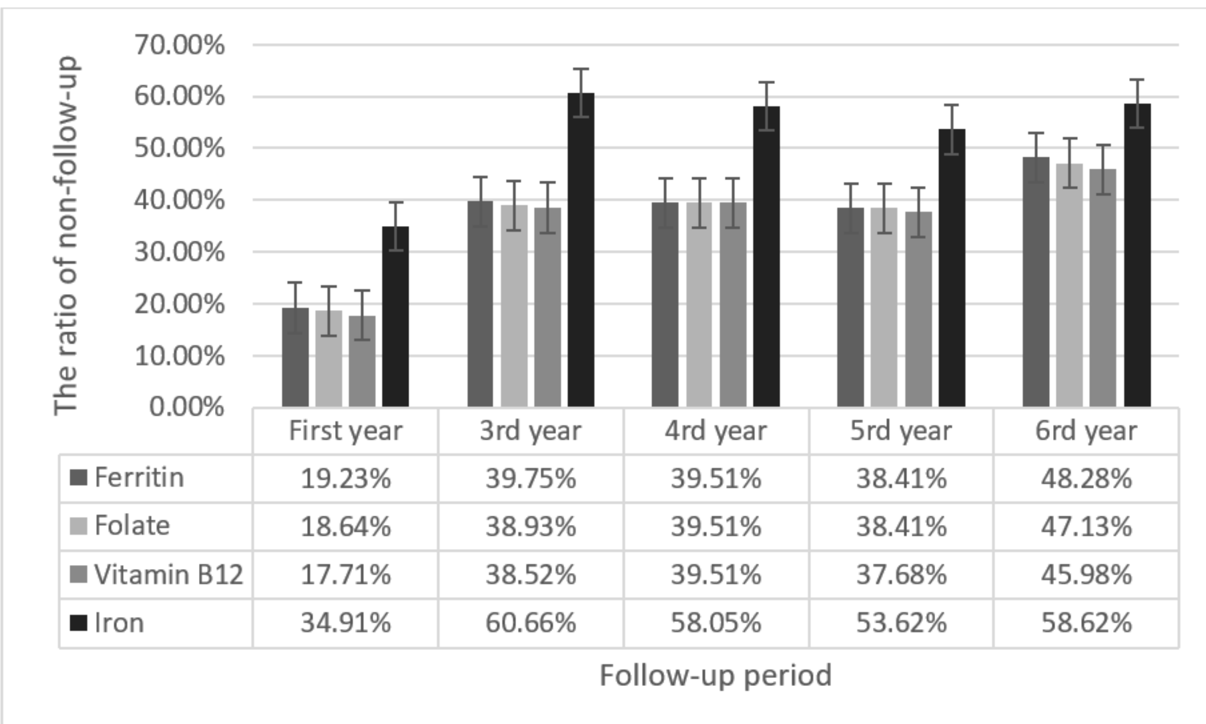

Figure 1

Non-follow-up rates in the postoperative period

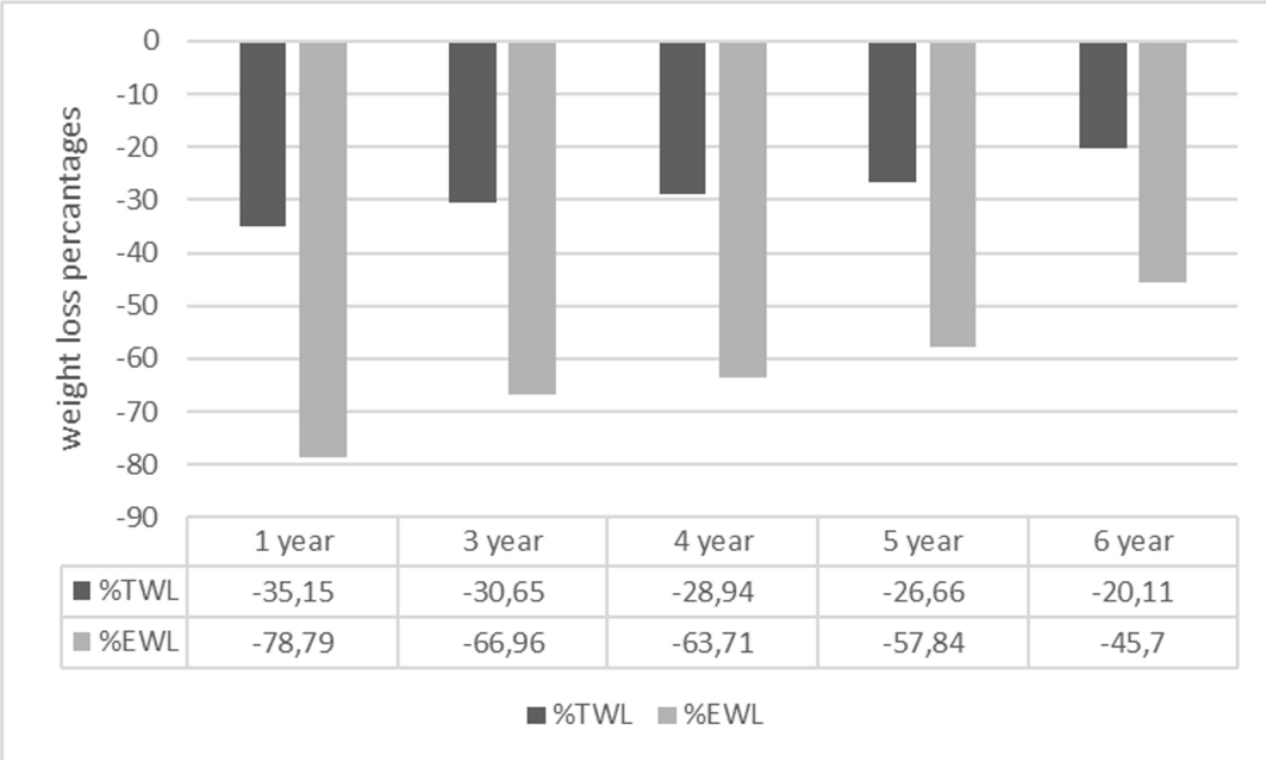

Figure 2

%Total weightloss (TWL) and %excessweightloss (EWL) outcomes of patients post LSG.

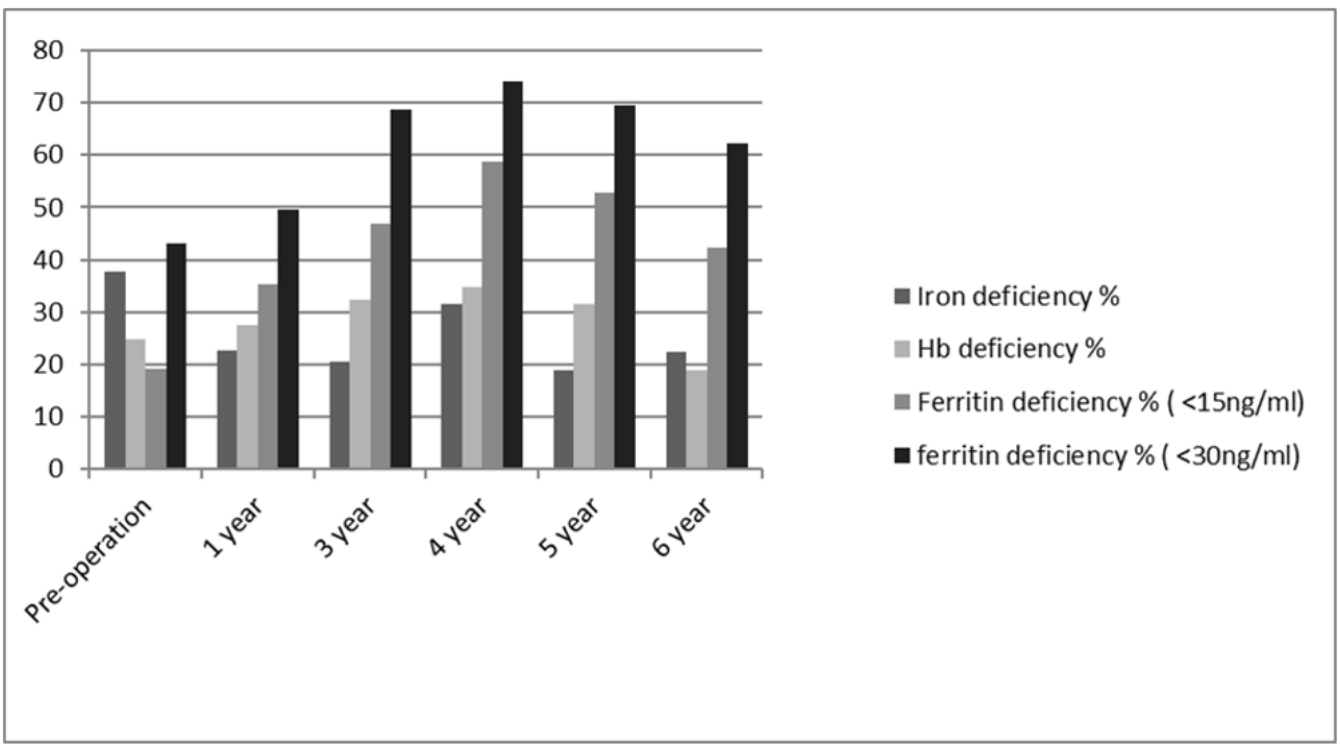

Figure 3

Proportion of patientswithanemia, low serum ironandhypoferritinemiabeforeandaftersurgery