T.C.
YEDITEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
DEPARTMENT OF NUTRITION AND DIETETICS

EFFECTS OF WEIGHT LOSS PERCENTAGE ON VITAMIN AND MINERAL LEVELS IN PATIENTS UNDERGOING SLEEVE GASTRECTOMY

Buse YAZAN

MASTER OF THESIS

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Istanbul, 2019

APPROVAL

TEZ ONAYI FORMU

Kurum : Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü

Program : Beslenme ve Diyetetik Anabilim Dalı

Tez Başlığı : Sleeve Gastrektomi Geçiren Hastalarda Kilo Kaybı Yüzdesinin Vitamin ve Mineral Seviyelerinin Değişimine Etkisi

Tez Sahibi : Buse YAZAN

Sınav Tarihi : 29.03.2019

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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu'nun 29/03/2019... tarih ve 2019/05-06... sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ
Sağlık Bilimleri Enstitüsü Müdürü

DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

29.03.2019

Buse YAZAN

ACKNOWLEDGEMENTS

I would like to express my gratitude to Prof. Dr. Nurullah BULBULLER for sharing his patients' data with me for this study. It was a great privilege to have his genuine support and guidance throughout this process.

I would like to thank my thesis advisor Assist Prof. Dr. Hülya DEMIR for supporting me in every step and sharing her enthusiasm and encouragement along the process.

Lastly, I am also thankful for my amazing family -my mother, sister, cousin, brother-in-law- and friends for their infinite support and patience.

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LIST of SYMBOLS and ABBREVIATIONS

1st	First
3rd	Third
6th	Sixth
kg	Kilogram
G	Gram
µg	Microgram
ng	Nanogram
pg	Picogram
kcal	Kilocalorie
m	Meter
cm	Centimeter
mm	Millimeter
α-TE	Alpha-tocopherol
AGB	Adjustable Gastric Banding
ALT	Alanine Aminotransferase
ASMBS	American Society for Metabolic and Bariatric Surgery
AST	Aspartate Aminotransferase
BMI	Body Mass Index
BPD+DS	Biliopancreatic Diversion with Duodenal Switch
CB1	Cannabinoid Receptors
D25(OH)D	25-Hydroxy Vitamin D
EBWL	Excess Body Weight Loss
FDA	Food and Drug Administration
GGT	Gamma-Glutamyl Transpeptidase

GHO	Global Health Observatory
HbA1c	Hemoglobin A1c
HDL	High Density Lipoprotein
IU	International Unit
LCDs	Low-Calorie Diets
LDL	Low Density Lipoprotein
LSG	Laparoscopic Sleeve Gastrectomy
NCD RisC	Non-communicable Disease Risk Factor Collaboration
NCSS	Number Cruncher Statistical System
NE	Niacin Equivalent
O_2	Oxygen
PTH	Parathyroid Hormone
RDA	Recommended Daily Allowance
RE	Retinol
RYGB	Roux-En-Y Gastric Bypass
SHPT	Secondary Hyperparathyroidism
TSH	Thyroid-Stimulating Hormone
TURDEP	Turkey Diabetes, Hypertension, Obesity and Endocrinology Diseases Prevalence
USA	United States of America
VLCDs	Very Low-Calorie Diets
WHO	World Health Organization

ABSTRACT

Yazan, B (2019). Effects of Weight Loss Percentage on Vitamin and Mineral Levels in Patients Undergoing Sleeve Gastrectomy. Yeditepe University, Institute of Health Science, Department of Nutrition and Dietetics, Master Thesis, İstanbul.

The study was conducted as a retrospective clinical research with 41 obese patients underwent Laparoscopic Sleeve Gastrectomy (LSG) at Antalya Lara Anatolian Hospital. Data had been collected for 2 years period (01.01.2016-01.02.2018) were evaluated and 41 people were selected among records. Clinical findings and anthropometric measurements of patients were evaluated in the postoperative 1st month, 3rd month and 6th month and preoperative period. Data includes biochemical values which are vitamin D, vitamin B12, folic acid, sodium, potassium, calcium, zinc, magnesium, phosphorus, iron, uric acid, glucose, hemoglobin A1c (HbA1c), parathyroid hormone (PTH), thyroid-stimulating hormone (TSH), albumin, total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), triglyceride and anthropometric measurements which include weight and height. The aim of this study is to determine the effect of weight loss percentages on some micronutrient levels in the first 6 months while bariatric patients were using multivitamin supplementation. Vitamin D, vitamin B12, folic acid, sodium, potassium, calcium, phosphorus, iron and magnesium mean values increased compared to preoperative measurements. Only zinc values linearly decreased but the mean values were not measured as a deficiency in any month. The weight loss percentages were calculated, and the percentages were achieved expectedly when evaluated according to the literature. These weight loss percentages were respectively; 11.80%, 22.67%, 31.24%. When all data was evaluated, the correlation analysis results indicated that the difference in weight loss percentage in patients was not related to the change in micronutrient values except folic acid.

Keywords: obesity, sleeve gastrectomy, micronutrient deficiency, weight loss, nutrition

ÖZET

Yazan, B (2019). Sleeve Gastrektomi Geçiren Hastalarda Kilo Kaybı Yüzdesinin Vitamin ve Mineral Seviyelerinin Değişimine Etkisi. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Beslenme ve Diyetetik Bölümü, Master Tezi. İstanbul.

Bu çalışma, retrospektif klinik araştırma olarak Antalya Lara Anadolu Hastanesi'nde Laparoskopik Sleeve Gastrektomi (LSG) ameliyatı geçirmiş olan 41 obez hasta ile gerçekleştirildi. 01.01.2016 - 01.02.2018 tarihleri arasında 2 yıl boyunca kaydedilmiş olan veriler değerlendirilerek uygun kayıtlardan seçinlen 41 kişi çalışmaya dahil edildi. Klinik bulgular ve hastaların antropometrik ölçümleri postoperatif 1. ay, 3. ay ve 6. ayda ve preoperatif dönemde değerlendirildi. Preoperatif ölçüm genellikle ameliyattan 1 gün önce yapıldı. Veriler, D vitamini, B12 vitamini, folik asit, sodyum, potasyum, kalsiyum, çinko, magnezyum, fosfor, demir; ek olarak ürik asit, glukoz, hemoglobin A1c (HbA1c), paratiroid hormonu (PTH), tiroid uyarıcı hormon (TSH), albümin, toplam kolesterol, yüksek yoğunluklu lipoprotein (HDL), düşük yoğunluklu lipoprotein (LDL), trigliserit biyokimyasal değerlerini ve antropometrik ölçümlerden boy ve kilo değerlerini içerir. Bu çalışmanın amacı, multivitamin takviyesi kullanan bariatrik hastalarda ilk 6 ayda kilo kaybı değişim yüzdelerinin bazı mikro besin düzeylerine etkisini belirlemektir. Yapılan değerlendirmelere göre; D vitamini, B12 vitamini, folik asit, sodyum, potasyum, kalsiyum, fosfor, demir ve magnezyum değerleri preoperatif ölçümlere göre arttı. Sadece çinko değerleri azaldı ancak ortalama değerler hiçbir ayda eksiklik olarak ölçülmedi. D vitamini ortalama değeri preoperatif ölçümde yetersizlik sınıfındaydı ancak postoperatif ölçümlerde ortalama değerler optimal seviyelere ulaştı. Kilo kaybı yüzdeleri ameliyat sonrası 1. ay, 3. ay ve 6. aylarda hesaplandı. Bu kilo kayıp yüzdeleri sırasıyla; 11.80%, 22.67%, 31.24% idi. Tüm veriler değerlendirildiğinde korelasyon analizi sonuçları, hastalarda kilo kaybı yüzdesinin, folik asit dışındaki diğer mikro besin değerlerinde meydana gelen değişiklikler ile ilişkili olmadığını göstermiştir. Folik asit değişimi ve kilo kaybı ilişkisi ameliyat öncesi ve ameliyat sonrası 1. ay ölçümleri aralığında istatistiksel olarak ($p<0.05$) anlamlı bulunmuştur.

Anahtar Kelimeler: obezite, sleeve gastrektomi, mikro besin eksiklikleri, kilo kaybı, beslenme

1.INTRODUCTION

Obesity is a chronic disease related to increased body mass by many causes. The prevalence has increased rapidly in the past 30 years (1). Worldwide estimates (2) declared that there are over 500 million obese people greater than the age of 18 years. Therefore, research on treatment methods related to obesity has gained importance.

Treatment of obesity is not an easy process. The treatments have demonstrated limited efficacy with a diet, exercise, behavioral change, medical treatment, pharmacotherapy to weight control for long. With these treatment methods, loss of 5-10% of initial body weight is observed (3-5). When all treatment methods were evaluated, obesity treatment required a multidisciplinary approach.

There are different types of bariatric surgery and all types make an alteration of the digestive system. All interventions cause either a restrictive, malabsorptive or both effects (6-10).

It is thought that bariatric surgery may increase existing deficiencies or lead to a decrease in normal micronutrient levels. (11). Laparoscopic Sleeve Gastrectomy (LSG) is a restrictive surgical method in which a curved portion of the stomach is resected, and a tube shape stomach remains. (12). LSG reduces food intake with many factors and thus changes the body weight (13). While some studies argue that there will be no malnutrition development in this process, there are also conflicting studies (14, 16).

1.1 Obesity

Based on the general opinion if the daily energy intake is higher than the daily energy consumption, this energy is stored in the body as adipose tissue, and the chronic progression of this condition causes obesity (17). Obesity has been defined as a disease that is associated with the high adipose tissue to non-fat body mass ratio. Adipose tissue increased compared to other tissues (18).

There are many factors such as environmental, hormonal, genetic, sociocultural and behavioral factors that cause obesity. (19-21). Obesity brings with it very risky situations; it has been correlated with an increased hazard ratio for mortality (22).

Metabolic, physiological and psychosocial results of obesity have a significant relationship with health problems, including hypertension, coronary artery disease, diabetes, dyslipidemia, cancer, sleep apnea, and osteoarthritis (23).

1.2 Clinical Evaluation of Obese and Overweight Patients

1.2.1 Anthropometric Evaluation

Body mass index (BMI) is a criterion for the definition of weight classification in adults. BMI is described as a person's weight in kilograms (kg) divided by the square of his or her height in meters (kg/m^2).

World Health Organization (WHO) describes overweight and obesity for adults as follows: Class of overweight BMI is greater than or equal to 25 kg/m^2, and class of obesity BMI is greater than or equal to 30 kg/m^2.

WHO international obesity classification based on BMI. Details are shown in Table 1.1 (25)

Table 1.1 Classification of BMI (kg/m^2)

Nutritional Status	**BMI kg/m^2**
Underweight	<18.5
Normal weight	18.5 - 24.9
Pre-obesity	25.0 – 29.9
Obesity	≥30.0
Obesity class I	30.0 – 34.9
Obesity class II	35.0 – 39.9
Obesity class III	≥40.0

The body fat amount and body composition are correlated with the risk of overweight and obesity too.

In addition to BMI, Triceps skinfold measurement is also used to determine obesity. Female with greater than 30 mm and male with greater than 23 mm are considered overweight according to this method (18).

Another measurement associated with obesity is waist circumference. If the waist circumference greater than 80 cm for female and greater than 94 cm for male that measurements are correlated to obesity (18). It should be measured at the level of the iliac crest.

And the other measurement is the waist-hip ratio. If this ratio of greater than 0.85 in female and greater than 0.9 in male and also correlates with increased cardiovascular risk (26).

There is another classification based on the excess body fat and where it is stored in the body. There are two different body types. If excess body fat is stored on the lower part of the body, it is called Gynoid Type. People with gynoid type have a small bust, narrow shoulders, and waist, large hips and thighs. If excess body fat is stored on the upper part of the body, it is called Android Type. People with android type have a large chest, extensive abdomen, and slim legs.

Linking obesity to cardiometabolic risk, body fat distribution and waist circumference is more important than measuring percentage body fat or BMI alone. People who accumulate visceral fat and have higher waist circumference (metabolic obesity) are under a clinically important risk for metabolic disorders than have with the same BMI or the same percentage of body fat but a lower waist circumference (27).

Table 1.2 Classification of Overweight and Obesity by BMI and Waist Circumference (28)

Classification	BMI		Waist	
	BMI (kg/m^2)	Comorbidity Risk	Waist Circumference* and Comorbidity Risk	
			Male ≤ 102 cm Female ≤ 88 cm	Male > 102 cm Female > 88 cm
Under weight	<18.5	Low but other problems		
Normal weight	18.5 - 24.9	Average		
Overweight	25 – 29.9	Increased	Increased	High
Obese class I	30 – 34.9	Moderate	High	Very high
Obese class II	35 – 39.9	Severe	Very high	Very high
Obese class III	≥ 40	Very severe	Extremely high	Extremely high

BMI = body mass index *An increased waist circumference may show increased disease risk even at a normal weight.

A study including a recent international research data of about 4 million individuals from 189 studies has shown that a BMI value above 25 kg/m^2 is correlated with increased mortality rate. It has risk of chronic diseases as well (29).

1.2.2 Biochemical Evaluation and Patient History

In addition to anthropometric measurements, some assessments are required for the correct approach to patients.

Biochemical assessment and patients' history are necessary to determine the general nutritional status and comorbidities of the patient. Also determine to the severity

of the comorbidity. According to this information, the scope of the treatment to be applied can be evaluated.

The most important biochemical tests used to determine general nutritional status are: Hemoglobin, Hematocrit, Albumin, Blood Glucose and Glycosylated Hemoglobin.

Tests related to liver and lipid profile the criteria are we can have information about Cardiovascular risk and liver fatigue (hepatosteatosis). The most commonly used values for the detection of hepatosteatosis are gamma-glutamyl transpeptidase (GGT) aspartate aminotransferase (AST) alanine aminotransferase (ALT) tests. Lipid profile should be evaluated: total cholesterol, triglyceride, low density lipoprotein (LDL), high density lipoprotein (HDL).

When combined with anthropometric data, biochemical information and patient history, a health risk profile can be established for the patient.

Clinical examination should include the physical examination and health history. The following information (30) should be obtained in the assessment to be applied to the obese patient:

-Story about the patient's weight

- Dietary habits

-Activity

The aim is to support the care of patients and to provide a scientific angle to management that improves health outcomes.

1.3 Obesity Epidemiology

The global prevalence of obesity almost tripled between 1975 and 2016. While overweight and obesity were previously considered the problem of high-income countries, they are increasing in middle and low-income countries recently (24).

Adults aged ≥18 years who are obese %23 Male, %22,9 Female in Turkey according to World Health Statistic 2015 values. The data of the Ministry of Health (Turkey) Nutrition Research and "Turkey Diabetes, Hypertension, Obesity and Endocrinology Diseases Prevalence Study-II" (TURDEP-II) showed that two out of three adults are overweight and obese in Turkey (31).

