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Comparison of Iron, Iron Binding Capacity and Ferritin Levels After Laparoscopic Bariatric Surgery

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ABSTRACT Objective: Obesity is a worldwide disease affecting more than 300 million adults, BMI greater than 30. The incidence of obesity in Turkey is increasing. Laparoscopic bariatric surgery is an effective procedure for weight loss. The aim of this study was to investigate patient nutritional deficiencies in terms of iron, total iron binding capacity and ferritin parameters following laparoscopic bariatric surgery. **Material and Methods:** A retrospective study was done on preoperative and postoperative laboratory results of randomly selected 100 patients who underwent laparoscopic bariatric surgery since 2011. Standard surgical techniques were applied in both laparoscopic gastric plication (LGP) and laparoscopic sleeve gastrectomy (LSG). **Results:** Randomly selected 100 patients (female: male=75:25) with a mean age of 38.1 year (range:16-60). Overall average Body Mass Index (BMI) of the patients was 46.9 kg/m^2. 62 of patients were applied LGP, on the other hand 38 of them were applied LSG.Iron, total iron binding capacity and ferritin levels were compared preoperatively and postoperatively (3th month after operation) in both surgical techniques. Decrease in iron and total iron-binding capacity levels and increase of ferritin levels were found statistically significant ($p<0.0001$). **Conclusion:** Nutritional deficiencies resulting from the bariatric surgery can be detected by routine laboratory screening. In this study we also review the current knowledge of nutritional deficits in obese patients and those that commonly appear after bariatric surgery, especially iron, total iron binding capacity and ferritin levels. Our results show that supplementation should suggest routinely.

Key Words: Obesity; bariatric surgery; iron; ferritins; malnutrition

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Obesity is a worldwide disease affecting more than 300 million adults, BMI greater than 30.[1]

The incidence of obesity in Turkey is increasing. Laparoscopic bariatric surgery, Laparoscopic Sleeve Gastrectomy (LSG) and Laparoscopic Gastric Plication (LGP), is an effective procedure for weight loss. Due to an increase in bariatric surgical procedures, complications associated with LSG and LGP should be understood and learned dealing with them. Delayed complications include nutritional deficiencies like iron.

The aim of this study was to investigate patient nutritional deficiencies in terms of iron, total iron binding capacity and ferritin parameters following laparoscopic bariatric surgery (LSG and LGP).

MATERIAL AND METHODS

A retrospective study was done on preoperative and postoperative laboratory results of randomly selected 100 patients who underwent laparoscopic bariatric surgery since 2011. Patients who completed post operative duration after 3 months, were selected for study.

38 of them were in LGP group and 62 of them were in LSG group. Blood samples were taken from the selected patients and iron, iron binding capacity and ferritin levels were detected after 3 months.

LSG AND LGP PROCEDURES

LSG and LGP procedures are kind of restrictive bariatric surgical procedures for the management of morbid obesity. LGP was performed in the French position in a 30° reverse Trendelenburg position. The surgeon stood between the patient's legs with assistants on both sides. Pneumoperitoneum was established to 15 mmHg using a Veress needle. The first trochar for camera was inserted 15cm distal to the xiphoid process, and the abdominal cavity was reflected outwards. Another trocar was placed on the epigastric angle, and the liver was retracted superiorly using a fan retractor. Then, two trocars were placed on the right and left upper quadrants. The dissection of the greater curve and the division of the short gastric vessels began 5-6cm proximal to the pylorus and extended to the angle of His. The greater curvature of the stomach was plicated from the angle of His with non-absorbable suture. At that point, approximately 75-80% of the stomach was plicated and this portion of stomach was left out from the digestive system.

LSG was performed at the patient is in a supine position with the arms spread apart. Pneumo-peritoneum is achieved using a closed technique with a Veress needle placed in the upper umbilicus area of the abdomen. Two 10 mm ports are placed in the supra-umbilical and right mid-abdominal areas. An additional 5 mm port is placed in the left mid-abdomen to pass the stapler to help retracting the left lobe of the liver medially. Finally, two additional 15 mm ports are placed in the left and right upper quadrants of the abdomen. The stomach is decompressed by placing an oro-gastric tube at the beginning of the operation. The surgeon stands to the patient's right with the first assistant standing to the patient's left. The angle of His is taken down bluntly using the dissector, exposing the left crus of the diaphragm. Dissection is started about 4 cm proximal to the pylorus by taking down the gastrocolic ligament using the Harmonic Scalpel Dissection is carried out proximally toward the short gastric vessels. This releases attachments to the greater curvature of the stomach and gastric fundus. The oro-gastric tube is then removed and replaced by a 32-French bougie placed in the stomach by the anesthesiologist and guided by laparoscop to sit in the lesser curvature of the stomach just distal to the pylorus. A 60 mm Endo GIA tri-stapler is then used to divide the stomach. We use two green cartridges initially to divide the distal stomach, starting 6 cm proximal to the pylorus. Next, 4-6 60 mm blue cartridges are used to complete the division of the remainder of the stomach. The specimen is then taken out of the abdominal cavity through the 15 mm port. The bougie is then removed, and intra-operative gastroscopy is performed with air insufflation and methylene blue to check any leaks.