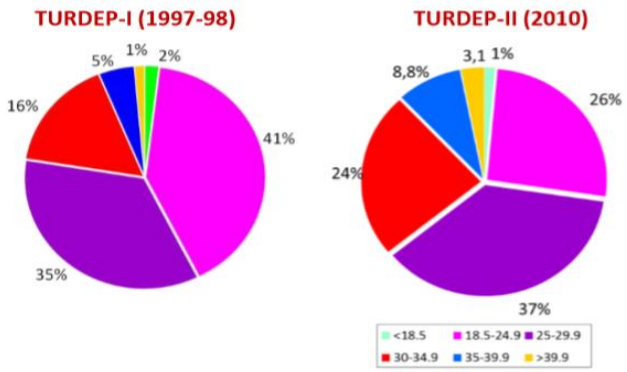

Figure 1.1 Exchange of BMI Groups in Turkish People

2018-2023 updated information about Turkey Healthy Eating and Active Life Program (32) was presented in the workshop; in the STEPS 2017 study conducted with WHO, the incidence of obesity was 32% for adults. In the studies conducted primary school children in 2016, obesity rate 9.9% and overweight rate 14.6% were observed. Obesity is 12.4%; excess weight is determined as 21% in children aged 10-15 years. (STEP: STEPwise Approach for Surveillance, STEPwise Approach: WHO Chronic Disease Surveillance Approach)

According to Global Health Observatory (GHO) data (33) the prevalence of overweight and obesity were lowest in South East Asia, obesity range is %3; highest in the Americas, obesity range is 26%. In these 3 regions have over 50% of female were overweight. Probably the obesity range was greater in female than male in all regions.

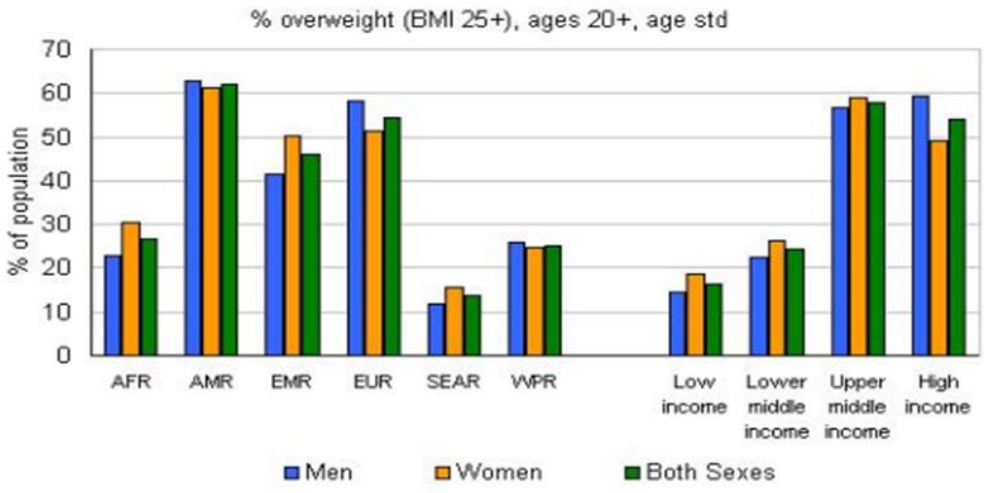

Figure 1.2 Global Health Observatory (GHO) Data Points for Overweight People

Global age-standardized mean BMI in male increased from 21·7 kg/m² to 24·2 kg/m², and in female from 22.1 kg/m² to 24.4 kg/m² in among 1975 to in 2014. The largest increase in male's mean BMI was performed in high-income English-speaking countries

and in female's in mean BMI Latin America. The increments in the BMI are superficially given in Figure 1.3 (34).

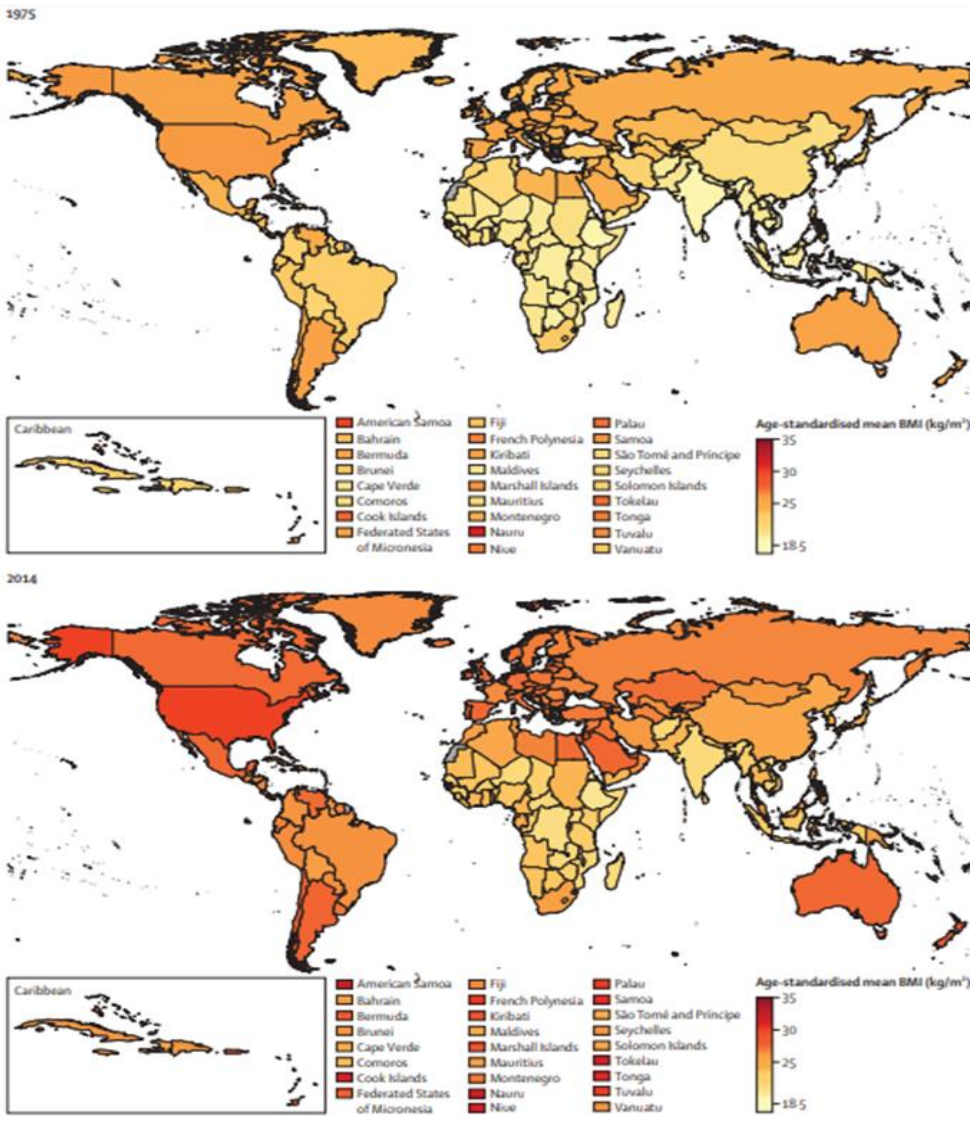

Figure 1.3 Age-standardized mean BMI in female by country in 1975 and 2014 (34)

In the United States of America (USA) and Canada, generally defined as waist circumference larger than 102 cm in male and larger than 88 cm in female (35). In people of Asian descent, defined (36) as waist circumference of 85 cm or more in male and 80 cm or more in female (74 cm or more in female according to some references). Table 1.3 shows the details of an earlier reference (37) which is from 2009.

Table 1.3 Waist Circumference Based on Population

Population	Organization	Male	Female
Europid	IDF	≥ 94 cm	≥ 80 cm
Caucasian	WHO	≥ 94 cm (↑ risk) ≥ 102 cm (↑↑ risk)	≥ 80 cm (↑ risk) ≥ 88 cm (↑↑ risk)
USA	AHA/NHLBI (ATP III)	≥ 102 cm	≥ 88 cm
Canada	Health Canada	≥ 102 cm	≥ 88 cm
European	European Cardiovasc. Societies	≥ 102 cm	≥ 88 cm
Asian (including Japanese	IDF	≥ 90 cm	≥ 80 cm
Asian	WHO	≥ 90 cm	≥ 80 cm
Japanese	Japanese Obesity Society	≥ 85 cm	≥ 90 cm
China	Cooperative Task Force	≥ 85 cm	≥ 80 cm
Middle East Mediterranean	IDF	≥ 94 cm	≥ 80 cm
Sub-Saharan African	IDF	≥ 94 cm	≥ 80 cm
Ethnic Central and South American	IDF	≥ 90 cm	≥ 80 cm

AHA: American Heart Association; ATP III: Adult Treatments Panel III; IDF: International Diabetes Federation; WHO: World Health Organization (37)

Noncommunicable Disease Risk Factor Cooperation (NCD RisC) (34-38) investigated regional changes in obesity prevalence. According to the results of this research, the regions that prevalence of obesity is greater than 25% are high-income Western countries; Central and Eastern Europe; Central Asia, Middle East, and North Africa; Latin America and the Caribbean; and Oceania in 2016. The regions that prevalence of obesity is lower than 10% are East and South East Asia, high-income Asia Pacific, South Asia, and Sub-Saharan Africa in 2016.

The prevalence of overweight is highest in people with under than high school education. (1).

1.4 Causes of Obesity

Obesity is a heterogeneous chronic disease characterized by genetic, environmental, hormonal, sociocultural and behavioral factors that increase the fat mass in the body.

According to basic opinions, the most important reason for obesity is the imbalance between energy intake and consumption. There is a positive correlation between high-fat food consumption and obesity. Furthermore, the high rate of simple carbohydrates consumption causes weight gain by converting excess energy into fat in the body (18).

With the worldwide development, access to food has been facilitated but with the increase in population, the production of high-energy and low-priced foods has started.

Increasing levels of industrialization and welfare, has been limited the physical activity of people. The daily physical activity helps to keep the body weight at the required level. Increasing levels of industrialization and welfare limit the physical activity of people.

When all other conditions are the same, physically active people consume more calories than sedentary people and they do not gain weight (39-43). On the other hand, sedentary people gain weight, although they usually intake less calories than physically active people (40,41,44,45).

2018-2023 updated information about Turkey Healthy Eating and Active Life Program (32) was presented in the workshop; in the STEPS 2017 study conducted with WHO, insufficient physical activity was found in 43.3% of individuals aged 15 years and older.

More energy intake than the daily energy requirement is important in the development of obesity. But it is not correct to assume that overeating is the only cause of obesity. There are many different and complicated causes.

Also, obesity can be thought to be related to polygenic genetic factors. Study (46) with adopted children have shown that they have related BMIs to their biologic parents but not related their adoptive parents. Different researches with twins also proved a there is a genetic effect on BMI. As mentioned above, some disorders related to endocrine problems and some medications can be indirect causes of obesity.

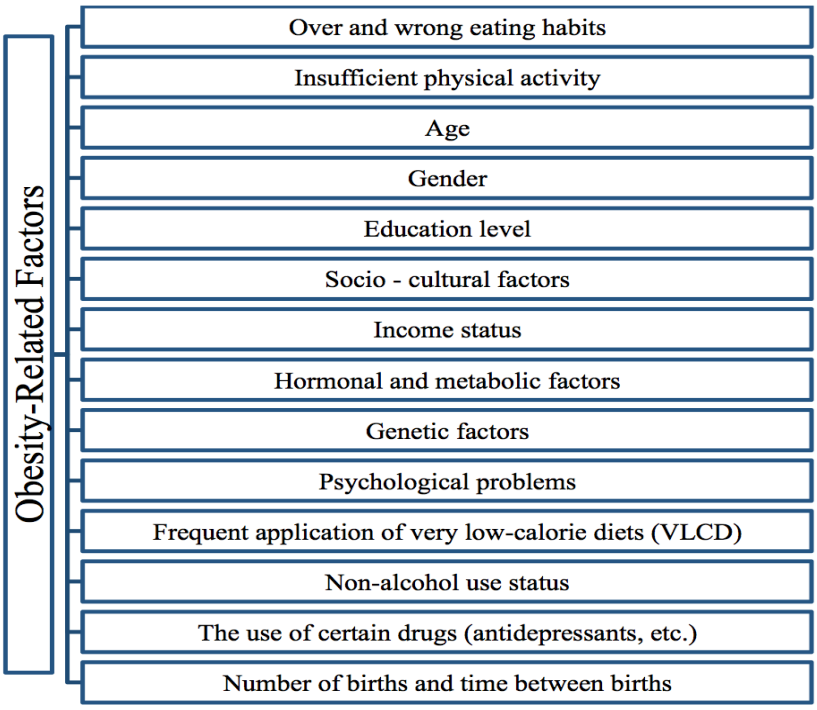

Figure 1.4 Risks and factors affecting of obesity (47,48)

Evidence of studies has shown that higher obesity rates among groups with lower socioeconomic status may be the result of higher exposure to environments where there are barriers to access to healthy food and fewer opportunities to participate in physical activity (49).

In the development of obesity, intrauterine and postnatal periods are also important. In studies conducted, it is reported that the incidence of obesity is lower in children fed with breast milk than in children who are not breastfed and also being reported that the duration of breastfeeding and the type, amount, time of initiation of complementary nutrients affects obesity (47,50).

Besides the above information, considering that many environmental factors change gene expression, the cause of obesity may not due to only a single factor.

1.5 Treatment Methods in Obesity

1.5.1 Reduced Caloric Intake and Lifestyle Intervention

Excess body fat is energy store for the body. This energy storage can be consumed by limiting the energy taken by food and increasing physical activity. The most important point in preventing obesity is to make a diet suitable for energy balance. This diet method

should be considered as a lifestyle. Diet and exercise are the preferred safe methods for weight control and loss weight.

It should be aimed to reduce the body weight to the level of the body height (BMI = 18.5 - 24.9 kg / m^2). The planned diet to help to make a shortfall of 500 to 1,000 kilocalorie (kcal) daily is part of a program that aims to lose 1-2 pounds per week (51).

The recommended best practice is to maintain health status along with optimal weight loss. For this, 5-15% weight loss can be targeted for 6 months (52, 53). For those with a higher BMI, the weight loss goal may change (20% weight loss for BMI 35 kg / m^2) (54).

In some cases, low-calorie diets (LCDs) and very low-calorie diets (VLCDs) can be used. LCDs have an energy 800-1,200 kcal/day. VLCDs give less than 800 kcal/day and only can be used under the supervision of an obesity specialist or nutritionist. (54-57)

Treatment of behavioral change in the control of body weight aims to positively change or decrease the negative behaviors related to nutrition and physical activity which cause excess weight gain. (48).

Steps of behavior change treatment (55,58):

- Self-monitoring
- Stimulus control
- Alternative behavior development
- Consolidation, self-awarding
- Cognitive restructuring
- Social support

Lifestyle interventions and pharmacotherapy together commonly result in modest weight loss of 5–10%: studies reveal a decrease of almost 2.5 kg at 24 months for diet and exercise (59). After the diet period, one-third to two-thirds of dieters thereafter regain weight (60).

When diet, exercise and behavior therapy were applied together, weight loss and metabolic syndrome were significantly improved. (59).

1.5.2 Physical Activity

Physical activity is one of the effective ways of achieving and maintaining weight loss. In a study (61), the exercise details of obese patients were investigated to fat

oxidation for weight loss and the exercises with a maximum capacity of 65% oxygen (O_2) for more than 30 minutes showed optimal efficiency.

In studies, it has been reported that exercise prevents and treats both obesity and obesity related complications (62).

An exercise session is intended to consume 300 kcal for adults and 250 kcal for children (63). Other daily activities of exercise also provide additional energy consumption. Persons must be active outside the sport during the day.

Table 1.4 Calorie values spent during daily activities per hour (64)

Activity	Calories Burned per Hour		
	0-50 kcal	50-100 kcal	100-200 kcal
Cleaning		X	
Cooking		X	
Ironing		X	
Vacuuming			X
Climbing stairs			X
Walking (strolling pace)			X
Walking (briskly)			X
Driving automobile	X		
Gardening			X
Bicycling			X
Playing tennis			X
Playing the musical instrument		X	
Swimming			X
Watching TV	X		

1.5.3 Pharmacotherapy

In obesity treatment, drugs are used in cases where exercise and low-calorie diets are insufficient. For patients, the most appropriate weight loss medication should be selected by clinicians. During the selection of the drug, details such as the effects, side effects of the drug, weight-related complications of the patients are examined (36).

Sympathomimetic anorectics: amphetamine, phentermine, diethylpropion and phenylpropanolamine. These sympathomimetic agents are releasing noradrenaline and dopamine. The increase in noradrenaline release results in the inhibition of appetite. Rimonabant blocks cannabinoid receptors (CB1). These receptors cause more eating of fatty and sugary foods. Rimonabant is a CB1 antagonist. In this wise, it prevents the consumption of some foods (65).

Sibutramine acts as a norepinephrine, serotonin and dopamine reuptake inhibitor in nerve endings (66). It is suggested that sibutramine acts by increasing the feeling of saturation while eating (67,68).

Major function of gastric and pancreatic lipases enzymes is digesting fat from the food intake. Orlistat is an inhibitor of these enzymes (69). Orlistat is helping progress of treatment of obesity-related disease as well (70-72).

Table 1.5 Properties and Effects of Slimming Drugs

Active Component	Trading Name	Expected Average Weight Loss	Side Effects of the Medicine
Appetite Suppressants			
Fentermine	Adipex-P, Fastin, Obenix, Obephen, Obermine, Obestin, Phentamine, Phentride, T-Diet, Zantryl	3,6 kg *	Headache, insomnia, dizziness, anxiety, irritability, increased heartbeat and blood pressure
Dietilproprion hidroklorid	Tenuate, Tepanil, Tenuate, Dospan	3 kg *	
Sibutramin	Meridia, Reductil	At least %5 of EBWL	Increased heartbeat and blood pressure, increased heart attack and risk of stroke (Prohibited by FDA)
Rimonaband	Zimulti, Acomplia	Unapproved in the USA	Depression, anxiety, agitation, sleep disturbances and suicide attempted
Fat Absorption Inhibitors			
Orlistat	Xenical	8 kg per year *	Flatulence, abdominal distention, rectal discharge, fecal jamming, oily stool, need vitamin supplements to prevent deficiency of fat-soluble vitamins.
Drugs that are not used for weight loss directly but cause weight loss			
Fluoksetin	Prozac	Broad spectrum	Lack of energy, headache, prostration, insomnia, nauseation, diarrhea, dryness of the mouth, anxiety, sexual disfunction
Sertralin	Zoloft	There are limited studies	
Bupropion	Wellbutrin; Zyban	4 kg *	İnsomnia, dryness of the mouth
Topiramate	TOPAMAX	%6.5 of initial weight	Prostration, irritability, attention deficit disorder, confusion, depression, anorexia, anxiety, mood problems, changes of taste sensation
Zonisamide		%6 of initial weight	
Over the Counter Drugs			
Orlistat (low dose)	Alli	%5 of initial weight	Vitamin supplementation is required

USA: United States of America, EBWL: Excess Body Weight Loss, FDA: U.S. Food and Drug Administration

Although the time to maintain weight loss is higher for drug users, weight regain is usually achieved when drug intake is discontinued (73). It has been determined that short-term treatment with medication has not had long-term effects on health development (36).

1.5.4 Surgical Treatment

In recent years, bariatric surgery has become the gold standard treatment for morbid obesity. It showed better results compared to other clinical treatments (74).

Bariatric surgery can be a quite efficient method of weight loss for obese people. The weight loss range (75) is 12% to 39% of presurgical body weight or 40–71% EBWL

(excess body weight loss). There are two main approaches for surgical treatment of obesity which are restrictive and malabsorptive.

Restrictive methods are aimed at reducing the volume of stomach consumed by reducing the amount of food consumed and causing weight loss. In malabsorptive methods, it is aimed to decrease the calories taken by limiting the nutrients absorbed into the body and to provide the feeling of satiety early by changing the anatomy of the intestines. (76).

The four common surgical procedures are adjustable gastric banding (AGB), SG, biliopancreatic diversion with duodenal switch (BPD+DS), and conventional Roux-en-Y (RYGB) gastric bypass (77).

Malabsorptive procedures, including (78):

-RYGB (also has a restrictive component)

-BPD+DS

- Restrictive procedures, including:

- AGB

- SG

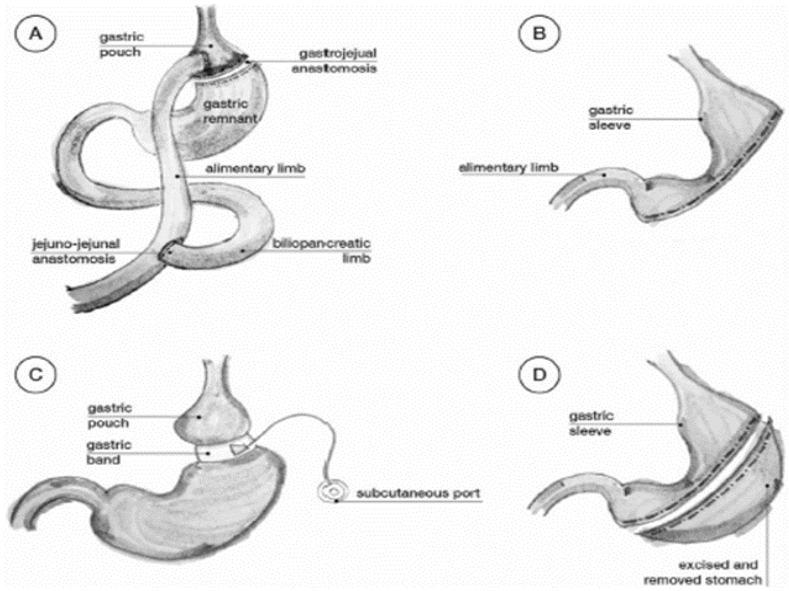

Figure 1.5 Bariatric surgery methods procedures.
(A) Roux-en-Y gastric bypass. (B) Biliopancreatic diversion with duodenal switch. (C) Adjustable gastric banding. (D) Sleeve gastrectomy.

Table 1.6 Comparison of Bariatric Surgery Methods (78)

	Procedure			
	AGB	**SG**	**RYGB**	**BPD ± DS**
Mechanism of Action	Restrictive	Restrictive, Metabolic	Restrictive, / Malabsorptive	Malabsorptive
Weight Loss	1st year 40-50% 5th year 30-50%	1st year 60-67% 5th year 53-65%	1st year 70% 5th year 60%	1st year 75% 5th year 70-90%
Advantages	- Easily applicable, less invasive technique - Does not require stomach and bowel resection -Low risk of malnutrition -Reversible	- Safe and simple -Ghrelin ↓ GLP-1 ↑ -Diminishing appetite -Intact pylorus -Dumping syndrome is not observed - Less vitamin and mineral deficiency -Low malnutrition risk -Suitable for severe obese and Crohn's disease	-Also, weight loss by causing hormonal changes → Ghrelin ↓, GLP-1 ve PYY ↑ -High weight loss -Good metabolic result - Available long-term data -Reversible	-Maximum weight loss - Best metabolic results
Disadvantages	-Band complications frequently (slip, perforation, port dissociation) -Esophageal spasm Gastroesophageal reflux -Port infection -Stoma obstruction	- Limited long-term data (> 5-10 years) - Leaks from the gate line -Irreversible	-Complicated and difficult technical - Leaks from the stapler -Stoma obstruction -Dumping syndrome -Vitamin and mineral deficiency more frequently	- High risk of malnutrition High risk of deficiency in fat-soluble vitamins -Protein deficiency high - Risk of chronic diarrhea and wind - Irreversible but can be modified

1.6 Sleeve Gastrectomy

In the past, SG has been used as the first step operation, for patients with very high BMI (> 60 kg / m^2), to reduce excess weight before more difficult and complex operations such as biliopancreatic diversion and gastric bypass (78). However, it was started to be performed as a primary surgery only after it was observed that it had high efficacy.

SG is a type of partial gastrectomy operation that removes the most curvature part of the stomach, thus giving a tube shape to the stomach (79). American Society for Metabolic and Bariatric Surgery (ASMBS) (80) recommends that approximately 80 percent of the stomach is removed, and the remaining stomach size is 150-200 m^3 (81) in this procedure.

LSG is performed to provide weight loss by restricting the food capacity of the stomach and early stomach filling (15). Besides physiological pathways were not as

simple as thought. LSG may change appetite and body weight by multiple mechanisms including the decrease in the secretion of the peptide ghrelin and the activation of receptors caused by the increase bile acids concentration (10, 13). Ghrelin hormone involved in appetite stimulation produced in the gastric fundus, is reduced after LSG. (82)

In a study conducted by Lazzati et al. (83) found a 66% loss of excess weight, comparable to the general population for two years. In vertical SG which is the most common procedure, perioperative mortality range was similar to the general population.

Boza et al. (84) indicated that LSG is a secure and useful surgical technique for morbid obesity as a stand-alone method.

1.7 Nutritional Deficiencies After Bariatric Surgery

Deficiencies in micronutrients after bariatric interventions are a known risk if not properly managed (15,85,86).

LSG does not bypass the intestine like other more invasive procedures, it has been estimated to affect micronutrient levels minimally (87). But during the procedure, the area that secretes important enzymes and co-factors for nutrient absorption is removed; for this reason, micronutrient-related malabsorption could occur (88). And the rapid passage of nutrients from the stomach can make it difficult to absorb in the stomach after LSG (81). The most common nutritional deficiencies after bariatric surgery are vitamin B12, iron, folate, calcium, and vitamin D (89,90).

Daily requirements must be known to control nutrient deficiencies. According to Dietary Guidelines for Americans the recommendation daily allowance of micronutrients that we researched; 2.4 μg for vitamin B12, 600 International Unit (IU) for vitamin D, 400 μg for folate, 2,300 mg (upper tolerable intake level) for sodium, 4.7 mg (adequate intake) for potassium, among 1,000-1,200 mg for calcium, among 8-11 mg for zinc, among 310-420 mg for magnesium, 700 mg for phosphorus, among 8-11 mg for iron level (91).

Vitamin B12 deficiency can occur due to food intolerances or restricted intake of protein and vitamin B12 containing foods. J. Parrott et al. suggested the required daily micronutrient supplementation doses to prevent micronutrient deficiency after LSG surgery. The recommendations were: 350–500 μg for vitamin B12 by orally, 400–800 μg oral for folic acid, 3000 IU until blood levels of 25-Hydroxy Vitamin D (D25(OH)D) (25(OH)D is used biochemical analysis of vitamin D) are greater than sufficient (30

ng/mL) for vitamin D, 1200–1500 mg/d for calcium, 8–11 mg/d for zinc, 45–60 mg of elemental iron (92).

There are many studies defend that LSG is the most preferred and safer when complication development process and nutrient absorption are evaluated according to procedures that more invasive and intestinal anatomic revision but also there are inconsistent findings on the consideration that deficiency problem should not be a occur in SG (14, 78, 84). In this direction, the aim of this study is to determine the changes in vitamin and mineral values according to weight loss percentages after LSG.

2.MATERYAL METHOD

2.1 Ethical Approval

Ethical approval for the study was granted on 27.06.2018 by Akdeniz University Clinical Human Studies Ethics committee. Ethic committee code is 2012-KAEK-20 and decision number is 458. (Appendix 1)

2.2 Study Design

In this study, which is a retrospective data analysis, weight loss percentages and some biochemistry values of patients with LSG at the Lara Anadolu Hospital in Antalya was determined. The effects of weight loss percentages on changing some vitamin and mineral values were investigated.

Blood tests and body mass index measurements were performed from the pre-operative period and post-operative first (1st), third (3rd) and sixth (6th) months. Preoperative measurement was usually performed 1 day before surgery. Data which was evaluated in this study, was collected from 41 patients between 15.01.2016 and 01.02.2018.

The percentage of weight loss was calculated by dividing the total loss of weight of the patients in the 1st, 3rd and 6th months by their initial weight and multiplying by 100.

Weight loss percent for 1st Month: (Weight loss value in the 1st month ÷ Initial weight) ×100

The evaluated blood test parameters include vitamin D, B12, folic acid, sodium, potassium, calcium, zinc, magnesium, phosphorus, iron and uric acid, glucose, hemoglobin A1c (HbA1c), parathyroid hormone (PTH), thyroid stimulating hormone TSH), albumin, total cholesterol, HDL, LDL, triglyceride values, in addition to these vitamins and minerals, were also examined. The percentage of postoperative weight loss and changes in these biochemical parameters were evaluated retrospectively.

The deficiencies detected in the tests were examined and the necessary treatments were applied. In cases of vitamin B deficiency Apikobal® tablet (Santa Farma, Turkey), vitamin D deficiency Devit-3® ampules (Deva Holding, Turkey), magnesium deficiency Magnorm® tablets (Vitalis, Turkey), iron deficiency Ferro Sanol® capsule (Adeka,

Turkey), zinc deficiency Zinco® capsule (Berko, Turkey), folic acid deficiency Folbiol® tablets (İ.E. Ulagay, Turkey), calcium deficiency Calcimax-D3® effervescent tablet (Basel, Turkey), B12 deficiency Dodex® ampul (Deva Holding, Turkey) was used.

Table 2.1 Reference Ranges of Biochemical Parameters

BIOCHEMICAL PARAMETERS	REFERENCE RANGE
Vitamin D25-OH (ng/ml)	
Deficiency	<20
Insufficiency	20-29
Optimal	30-100
Vitamin B12 (pg/ml)	187-833
Folic Acid (ng/ml)	3.1-20.5
Sodium (mmol/l)	136-145
Potassium (mmol/l)	3.5-5.1
Calcium (mg/dl)	8.4-10.2
Zinc (µg/DL)	70-130
Magnesium (mg/dl)	1.6-2.6
Phosphorus (mg/dl)	2.3-4.7
Iron (µg/DL)	50-170
Glucose (fasting) (mg/dl)	70-115
Hba1c (%)	4-6
Albumin (g/dl)	3.5-5
Uric Acid (mg/dl)	2.6-7.1
Total Cholesterol (mg/dl)	0-200
HDL (mg/dl)	35-75
LDL (mg/dl)	60-140
Triglyceride (mg/dL)	0-150
PTH (pg/mL)	10-65
TSH (µIU/mL)	0.35-4.94

7-step nutrition training was given to patients who had underwent LSG operation. Nutritional supplement and stomach preservation were applied to each patient in the same

order. Protein supplement was given 60-80 g daily at least for 2 months after the operation. Protifar® 225 g (Nutricia, Netherlands) was used as a protein supplement.

Pharmaton® Multivitamin (Sanofi, Sweden) and Polivit Syrup® (Abdi İbrahim, Turkey) were used as nutritional supplements. Pharmaton was used after surgery at least for 1 year and 1 capsule per day. Polivit Syrup was used after surgery at least for 1 month and 3 scales per day.