Oral taking is off until postoperative day 3. A clear fluids diet is subsequently initiated about postoperative day 3. After the toleration of regimen 3 about post operative day five, the patient will be discharged. There was no detected early and late complication. Moreover, blood transfusion was not required any patient.

RESULTS

In our study, randomly selected 100 patients (female: male=75:25) with a mean age of 38.1 year (range: 16-60). Overall average Body Mass Index (BMI) of the patients was 46.9 kg/m^2.

Iron, total iron binding capacity and ferritin levels were compared preoperatively and postoperatively. Decrease in iron and total iron-binding capacity levels and increase of ferritin levels were found statistically significant ($p<0.0001$).

Before operation both iron and iron binding capacity levels are normal. Standart deviations are on the tables below. Table 1 shows iron, iron binding capacity and ferritin levels of patients and p values preoperatively and postoperatively. Table 2, 3 and 4 show iron, iron binding capacity and ferritin levels of patients and p values preoperatively and postoperatively according to the subgroups as LGP and LSG.

DISCUSSION

Nutritional deficiencies are common after bariatric surgery. The etiology is multi-factorial owing to impaired absorption and decreased oral intake. Routine blood work is therefore warranted after bariatric surgery to diagnose iron deficiency. At our institution, we routinely monitor patients' serum iron, total iron binding and ferritin levels at 3 month after surgery and treat them accordingly, if necessary.

In our study, it is realized that iron levels decrease comparatively and this can be related with the metabolism of iron absorption. Indeed, physiology of iron absorption begins at the low ph meter in stomach and continues with the duodenum. In both operation, the surface of absorption decreases duo the restrictive procedures. Moreover, parietal cells secreting the HCl acid located at fundus and corpus of stomach are affected in both procedures. Decreased acidity causes decrease of iron absorption. On the other hand, decrease in oral intake can be cause decrease iron level. Postoperatively, oral intake of patients stops until the discharge of gas and feces approximately 3th day.

The availability of inorganic iron for absorption in the small intestine is largely depend on its physical and chemical state when it reaches the point of entry into the epithelial cells of the jejunum. This state is influenced by intraluminal factors both in the stomach and the upper intestine. Iron absorption can be increased in achlorhydric subjects by the administration of hydrochloric acid and in anemic patients iron absorption is correlated with the amount of intrinsic acid secretion.[2] Ferric ions normally undergo polymerization followed by precipitation when acid solutions are brought to neutrality and ferrous ions in similar conditions tend to be oxidized to ferric forms. Acid limits the polymerization of iron in solution and prevents protein binding so that at a low pH it is in a reactive state and potentially available for absorption.[3]

Beutler, Fairbanks, and Fahey found that normal gastric juice contains substances that stabilize iron and prevent it from being precipitated at raised pH.[4] When the pH of an inorganic iron solution is raised eventual precipitation can only be prevented if soluble complexes are formed with other substances. The present study confirms that normal gastric juice contains substances which combine with iron in this way at a low pH and maintain it in a soluble form at neutral pH. This reaction is responsible for the availability of iron in a suitable state for absorption when it reaches the small intestine.[4]

Secondly, Iron Binding Capacity levels decreased in this study. Levels were lower in normal-

TABLE 1: Preoperative and postoperative iron, iron binding capacity and ferritin levels of patients and p values.

		Pre-Operative			Post-Operative		
100 Patients	Age (years)	Iron (g/dL)	TIBC (ug/dL)	Ferritin (ng/mL)	Iron (g/dL)	TIBC (ug/dL)	Ferritin (ng/mL)
Mean	38,1	61,8	371,69	56,697	44,485	323,06	74,915
Median	38	55	369	31,35	35,5	318,5	44,3
Min-Max	(16-60)	(16-158)	(67-498)	(0,50-544,50)	(4-148)	(136-498)	(4,90-467)
Std Dev	10,506	28,307	60,193	77,228	30,189	58,4	90,485
Std Err	1,05	2,83	6,019	7,722	3,018	5,84	9,048
Distribution		not	normal	not			
P		P<0.0001*	P<0.0001**	P<0.0001*			

TIBC: Total iron binding capacity, Std Dev: Standard deviation, Std Err: Standard error, *Wilcoxon, ** Paired samples test.