Polivit syrup contains (94) 450 µg vitamin A, 1 mg of vitamin B1, 1.2 mg of B2 vitamin, 2 mg of vitamin B6, 25 mg of vitamin C, 400 IU (10 µg) of vitamin D3 and 5 mg of vitamin E in 1 scale (5 ml). In this study patients used 3 scales of Polivit Syrup for the 1st month. Details, for 3 scale, are shown in Table 2.2.

Table 2.2 Vitamin Components of Polivit Syrup for 3 scales (94)

Vitamins	3 scales (15 ml) amount
Vitamin A	4500 IU= 1350 µg
Vitamin B1	3 mg
Vitamin B2	3.6 mg
Vitamin B6	6 mg
Vitamin C	75 mg
Vitamin D3	1200 IU= 30 µg
Vitamin E	15 mg

Department of Nutrition and Dietetics in Hacettepe University has determined the daily reliable recommended vitamins, mineral intake levels for Turkey in 2015 (93). In this direction, we calculated the daily percentage of vitamin, mineral provided by Polivit Syrup and Pharmaton Capsule according to age ranges and sex. A daily basis with 1 scale of Polivit syrup supplies vitamin A in female 64%, 50% in male; Vitamin B1 was 91% in females and 83% in males; Vitamin B2 is 100% for female and 92% for male; Vitamin B6 in female and male 100%; Vitamin C in female and male in 28%; Vitamin D3 in female and male 100%; Vitamin E in female and male by 33%. Details are shown according to 3 scales in Table 2.3.

Table 2.3 The Percentage of Vitamins Supplied for The Daily Requirements of Turkey with 3 scales of Polivit Syrup

The Daily Requirements of Turkey (93)							Supplied Percentages (with 3 scales)					
Gender	Female			Male			Female			Male		
Age	19-30	31-50	51-65	19-30	31-50	51-65	19 - 30	31 - 50	51 - 65	19 - 30	31 - 50	51 - 65
Vitamin A	700µg	700µg	700µg	900µg	900µg	900µg	*	*	*	*	*	*
Vitamin B1	1.1 mg	1.1 mg	1.1 mg	1.2 mg	1.2 mg	1.2 mg	*	*	*	*	*	*
Vitamin B2	1.0 mg	1.1 mg	1.1 mg	1.3 mg	1.3 mg	1.3 mg	*	*	*	*	*	*
Vitamin B6	1.3 mg	1.3 mg	1.3 mg	1.3 mg	1.3 mg	1.7 mg	*	*	*	*	*	*
Vitamin C	90 mg	90 mg	90 mg	90 mg	90 mg	90 mg	% 83	% 83	% 83	% 83	% 83	% 83
Vitamin D3	10 µg	10 µg	10 µg	10 µg	10 µg	10 µg	*	*	*	*	*	*
Vitamin E	15 mg	15 mg	15 mg	15 mg	15 mg	15 mg	*	*	*	*	*	*

(*All needs are supplied.)

A capsule of Pharmaton multivitamin contains (95) 800 µg Retinol (RE) vitamin A, 60mg vitamin C, 12 mg Alpha-tocopherol (α-TE) vitamin E, 16.13 g Niacin Equivalent (NE) vitamin B3, 1.4 mg vitamin B6, 1.4 mg vitamin B2, 1.1 mg vitamin B1, 2.5 µg vitamin B12, 5 µg vitamin D, 200 µg Folic Acid, 50 µg Biotin, 120 mg Calcium, 10.5 mg Iron, 2 mg Manganese, 1.5 mg Zinc, 1000 µg Copper and 55 µg Selenium. Details are shown in Table 2.4.

Table 2.4 Vitamin-Mineral Components of Pharmaton Capsule (95)

Vitamins and Minerals	1 capsule amount
Vitamin A	800 µg RE
Vitamin C	60 mg
Vitamin E	12 mg α- TE
Vitamin B3 (niacin)	16.13 mg NE
Vitamin B6 (pyridoxine)	1.4 mg
Vitamin B2 (riboflavin)	1.4 mg
Vitamin B1 (thiamine)	1.1 mg
Vitamin B12 (cobalamin)	2.5 µg
Vitamin D	5 µg
Folic Acid	200 µg
Biotin	50 µg
Calcium	120 mg
Iron	10.5 mg
Manganese	2 mg
Zinc	1.5 mg
Copper	1000 µg
Selenium	55 µg

A daily basis with 1 capsule of Pharmaton supplies, vitamin A in female 100%, 89% in male; Vitamin B1 was 100% in females and 92% in males; Vitamin B2 is 100% both for female and male; Vitamin B6 in female and male 100%; Vitamin C in female and male in 67%; Vitamin D in female and male 50%; Vitamin E in female and male 80%; Vitamin B3 in female and male 100%; Vitamin B12 in female and male 100%, Biotin in female and male 100%, 12% of Calcium in female and male who are between the age of 19-50, 10% of Calcium in female and male above the age of 10%; 58% of Iron in female between the age of 19-50 and 100% in female above 51 and all male; Manganese 100% in female and 87% in male; Zinc 15% in female and 14% in male; Virgin 100% in both female and male; Selenium 100% in both female and male. Details are shown in Table 2.5.

Table 2.5 The Percentage of Vitamins and Minerals Supplied for The Daily Requirements of Turkey with Pharmaton Capsule

The Daily Requirements of Turkey (93)							Supplied Percentages (for 1 capsule)					
Gender	Female			Male			Female			Male		
Age	19-30	31-50	51-65	19-30	31-50	51-65	19 - 30	31 - 50	51 - 65	19 - 30	31 - 50	51 - 65
Vitamin A	700µg	700µg	700µg	900µg	900µg	900µg	*	*	*	% 89	% 89	% 89
Vitamin B1	1.1 mg	1.1 mg	1.1 mg	1.2mg	1.2 mg	1.2 mg	*	*	*	% 92	% 92	% 92
Vitamin B2	1,0 mg	1.1 mg	1.1 mg	1.3mg	1.3 mg	1.3 mg	*	*	*	*	*	*
Vitamin B6	1.3 mg	1.3 mg	1.3 mg	1.3mg	1.3 mg	1.7 mg	*	*	*	*	*	*
Vitamin C	90 mg	90 mg	90 mg	90 mg	90 mg	90 mg	% 67	% 67	% 67	% 67	% 67	% 67
Vitamin D3	10 µg	10 µg	10 µg	10 µg	10 µg	10 µg	% 50	% 50	% 50	% 50	% 50	% 50
Vitamin E	15 mg	15 mg	15 mg	15 mg	15 mg	15 mg	% 80	% 80	% 80	% 80	% 80	% 80
Vitamin B3	14 mg	14 mg	14 mg	16 mg	16 mg	16 mg	*	*	*	*	*	*
Vitamin B12	2.4 µg	2.4 µg	2.4 µg	2.4µg	2.4 µg	2.4 µg	*	*	*	*	*	*
Folic Acid	400 µg	400 µg	400 µg	400µg	400 µg	400 µg	% 50	% 50	% 50	% 50	% 50	% 50
Biotin	30 µg	30 µg	30 µg	30 µg	30 µg	30 µg	*	*	*	*	*	*
Calcium	1000 mg	1000 mg	1200 mg	1000 mg	1000 mg	1200 mg	% 12	% 12	% 10	% 12	% 12	% 10
Iron	18 mg	18 mg	10 mg	10 mg	10 mg	10 mg	% 58	% 58	*	*	*	*
Manganese	1.8 mg	1.8 mg	1.8 mg	2.3mg	2.3 mg	2.3 mg	*	*	*	% 87	% 87	% 87
Zinc	10 mg	10 mg	10 mg	11 mg	11 mg	11 mg	% 15	% 15	% 15	% 14	% 14	% 14
Copper	900µg	900µg	900µg	900µg	900µg	900µg	*	*	*	*	*	*
Selenium	55 µg	55 µg	55 µg	55 µg	55 µg	55 µg	*	*	*	*	*	*

(*All needs are supplied.)

2.3 Body Composition Assessment

We considered height and weight as body composition parameters and measured them in time periods preoperative, postoperative 1st month, postoperative 3rd months and postoperative 6th months. Jawan GAIA Plus for weight and Secca for height measurements are utilized in the process.

2.4 Inclusion and Exclusion Criteria of the Research

2.4.1 Inclusion Criteria

- Patients who operated before the date 01 February 2018,
- Patients who the weight measurements and blood test are complete (preoperative and postoperative 1st month, 3rd month and 6th month),
- Patients aged over 18 and under 65 years,
- BMI> 35 kg/m^2 with co-morbid disease and BMI> 40 kg/m^2 with no need to check co-morbid disease (Diabetes, hypertension, sleep apnea and severe joint disorders were evaluated as comorbid diseases.),
- Patients who received postoperative nutrition training were evaluated.

2.4.2 Exclusion Criteria

- Improper operation date,
- Patients who under 18 years or over 65 years,
- Patients who had lack of blood test or weight tracking were excluded from the study.

2.5 Postgastrectomy Diet Process

2.5.1 Step 1

It is a diet applied after hospitalization period and after leak tests. It is applied 1 or 2 days until discharge.

Goals: 1600 ml of fluid intake per day at a maximum of 100 ml per hour.

Foods that added to diet: Plain meat or chicken broth, apple, grape, peach juice and sugar free soft drinks will be used in one-to-one ratio.

2.5.2 Step 2

It is a diet applied for 10 days after discharge.

Goals: 1600-1800 ml of fluid intake per day at 100-120 ml per hour.

Foods that added to diet: In addition to the 1st stage liquid protein contents as non-fat ayran, yogurt, semi-skimmed milk.

2.5.3 Step 3

It is a diet applied for a week after post-operative second week.

Goals: 1600-1800 ml of fluid intake per day 100-120 ml per hour.

Foods that added to diet: Non-fat yogurt, non-fat cottage cheese, low-fat cream cheese, boiled egg, sugar free pudding, soup of the consistency of baby formula, potato puree, blenderized beans, legumes, vegetable puree or grated vegetables, oatmeal puree, fruits without peel and acid.

2.5.4 Step 4

It is a diet applied for 1 week after post-operative third week.

Goals: 1600-1800 ml of fluid intake per day 100-120 ml per hour.

Foods that added to diet: This step is the transitional stage from puree to soft food. Fish, soups, oatmeal, soft fresh fruits (like bananas, peaches, watermelons), well-cooked veggies, cheese.

2.5.5 Step 5

It is a diet applied for 1 week after post-operative fourth week.

Goals: 1600-1800 ml of fluid intake per day 100-120 ml per hour.

Solid food intake from 25 grams to 150 grams in a single meal.

Foods that added to diet: minced meat, chicken meat, lettuce, spinach etc. (raw vegetable). A trade of rice and bulgur can be added.

2.5.6 Step 6

It is a diet applied for 1 week after post-operative fifth week.

Goals: 1600-1800 ml of fluid intake per day 100-120 ml per hour.

Solid food intake from 25 grams to 150 grams in a single meal. Protein needs will be met with liquid protein supplements and added foods.

Foods that added to diet: Pasta, bread, fresh fruits and vegetables.

2.5.7 Step 7

It is a diet applied for 1 week after post-operative sixth week.

Goals: 1600-1800 ml of fluid intake per day 100-120 ml per hour. Solid food intake from 25 grams to 150 grams in a single meal. Protein needs will be met with liquid protein supplements and added foods. Snacks must be away from fried foods. Meals must be chew very well.

After this step all healthy foods will be added respectively. Must be away from like high calorie foods, deserts with syrup, fizzy drinks, fried foods, roasted appetizers and high incidence of fat foods. Liquid drinks must not take with or just before meals. Protein content should be consumed before eating.

2.6 Data Analysis

For statistical analysis, NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used. Descriptive statistical methods are used during the evaluation of study data Qualitative data is challenged against normal distribution via Kolmogorov-Smirnov, Shapiro-Wilk test and graphical tools. For the data which are not normally distributed, Mann Whitney U test is used for dual comparison. For the evaluation of the normally distributed variable data Repeated Measures ANOVA (Variance Analysis of recurrent measurements) test is used, where Bonferroni test is used for dual comparison evaluation. For the evaluation of the not normally distributed variable data Friedman test is used, where Wilcoxon Signed Ranks test is used for dual comparison evaluation. Spearman's Correlation Analysis method is used for the evaluation of the correlation between the non-normal distributed variables. $p<0.05$ level is taken as the min level to have a meaningful data result. $p<0.05$ was considered significant.

3.RESULTS

A total of 41 patients' data, 78% (n=32) female and 22% (n=9) male, who had undergone LSG surgery in Antalya Lara Anatolian Hospital between 15.01.2016 and 01.02.2018, were used in the study. The ages of the patients ranged from 18 to 58 years and mean value was 40. 66 ± 11.10.

Table 3.1 Range of Demographic Characteristics

		n (%)
Age (year)	*Min-Max (Median)*	18-58 (43)
	Mean±SD	40,66±11,10
Gender	**Female**	32 (78,0)
	Male	9 (22,0)

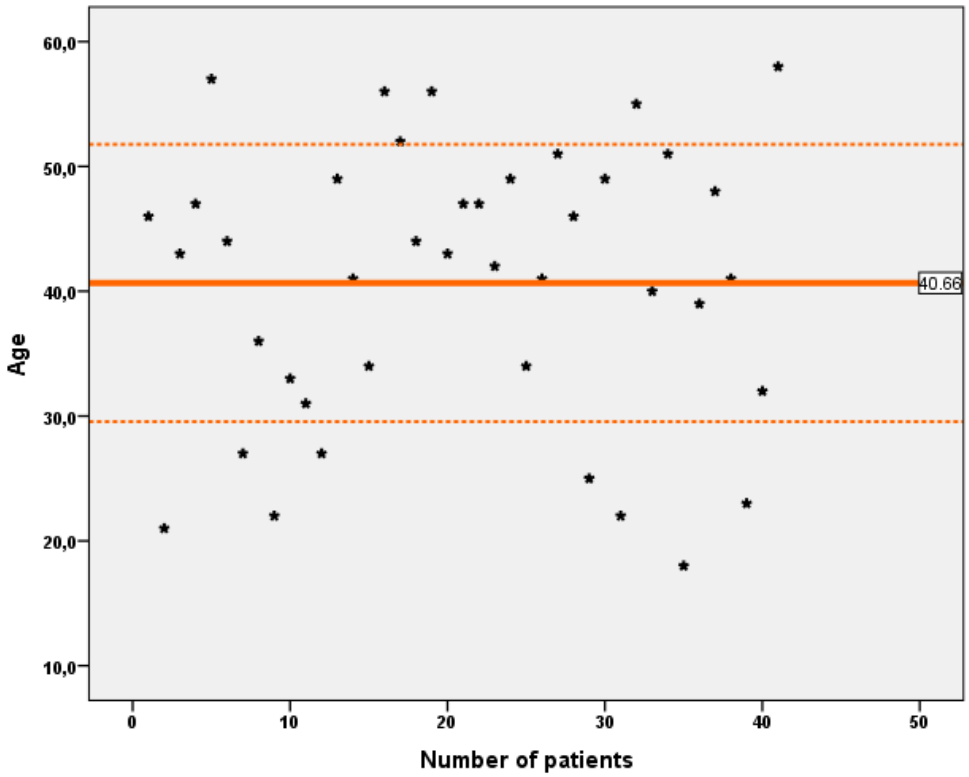

Figure 3.1 Age Range

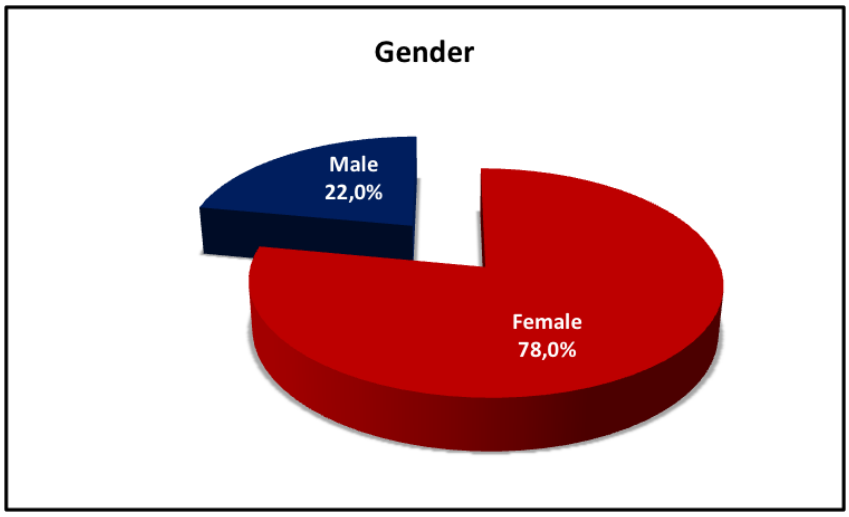

Figure 3.2 Gender Range

Table 3.2 Evaluation of Weight Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Weight (kg)	**Pre-op**	84,9-198,7 (114,7)	118,31±23,11
	Post-op 1.month	75,4-184 (103,2)	104,35±22,51
	Post-op 3.month	64-166,9 (88,3)	91,48±20,78
	Post-op 6.month	57,1-144 (77,1)	81,35±18,08
	[a]p	***0,001****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001****	
[b]p	**Pre-op - Post-op 3.month**	***0,001****	
	Pre-op - Post-op 6.month	***0,001****	
	Post-op 1.month-3.month	***0,001****	
	Post-op 1.month-6.month	***0,001****	
	Post-op 3.month- 6.month	***0,001****	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

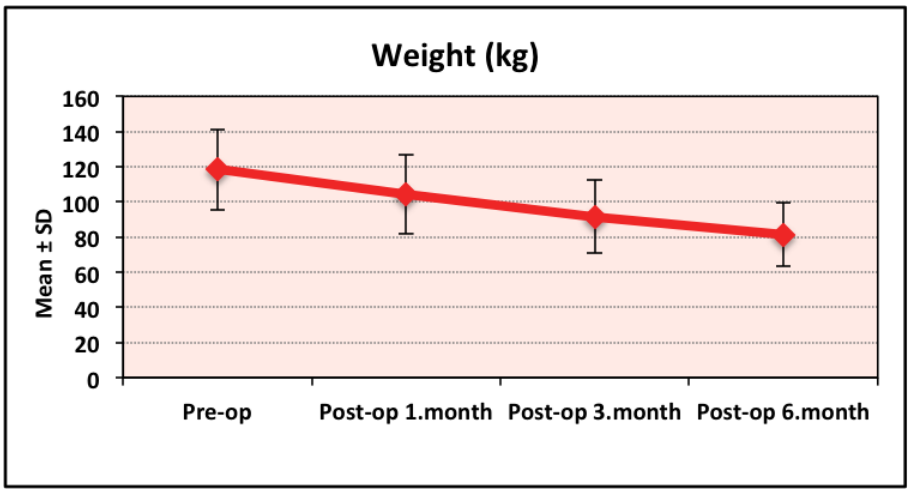

Figure 3.3 Chart of Weight Measurements in Follow-up

While the mean preoperative weight measurement of the patients was 118,31±23,11 kg postoperative first month measurement was 104,35±22,51 kg, postoperative third month measurement was 91,48±20,78 kg and postoperative sixth month measurement was 81,35±18,08 kg. Mean weight loss percentages 1st, 3rd, 6st months respectively; 11.80%, 22.67%, 31.24%. Preoperative and postoperative 1st, 3rd ,6th months weight measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month, 3rd month and 6th month weight measurements compared to preoperative measurements were statistically significant. (p = 0.001; p = 0.001; p = 0.001; p <0.01, respectively). The decrease in the postoperative 3rd month and 6th month weight measurements compared to 1st month measurements was statistically significant too (p = 0.001; p = 0.001; p <0.01, respectively). The decrease in weight measurements of the 6th month compared to the 3rd month postoperatively was also statistically significant (p = 0.001; p <0.01).

Table 3.3 Evaluation of BMI Measurements in Follow-up

			Min-Max (Median)	Mean±SD
BMI (kg/m²)	**Pre-op**		35,3-68,8 (42,8)	44,08±7,17
	Post-op 1.month		29-63,1 (37,1)	38,89±7,13
	Post-op 3.month		24,5-57,4 (33)	34,09±6,70
	Post-op 6.month		22,6-50,8 (28,8)	30,23±6,01
		[a]p	***0,001****	
Paired comparisons;	**Pre-op – Post-op 1.month**		***0,001****	
[b]p	**Pre-op – Post-op 3.month**		***0,001****	
	Pre-op – Post-op 6.month		***0,001****	
	Post-op 1.month- 3.month		***0,001****	
	Post-op 1.month- 6.month		***0,001****	
	Post-op 3.month- 6.month		***0,001****	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

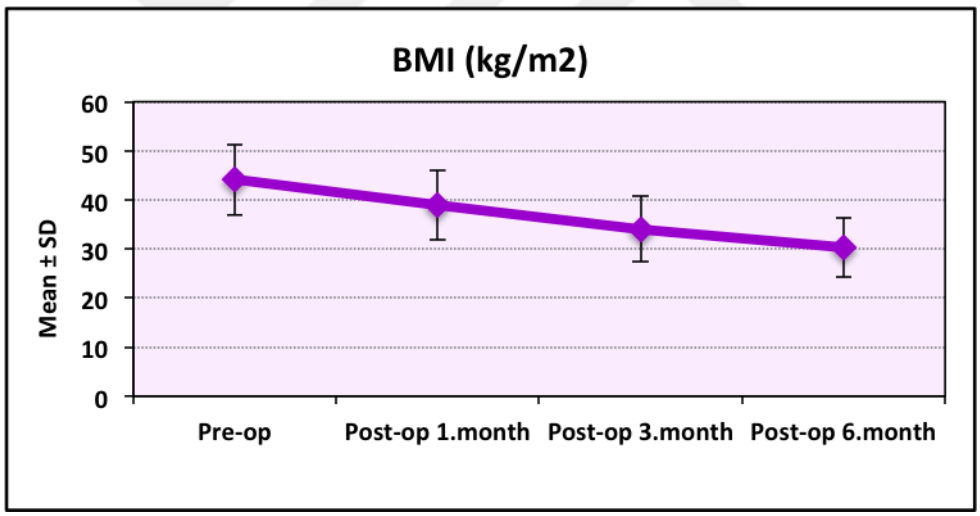

Figure 3.4 Chart of BMI Measurements in Follow-up

While the mean preoperative BMI measurements of the patients were 118.31±23.11 kg, postoperative 1st month measurement was 104.35±22.51 kg, postoperative 3rd month measurement was 91.48±20.78 kg and postoperative 6th month measurement was 81.35±18.08 kg. Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month BMI measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01). As a result of paired comparisons; the decrease in postoperative 1st month, 3rd month and 6th month BMI measurements compared to preoperative measurements were statistically significant (p = 0.001; p = 0.001; p = 0.001;

p <0.01, respectively). The decrease in the postoperative 3rd month and 6th month BMI measurements compared to postoperative 1st month measurement was statistically significant as well (p = 0.001; p = 0.001; p <0.01, respectively). The decrease in BMI measurements of the postoperative 6th month compared to the postoperative 3rd month was also statistically significant (p = 0.001; p <0.01).

Table 3.4 Evaluation of Vitamin D25-OH Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Vitamin D25-OH	**Pre-op**	5,3-105,6 (20,7)	26,61±21,26
(ng/mL)	**Post-op 1.month**	8,8-95,4 (28,2)	33,22±20,05
	Post-op 3.month	11,7-98,5 (34,2)	40,32±17,60
	Post-op 6.month	17,5-73,7 (32,1)	33,76±11,40
	[c]p	***0,001***	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001***	
[d]p	**Pre-op – Post-op 3.month**	***0,001***	
	Pre-op – Post-op 6.month	***0,005***	
	Post-op 1.month- 3.month	***0,104***	
	Post-op 1.month- 6.month	***0,403***	
	Post-op 3.month- 6.month	***0,034****	

[c]Friedman Test *[d]Wilcoxon Signed Ranks Test* ***p<0.01* **p<0.05*

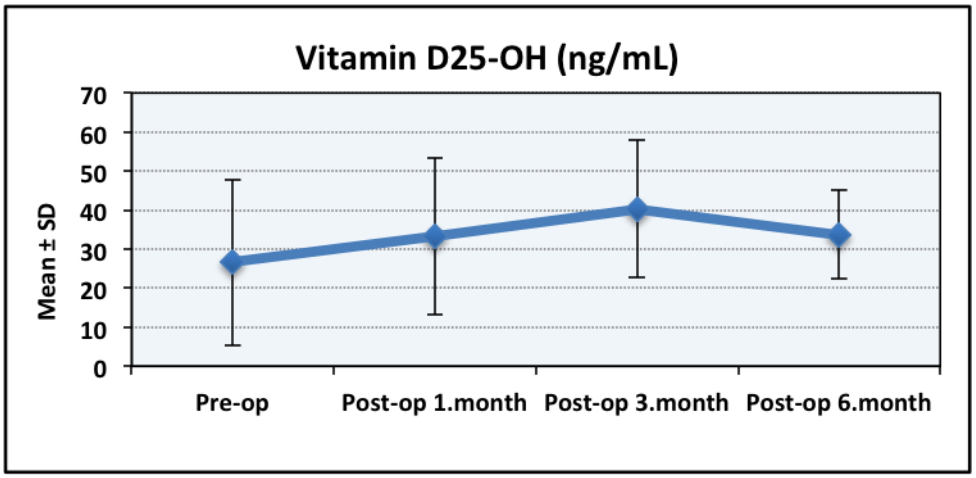

Figure 3.5 Chart of Vitamin D25-OH Measurements in Follow-up

While the mean preoperative Vitamin D measurement of the patients was 26.61±21.26 ng/mL, postoperative 1st month measurement was 33.22±20.05 ng/mL, postoperative 3rd month measurement was 40.32±17.60 ng/mL, and postoperative 6th month measurement was 33.76±11.40 ng/mL. Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Vitamin D measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01). As a result of paired comparisons; the increase in postoperative 1st month, 3rd month and 6th month Vitamin D measurements compared to preoperative measurements were statistically significant (p = 0.001; p = 0.001; p = 0.005; p <0.01, respectively). The decrease in Vitamin D measurement of the postoperative 6th month compared to the postoperative 3rd month was also statistically significant (p = 0.034; p <0.05). The other changes were not statistically significant (p>0.05).

Table 3.5 Evaluation of Vitamin B12 Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Vitamin B12	**Pre-op**	123-479 (256)	286,29±103,69
(pg/mL)	**Post-op 1.month**	204-718 (406)	428,34±130,77
	Post-op 3.month	117-655 (328)	359,15±135,12
	Post-op 6.month	89-612 (282)	311,49±121,26
	[c]p	***0,001****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001****	
[d]p	**Pre-op – Post-op 3.month**	***0,001****	
	Pre-op – Post-op 6.month	***0,241***	
	Post-op 1.month- 3.month	***0,001****	
	Post-op 1.month- 6.month	***0,001****	
	Post-op 3.month- 6.month	***0,021****	

[c]Friedman Test *[d]Wilcoxon Signed Ranks Test* ***p<0.01* **p<0.05*

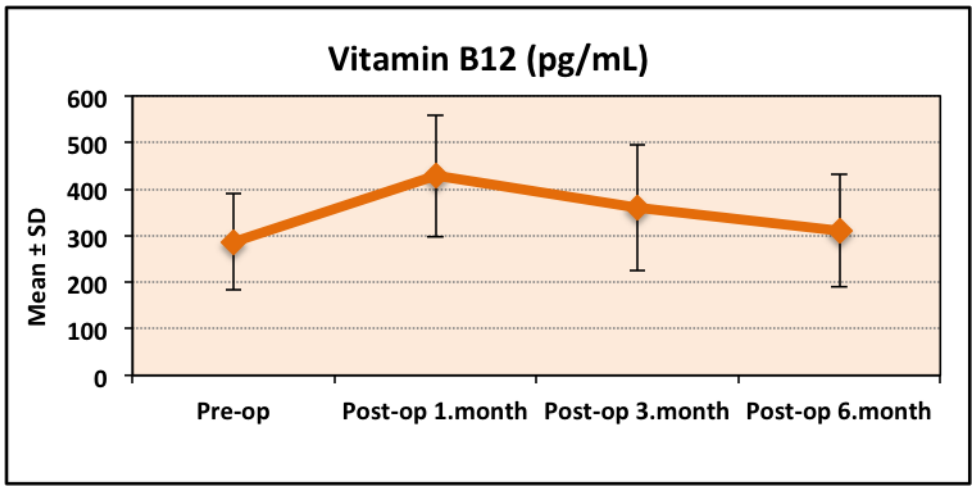

Figure 3.6 Chart of Vitamin B12 Measurements in Follow-up

The mean preoperative Vitamin B12 measurement of the patients was 286.29±103.69 pg/mL, postoperative 1st month measurement was 428.34±130.77 pg/mL, postoperative 3rd month measurement was 359.15±135.12 pg/mL, and postoperative 6th month measurement was 311.49±121.26 pg/mL. Preoperative measurements and postoperative 1st and postoperative 3rd month measurements of Vitamin B12 were evaluated and the change was statistically significant (p=0.001; p<0.01). As a result of paired comparisons; the increase in postoperative 1st and 3rd month Vitamin B12 measurements compared to preoperative measurement was statistically significant (p=0.001; p=0.001; p<0.01, respectively). The decrease in Vitamin B12 measurements of the postoperative 3rd month and postoperative 6th month compared to the preoperative measurement was also statistically significant (p=0.001; p=0.001; p<0.01 respectively). The decrease in Vitamin B12 measurement of the postoperative 6th month compared to the postoperative 3rd month was also statistically significant (p=0.021; p <0.05).