TABLE 2: Preoperative and postoperative iron levels of patients and p values.

Iron (g/dL)	pre-op	post-op	p value
LGP	62,27±27,8	47,23±32,2	
LSG	60,81±27,99	37,19±23,07	0,00
P Value	0,959	0,126	

TABLE 3: Preoperative and postoperative iron binding capacity levels of patients and p values.

Total Iron Binding Capasity (ug/dL)	pre-op	post-op	p value
LGP	366,5±63,69	320,01±55,69	
LSG	378,61±49,65	324,23±66,04	0,00
P Value	0,407	0,879	

TABLE 4: Preoperative and postoperative ferritin levels of patients and p values.

Ferritin (ng/mL)	pre-op	post-op	p value
LGP	84,77±141,04	92,22±123,23	0,26
LSG	90,8±211,68	218,33±382,2	0,03
P Value	0,322	0,997	

weight individuals compared to the obese patients. The mechanism underlying the reduced iron status in obese individuals remains to be clarified. Iron depletion might result from the increased iron requirement of obese people because of their larger blood volume and/or their consumption of energy-dense, nutrient-poor foods.[5,6] Decrease in the level of iron binding capacity can be also explained with the time of blood samples' receipt. In our study, the last samples were taken at third month. It could cause inadequate increase in the level of iron binding capacity to future iron deficiency anemia; on the other hand it could not explain the level of decrease.

Thirdly, according to the ferritin levels, the level of increase was realized. Ferritin is a protein found inside cells that stores iron so the body can use it later. According to the decrease in iron level, we expect reduction in ferritin levels. However, there is an increase in ferritin levels in both groups, especially a significant incrase in LSG. It depends on the acute phase reactivity characteristics' of ferritin due to the gastric operation. Plasma ferritin concentration is affected by a number of factors other than the amount of storage iron and inflammatory activity. Other conditions known to influence plasma ferritin levels include tissue necrosis, damage to ferritin-rich tissue, infections, neoplastic disease, increased red blood cell turnover, malnutrition as in anorexia nervosa and surgery.[7] Operation is the origin of an inflammatory process. Increase in ferritin levels can be explained with this process and date of taken blood samples.

Increasing BMI has been associated with low serum iron and hemoglobin as well as elevated serum ferritin levels. These findings may be explained by the low-grade chronic inflammation of obesity and have been implicated in many obesityrelated problems. Subjects may have subclinical abnormalities in iron status without anemia. Thus, routine screening for serum ferritin and serum iron with obese patients should be considered to assess the body iron store and the risk for developing anemia.

Some limitataions of our study include: First of all, these results can occur due to oral intake deficiency, especially post-operative duration. On the other hand, this deficiency can be seen preoperatively. Secondly, iron deficiency is very common in our country.

There are no literature knowledge about these parameters after bariatric surgeries, For this reason, this work is a pilot study for further studies.

We recommend close monitoring of the iron status for people with obesity the patients with identified iron decrease should receive iron supplements.

CONCLUSION

LSG and LGP are effective procedures for the surgical management of morbid obesity. Therefore, the number of patients undergoing this procedure will continue to rise. Understanding of common complications and available treatment options is essential for all practicing general surgeons. This paper offers basic nutritional importance of complications after bariatric surgery. Nutritional deficiencies resulting from the bariatric surgery can be detected by routine laboratory screening. In this study we also review the current knowledge of nu-tritional deficits in obese patients and those that commonly appear after bariatric surgery, especially iron, total iron binding capacity and ferritin levels. Our results show that close follow up protocol and supplementation should suggest routinely.

In conclusion, this study will be a guide for our future prospective study with their long term results.

Conflict of Interest

Authors declared no conflict of interest or financial support.

Authorship Contributions

Opinion/Concept: To create the hypothesis or idea of research and/or article: Fatih Çelebi; Design Designing the way to achieve the results: Merve Tokoçin; Inspection/Consultancy Organizing, supervising and taking responsibility for the conduct of the Research/Study: Atilla Çelik; Data Collection and/or Treatment Taking responsibility for the follow-up of patients, collection of relevant biological materials, organization and reporting of data, conducting experiments: Talar Vartanoğlu; Analysis and/or Consideration: Taking responsibility for the logical evaluation and conclusion of findings: Onur Tokoçin; Resource Agreement: Take responsibility for the search for resources required for work: Rıza Kutaniş; Complete Writing: Take responsibility for the writing of all or most important parts of the work: Talar Vartanoğlu.

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