Table 3.6 Evaluation of Folic Acid Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Folic acid (ng/mL)	**Pre-op**	2,9-17,2 (5,8)	7,14±3,36
	Post-op 1.month	2,3-19,6 (7,3)	8,11±3,28
	Post-op 3.month	2,3-21,7 (7,6)	8,27±3,81
	Post-op 6.month	2-23,1 (7)	8,75±5,03
		[c]p	***0,565***

[c]Friedman Test

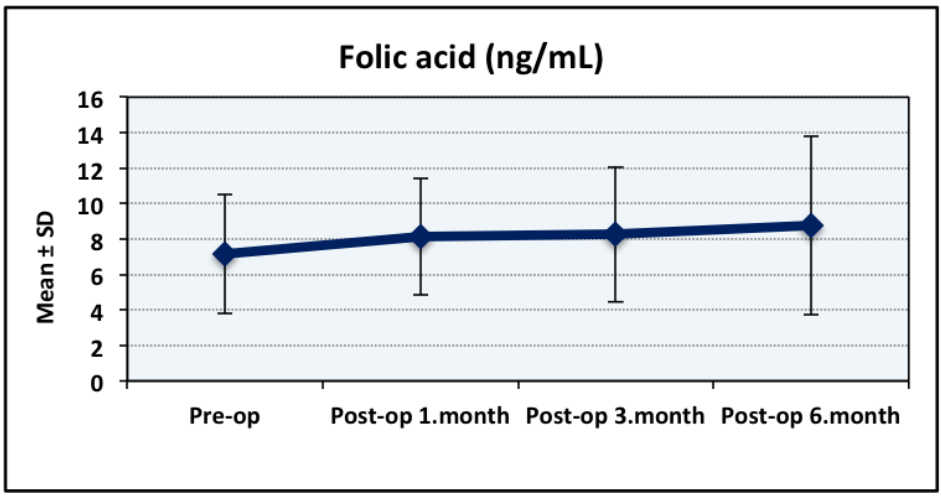

Figure 3.7 Chart of Folic Acid Measurements in Follow-up

The mean preoperative Folic Acid measurement of the patients was 7.14±3.36 ng/mL, postoperative 1st month measurement was 8.11±3.28 ng/mL, postoperative 3rd month measurement was 8.27±3.81 ng/mL, and postoperative 6th month measurement was 8.75±5.03 ng/mL. Preoperative measurement and postoperative 1st, 3rd and 6st month measurements of Folic acid were evaluated and the change was not statistically significant (p>0.05).

Table 3.7 Evaluation of Sodium Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Sodium (mmol/L)	**Pre-op**	136-144 (139)	138,95±1,70
	Post-op 1.month	136-145,9 (141)	141,12±1,75
	Post-op 3.month	138-144 (141)	140,95±1,58
	Post-op 6.month	124-145,5 (141)	140,47±3,10
	[a]p	***0,001*****	
Paired comparisons; [b]p	**Pre-op – Post-op 1.month**	***0,001*****	
	Pre-op – Post-op 3.month	***0,001*****	
	Pre-op – Post-op 6.month	***0,060***	
	Post-op 1.month- 3.month	***1,000***	
	Post-op 1.month- 6.month	***1,000***	
	Post-op 3.month- 6.month	***1,000***	

*[a]Repeated Measures Test [b]Adjustment for multiple comparisons: Bonferroni **p<0.01*

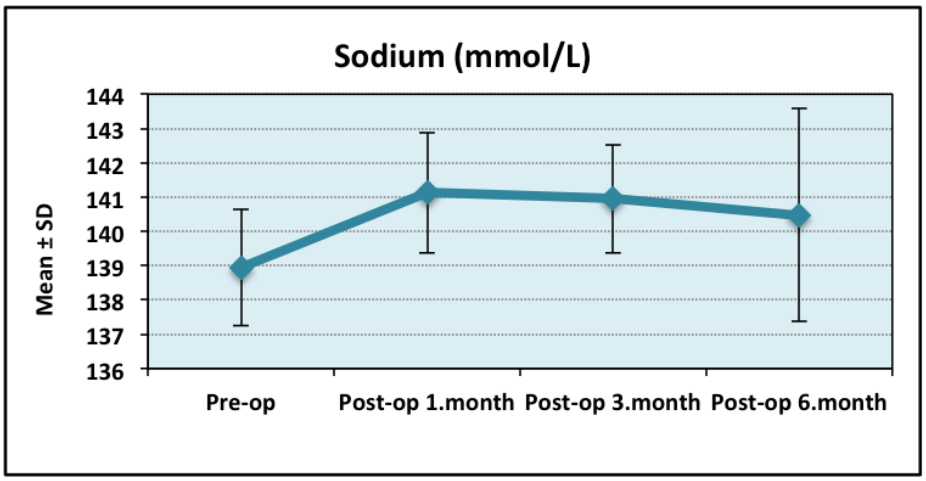

Figure 3.8 Chart of Sodium Measurements in Follow-up

While the mean preoperative Sodium measurement of the patients was 138.95±1.70 mmol/L, postoperative 1st month measurement was 141.12±1.75 mmol/L, postoperative 3rd month measurement was 140.95±1.58 mmol/L and postoperative 6th month measurement was 140.47±3.10 mmol/L. Preoperative measurement and postoperative 1st, 3rd and 6th month measurements of Sodium were evaluated and the change was statistically significant($p=0.001$; $p<0.01$). As a result of paired comparisons; the increase in postoperative 1st and 3rd month Sodium measurements with respect to preoperative measurement were statistically significant ($p=0.001$; $p=0.001$; $p<0.01$, respectively). The other changes were not statistically significant ($p>0.05$).

Table 3.8 Evaluation of Potassium Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Potassium	**Pre-op**	3,8-5,2 (4,4)	4,41±0,32
(mmol/L)	**Post-op 1.month**	3,5-5,3 (4,3)	4,35±0,40
	Post-op 3.month	3,7-5 (4,4)	4,41±0,35
	Post-op 6.month	4,1-5,6 (4,6)	4,64±0,36
	[a]p	***0,001****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***1,000***	
[b]p	**Pre-op – Post-op 3.month**	***1,000***	
	Pre-op – Post-op 6.month	***0,002****	
	Post-op 1.month- 3.month	***1,000***	
	Post-op 1.month- 6.month	***0,005****	
	Post-op 3.month- 6.month	***0,009****	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

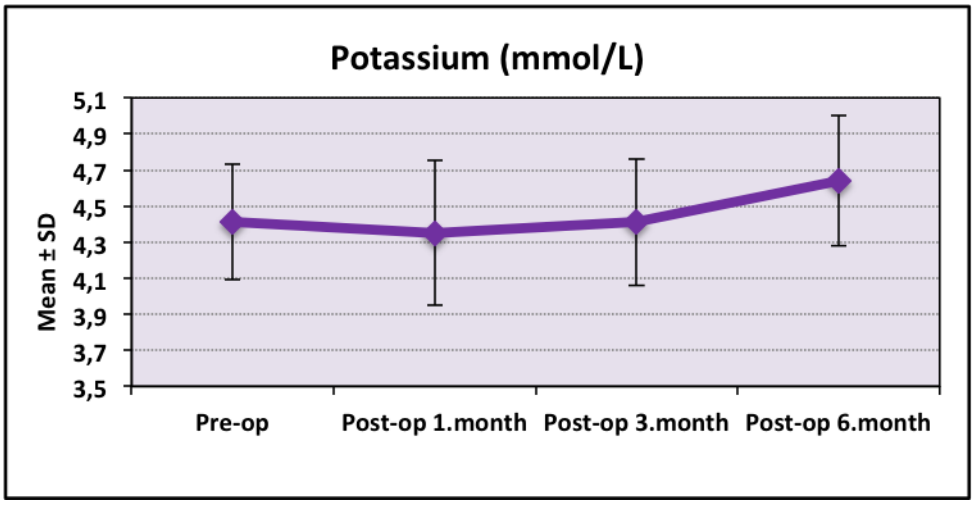

Figure 3.9 Chart of Potassium Measurements in Follow-up

While the mean preoperative Potassium measurement of the patients was 4.41±0.32 mmol/L, postoperative 1st month measurement was 4.35±0.40 mmol/L, postoperative 3rd month measurement was 4.41±0.35 mmol/L and postoperative 6th month measurement was 4.64±0.36 mmol/L. Preoperative measurement and postoperative 1st, 3rd and 6th month measurements of Potassium were evaluated, and the change was statistically significant (p=0.001; p<0.01). As a result of paired comparisons; the increase in postoperative 6th month measurement compared to postoperative 1st month measurement and increase 6th month measurement compared to postoperative 1st month Sodium measurement was statistically significant (p=0.005; p=0.009; p<0.01, respectively). The other changes were not statistically significant (p>0.05).

Table 3.9 Evaluation of Calcium Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Calcium (mg/dL)	**Pre-op**	8,6-10,1 (9,5)	9,51±0,35
	Post-op 1.month	8,9-10,4 (9,6)	9,58±0,36
	Post-op 3.month	8,1-10,3 (9,6)	9,61±0,40
	Post-op 6.month	8,8-10,4 (9,6)	9,53±0,39
		[a]p	***0,307***

[a]Repeated Measures Test

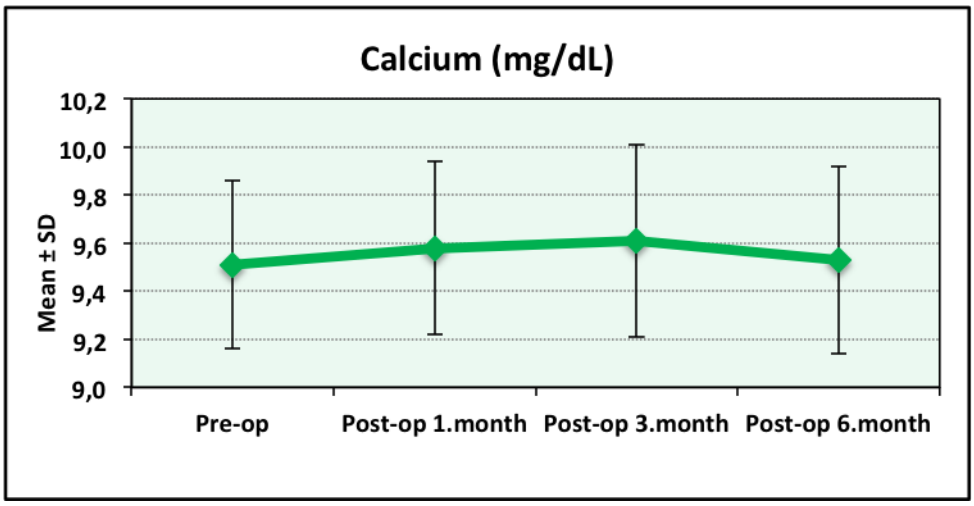

Figure 3.10 Chart of Calcium Measurements in Follow-up

While the mean preoperative Calcium measurement of the patients was 9.51±0.35 mg/dL, postoperative 1st month measurement was 9.58±0.36 mg/dL, postoperative 3rd month measurement was 9.61±0.40 mg/dL and postoperative 6th month measurement was 9.53±0.39 mg/dL. Preoperative measurement and postoperative 1st, 3rd and 6th month measurements of Calcium were evaluated, and the change was not statistically significant (p>0.05).

Table 3.10 Evaluation of Zinc Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Zinc (µg/dL)	**Pre-op**	68,9-115,8 (84,2)	86,36±11,97
	Post-op 1.month	56,1-122,4 (86)	85,58±16,49
	Post-op 3.month	50-118,3 (80,4)	79,63±16,58
	Post-op 6.month	40,2-102,4 (73,3)	72,80±14,96
	[a]p	***0,001****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***1,000***	
[b]p	**Pre-op – Post-op 3.month**	***0,147***	
	Pre-op – Post-op 6.month	***0,001****	
	Post-op 1.month- 3.month	***0,319***	
	Post-op 1.month- 6.month	***0,001****	
	Post-op 3.month- 6.month	***0,066***	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

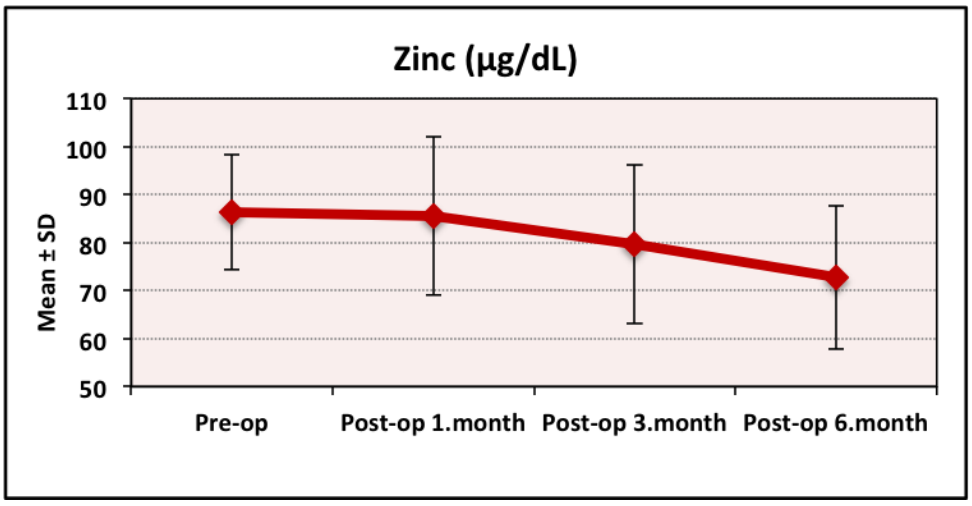

Figure 3.11 Chart of Zinc Measurements in Follow-up

While the mean preoperative Zinc measurement of the patients was 86.36±11.97 µg/dL, postoperative 1st month measurement was 85.58±16.49 µg/dL, postoperative 3rd month measurement was 79.63±16.58 µg/dL and postoperative 6th month measurement was 72.80±14.96 µg/dL. Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Zinc measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01). As a result of paired comparisons; the decrease in postoperative 6th month Zinc measurement compared to preoperative measurement was statistically significant (p = 0.001; p <0.01). The decrease in postoperative 6th month Zinc measurement compared to postoperative 1st month measurement was statistically significant (p = 0.001; p <0.01). The other changes were not statistically significant (p>0.05). The values decreased linearly, but the mean values were not measured as zinc deficiency in any month.

Table 3.11 Evaluation of Magnesium Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Magnesium	**Pre-op**	1,5-3,9 (2)	2,03±0,35
(mg/dL)	**Post-op 1.month**	1,5-2,4 (2)	1,94±0,18
	Post-op 3.month	1,7-2,5 (2,1)	2,05±0,19
	Post-op 6.month	1,7-20,5 (2)	2,48±2,89
		[a]p	***0,020****
Paired comparisons;	**Pre-op – Post-op 1.month**		***0,801***
[b]p	**Pre-op – Post-op 3.month**		***1,000***
	Pre-op – Post-op 6.month		***1,000***
	Post-op 1.month- 3.month		***0,027****
	Post-op 1.month- 6.month		***0,018****
	Post-op 3.month- 6.month		***1,000***

[a]Repeated Measures Test **p<0.05*

[b]Adjustment for multiple comparisons: Bonferroni

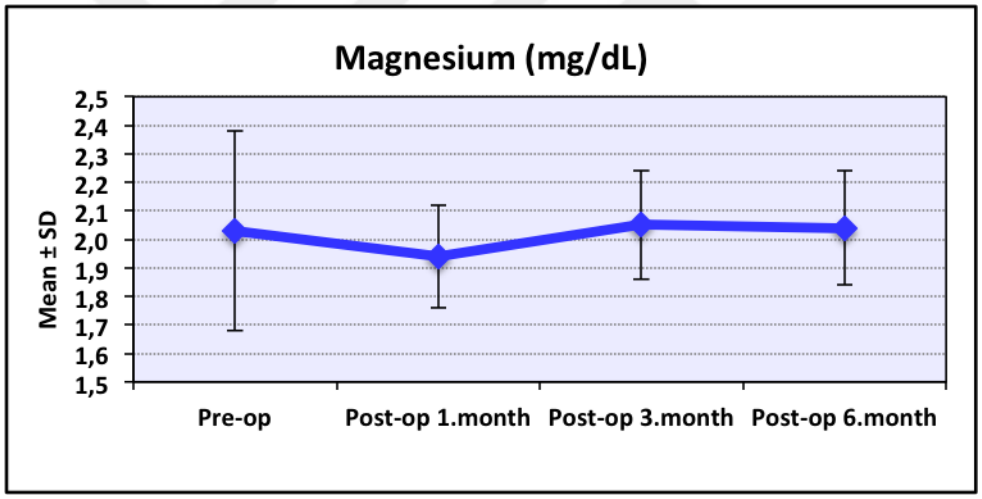

Figure 3.12 Chart of Magnesium Measurements in Follow-up

While the mean preoperative Magnesium measurement of the patients was 2.03± 0.35 mg/dL, postoperative 1st month measurement was 1.94±0.18 mg/dL, postoperative 3rd month measurement was 2.05±0.19 mg/dL and postoperative 6th month measurements was 2.04±0.20 mg/dL.

Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Magnesium measurements were evaluated, and the change was statistically significant ($p=0.020$; $p<0.05$). As a result of paired comparisons; the increase in postoperative 3th month and 6th month Magnesium measurements compared to postoperative 1st month

measurement was statistically significant (p=0.027; p=0.018; p<0.05, respectively). The other changes were not statistically significant (p>0.05).

Table 3.12 Evaluation of Phosphorus Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Phosphorus	**Pre-op**	2,5-4,7 (3,2)	3,28±0,45
(mg/dL)	**Post-op 1.month**	2,7-5,9 (3,4)	3,55±0,59
	Post-op 3.month	2,9-5,2 (3,7)	3,76±0,53
	Post-op 6.month	2,7-5 (3,9)	3,83±0,48
	[a]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,018****	
[b]p	**Pre-op – Post-op 3.month**	***0,001*****	
	Pre-op – Post-op 6.month	***0,001*****	
	Post-op 1.month- 3.month	***0,013****	
	Post-op 1.month- 6.month	***0,012****	
	Post-op 3.month- 6.month	***1,000***	

[a]Repeated Measures Test ***p<0.01* **p<0.05*

[b]Adjustment for multiple comparisons: Bonferroni

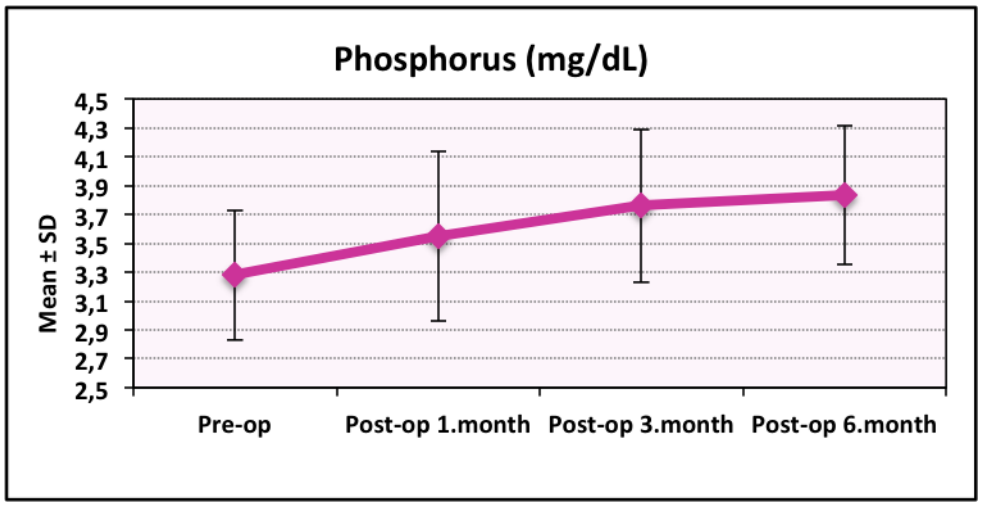

Figure 3.13 Chart of Phosphorus Measurements in Follow-up

While the mean preoperative Phosphorus measurement was 3.28±0.45 mg/dL, postoperative 1st month measurement was 3.55±0.59 mg/dL, postoperative 3rd month measurement was 3.76±0.53 mg/dL and postoperative 6th month measurement was

3.83±0.48 mg/dL of the patients. Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Phosphorus measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01). As a result of paired comparisons; the increase in postoperative 1st month, 3rd month and 6th month Phosphorus measurements compared to preoperative measurements were statistically significant (p=0.018; p=0.001; p=0.001; p<0.05, respectively). The increase in Phosphorus measurements of the postoperative 3rd and postoperative 6th month compared to the postoperative 1st month was also statistically significant (p = p=0.013; p=0.012; p<0.05, respectively). The other changes have not found as statistically significant (p>0.05).

Table 3.13 Evaluation of Iron Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Iron (µg/dL)	**Pre-op**	14-122 (59)	64,41±28,38
	Post-op 1.month	18,8-124,8 (63,9)	63,40±25,27
	Post-op 3.month	23,5-146,6 (78,9)	79,72±28,67
	Post-op 6.month	14,9-163,8 (83)	81,82±32,57
	[a]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***1,000***	
[b]p	**Pre-op – Post-op 3.month**	***0,047****	
	Pre-op – Post-op 6.month	***0,010****	
	Post-op 1.month- 3.month	***0,001*****	
	Post-op 1.month- 6.month	***0,003*****	
	Post-op 3.month- 6.month	***1,000***	

[a]Repeated Measures Test ***p<0.01* **p<0.05*

[b]Adjustment for multiple comparisons: Bonferroni

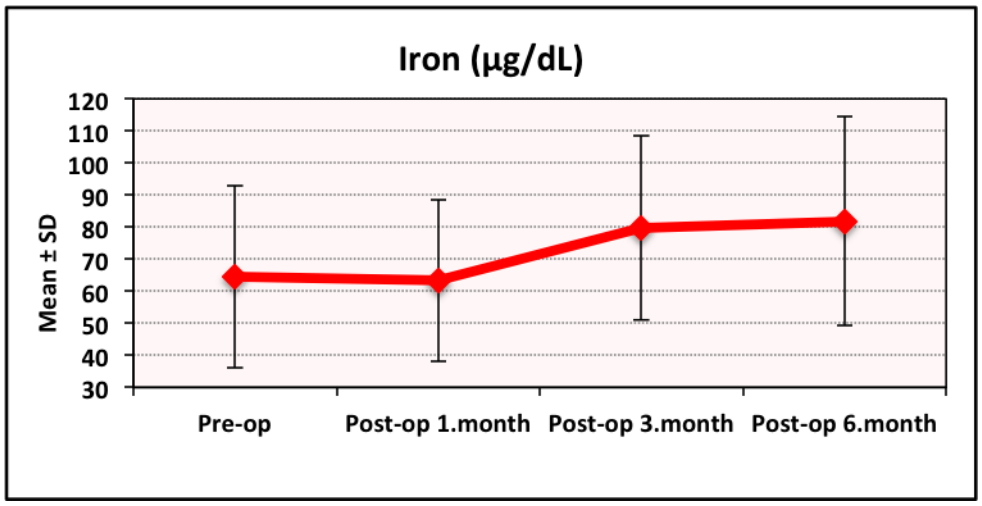

Figure 3.14 Chart of Iron Measurements in Follow-up

While the mean preoperative Iron measurement of the patients was 64.41±28.38 µg/dL, postoperative 1st month measurement was 63.40±25.27 µg/dL, postoperative 3rd month measurement was 79.72±28.67 µg/dL and postoperative 6th month measurement was 81.82±32.57 µg/dL. Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Iron measurements were evaluated, and the change was statistically significant ($p=0.001$; $p<0.01$). As a result of paired comparisons; the increase in postoperative 3rd month and 6th month Iron measurements compared to preoperative measurement were statistically significant ($p=0.047$; $p=0.010$; $p<0.05$, respectively). The increase in postoperative 3rd month and 6th month Iron measurements compared to postoperative 1st month measurement was statistically significant ($p=0.001$; $p=0.003$; $p<0.01$, respectively). The other changes have not found as statistically significant ($p>0.05$).

Table 3.14 Evaluation of Glucose Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Glucose (fasting) (mg/dL)	**Pre-op**	78-270 (104)	113,68±34,41
	Post-op 1.month	68-139 (90)	91,39±17,07
	Post-op 3.month	66-143 (86)	88,59±15,40
	Post-op 6.month	63-117 (85)	85,88±10,79
	[c]p	***0,001*****	
Paired comparisons; [d]p	**Pre-op – Post-op 1.month**	***0,001*****	
	Pre-op – Post-op 3.month	***0,001*****	
	Pre-op – Post-op 6.month	***0,001*****	
	Post-op 1.month- 3.month	***0,097***	
	Post-op 1.month- 6.month	***0,010****	
	Post-op 3.month- 6.month	***0,185***	

[c]Friedman Test *[d]Wilcoxon Signed Ranks Test* ***p<0.01* **p<0.05*

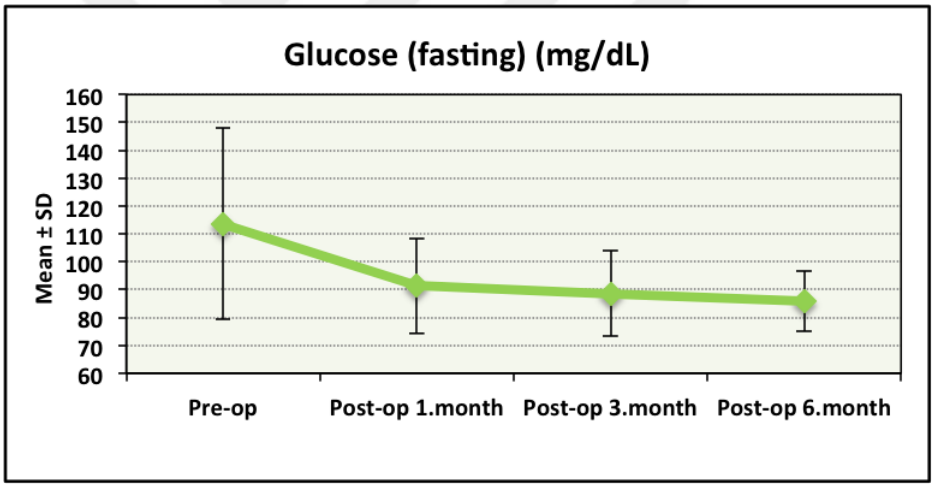

Figure 3.15 Chart of Glucose Measurements in Follow-up

Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Glucose measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month, 3rd month and 6th month weight measurements compared to preoperative measurement were statistically significant. (p = 0.001; p = 0.001; p = 0.001; p <0.01, respectively). The decrease in the postoperative 6th month glucose measurement compared to 1st month measurement was statistically significant as well (p=0.010; p<0.05). Other changes have not found as statistically significant. (p>0.05).

Table 3.15 Evaluation of HbA1c Measurements in Follow-up

		Min-Max (Median)	Mean±SD
HbA1c (%)	**Pre-op**	4,8-9 (5,6)	5,81±0,89
	Post-op 1.month	4,7-7,8 (5,2)	5,44±0,68
	Post-op 3.month	4,6-6,6 (5,4)	5,35±0,48
	Post-op 6.month	4-6,6 (5,3)	5,35±0,55
	[a]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001*****	
[b]p	**Pre-op – Post-op 3.month**	***0,002*****	
	Pre-op – Post-op 6.month	***0,006*****	
	Post-op 1.month- 3.month	***1,000***	
	Post-op 1.month- 6.month	***1,000***	
	Post-op 3.month- 6.month	***1,000***	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

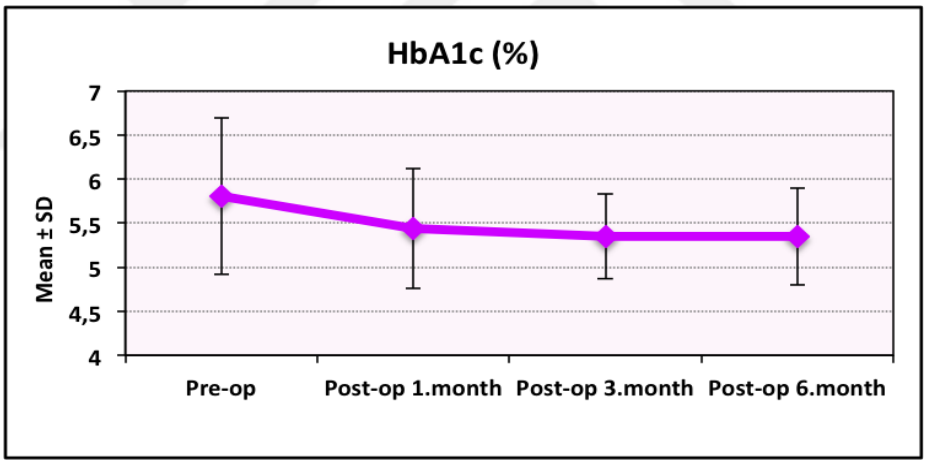

Figure 3.16 Chart of HbA1c Measurements in Follow-Up

Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month HbA1c measurements were evaluated and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month, 3rd month and 6th month weight measurements compared to preoperative measurement were statistically significant. (p=0.001; p=0.002; p=0.006; p<0.01, respectively). Other changes have not found as statistically significant. (p>0.05).

Table 3.16 Evaluation of Albumin Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Albumin (g/dL)	**Pre-op**	3,9-5,1 (4,4)	4,39±0,23
	Post-op 1.month	3,7-5 (4,2)	4,20±0,25
	Post-op 3.month	3,5-7,1 (4,2)	4,36±0,68
	Post-op 6.month	3,4-5 (4,2)	4,20±0,28
	[c]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001*****	
[d]p	**Pre-op – Post-op 3.month**	***0,007*****	
	Pre-op – Post-op 6.month	***0,001*****	
	Post-op 1.month- 3.month	***0,118***	
	Post-op 1.month- 6.month	***0,539***	
	Post-op 3.month- 6.month	***0,211***	

[c]Friedman Test *[d]Wilcoxon Signed Ranks Test* ***p<0.01* **p<0.05*

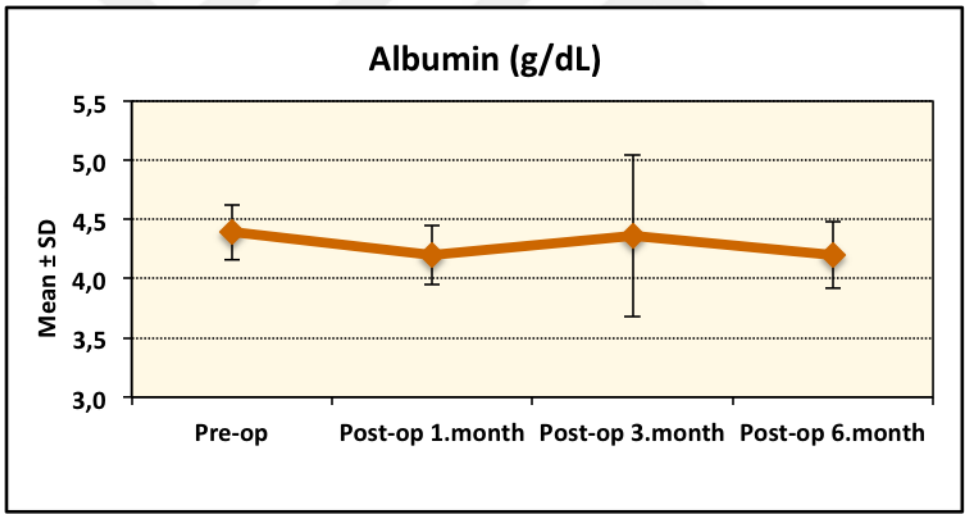

Figure 3.17 Chart of Albumin Measurements in Follow-up

Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Albumin measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month, 3rd month and 6th month weight measurements compared to preoperative measurement were statistically significant. (p=0.001; p=0.007; p=0.001; p<0.01, respectively). Other changes have not found as statistically significant. (p>0.05).

Table 3.17 Evaluation of Uric Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Uric acid (mg/dL)	**Pre-op**	4,1-11,7 (5,9)	6,23±1,48
	Post-op 1.month	3,6-13,2 (7)	7,65±2,45
	Post-op 3.month	3,2-9,5 (5,6)	5,91±1,56
	Post-op 6.month	2,9-8,2 (5,1)	5,25±1,28
	[a]p	***0,001****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,004****	
[b]p	**Pre-op – Post-op 3.month**	***0,349***	
	Pre-op – Post-op 6.month	***0,001****	
	Post-op 1.month- 3.month	***0,001****	
	Post-op 1.month- 6.month	***0,001****	
	Post-op 3.month- 6.month	***0,001****	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

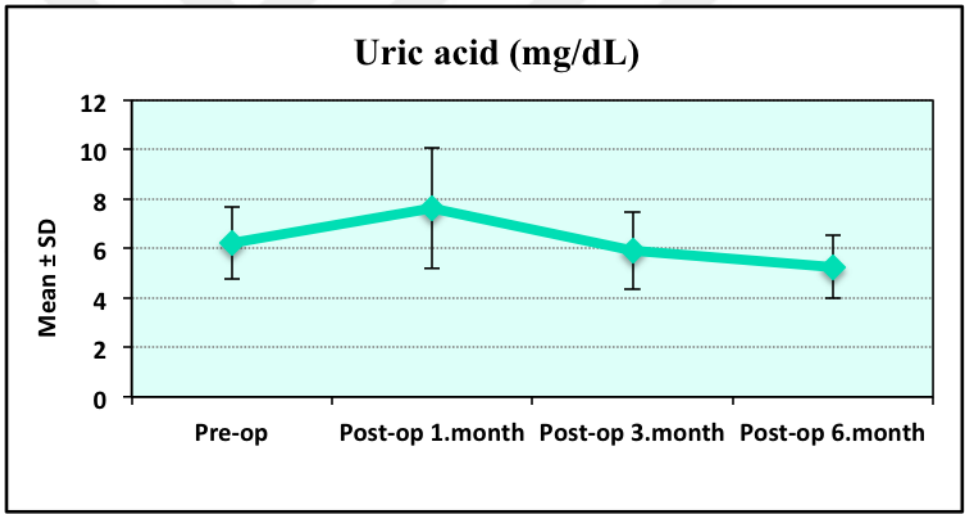

Figure 3.18 Chart of Uric Acid Measurements in Follow-up

Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month Uric acid measurements were evaluated and the changes were statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the increase in postoperative 1st month compared to preoperative measurement was statistically significant and the decrease in postoperative 6th month compared to preoperative measurement was statistically significant p=0.004; p=0.001; p<0.01, respectively). The decrease in the postoperative 3rd and 6th month uric acid measurements compared to 1st month measurement was statistically significant as well (p=0.001; p=0.001; p<0.01 respectively)

The decrease in the postoperative 6th month measurements compared to 3rd month measurements was statistically significant as well (p=0.001; p<0.01).

Table 3.18 Evaluation of Total Cholesterol Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Total cholesterol	**Pre-op**	121-289 (196)	204,10±38,53
(mg/dL)	**Post-op 1.month**	91-283 (172)	174,27±38,82
	Post-op 3.month	118-262 (191)	195,22±36,95
	Post-op 6.month	134-364 (211)	208,93±45,20
	[a]p	***0,001*****	
Paired	**Pre-op – Post-op 1.month**	***0,001*****	
comparisons; [b]p	**Pre-op – Post-op 3.month**	***0,143***	
	Pre-op – Post-op 6.month	***1,000***	
	Post-op 1.month- 3.month	***0,001*****	
	Post-op 1.month- 6.month	***0,001*****	
	Post-op 3.month- 6.month	***0,018****	

[a]Repeated Measures Test *[b]Adjustment for multiple comparisons: Bonferroni*

***p<0.01* **p<0.05*

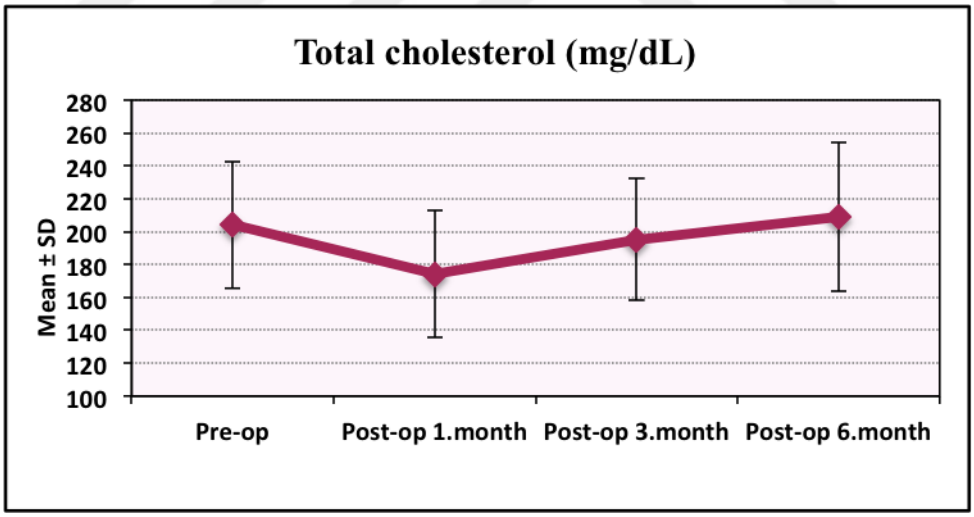

Figure 3.19 Chart of Total Cholesterol Measurements in Follow-up

Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month total cholesterol measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month total cholesterol measurements compared to preoperative measurements were statistically significant. (p=0.001; p<0.01) The increase in the postoperative 3rd and 6th month weight measurements compared to 1st month

measurement was statistically significant as well (p=0.001; p=0.001; p<0.01 respectively) The increase in the postoperative 6th month uric acid measurements compared to 3rd month measurement was statistically significant as well (p=0.018; p<0.05).

Table 3.19 Evaluation of HDL Measurements in Follow-up

		Min-Max (Median)	Mean±SD
HDL (mg/dL)	**Pre-op**	33-83 (45)	47,61±10,73
	Post-op 1.month	22,7-62,2 (39)	40,81±8,91
	Post-op 3.month	29,4-78 (45,2)	47,88±10,83
	Post-op 6.month	25,1-92 (53)	53,28±13,59
	[a]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001*****	
[b]p	**Pre-op – Post-op 3.month**	***1,000***	
	Pre-op – Post-op 6.month	***0,009*****	
	Post-op 1.month- 3.month	***0,001*****	
	Post-op 1.month- 6.month	***0,001*****	
	Post-op 3.month- 6.month	***0,001*****	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

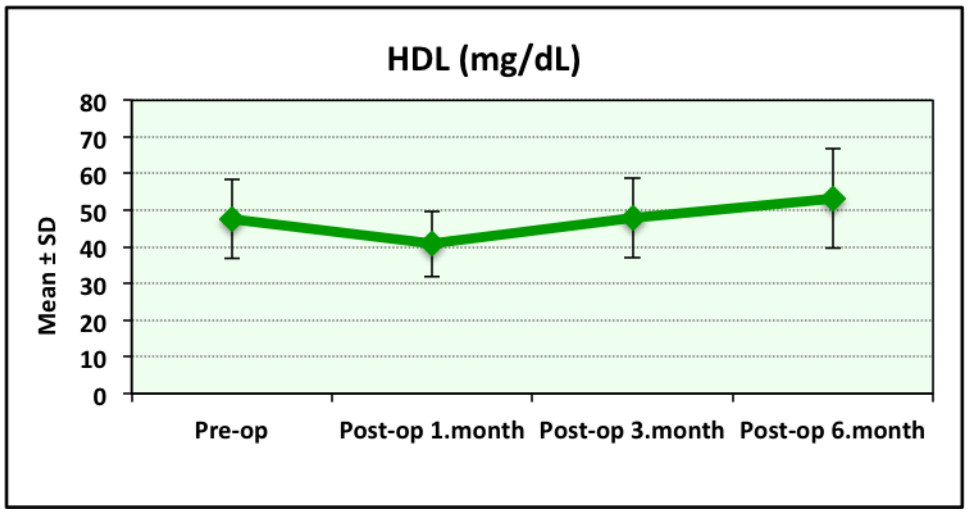

Figure 3.20 Chart of HDL Measurements in Follow-up

Preoperative and postoperative 1st, postoperative 3rd and postoperative 6th month HDL measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month and

the increase in 6th month measurement compared to preoperative measurement was statistically significant. (p=0.001; p<0.01) The increase in the postoperative 3rd and 6th month HDL measurements compared to 1st month measurement was statistically significant as well (p=0.001; p=0.001; p<0.01 respectively) The increase in the postoperative 6th month measurement compared to 3rd month measurement was statistically significant as well (p=0.001; p<0.01).

Table 3.20 Evaluation of LDL Measurements in Follow-up

		Min-Max (Median)	Mean±SD
LDL (mg/dL)	**Pre-op**	77-214 (137)	139,90±33,92
	Post-op 1.month	41-207 (105)	108,49±32,39
	Post-op 3.month	67-179 (122)	124,00±30,40
	Post-op 6.month	66-283 (134)	134,66±38,07
	[a]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001*****	
[b]p	**Pre-op – Post-op 3.month**	***0,001*****	
	Pre-op – Post-op 6.month	***1,000***	
	Post-op 1.month- 3.month	***0,001*****	
	Post-op 1.month- 6.month	***0,001*****	
	Post-op 3.month- 6.month	***0,058***	

[a]Repeated Measures Test ***p<0.01*

[b]Adjustment for multiple comparisons: Bonferroni

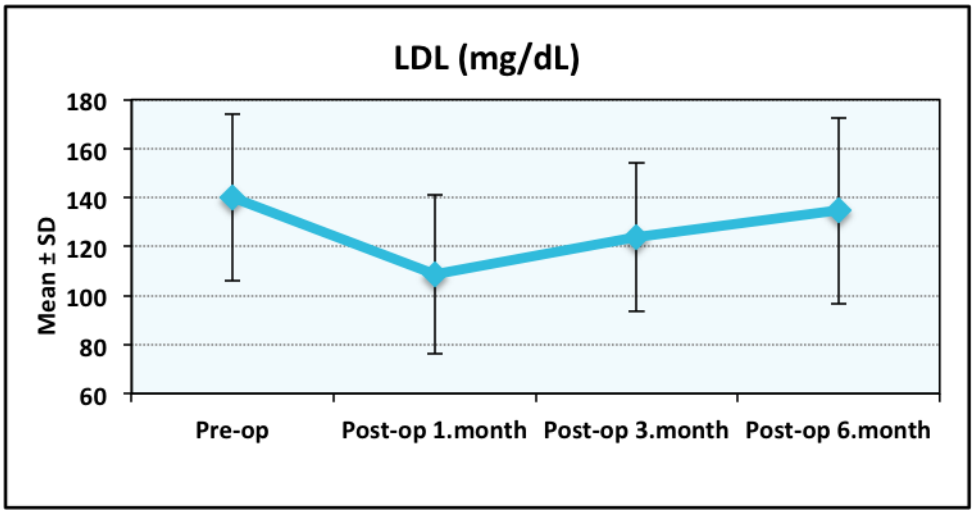

Figure 3.21 Chart of LDL Measurements in Follow-up

Preoperative and postoperative 1st, 3rd, and 6th months LDL measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month, 3rd month LDL measurements compared to preoperative measurement was statistically significant(p=0.001; p=0.001; p<0.01 respectively).The increase in the postoperative 3rd and 6th month weight measurements compared to 1st month measurement was statistically significant as well (p=0.001; p=0.001; p<0.01 respectively). Other changes have not found as statistically significant. (p>0.05).

Table 3.21 Evaluation of Triglyceride Measurements in Follow-up

		Min-Max (Median)	Mean±SD
Triglyceride	**Pre-op**	38-330 (126)	137,51±68,59
(mg/dL)	**Post-op 1.month**	63,3-210 (123)	123,68±39,10
	Post-op 3.month	55-184,4 (115,8)	116,45±34,08
	Post-op 6.month	50,5-193 (107,6)	106,22±31,49
	[a]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,735***	
[b]p	**Pre-op – Post-op 3.month**	***0,189***	
	Pre-op – Post-op 6.month	***0,012****	
	Post-op 1.month- 3.month	***0,451***	
	Post-op 1.month- 6.month	***0,005*****	
	Post-op 3.month- 6.month	***0,007*****	

[a]Repeated Measures Test *[b]Adjustment for multiple comparisons: Bonferroni*

***p<0.01* **p<0.05*

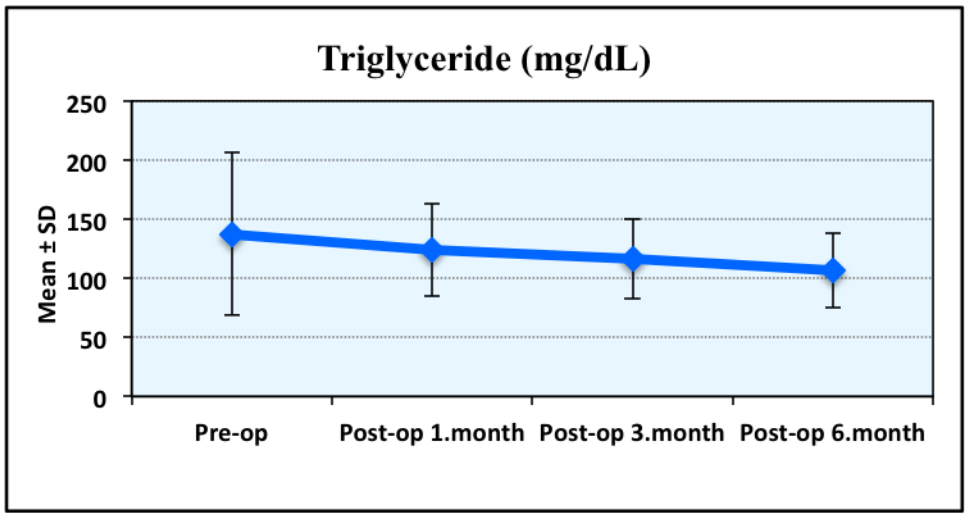

Figure 3.22 Chart of Triglyceride Measurements in Follow-up

Preoperative and postoperative 1st, 3rd, and 6th months Triglyceride measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 6th month triglyceride measurements compared to preoperative measurement was statistically significant (p=0.012; p<0.05). The decrease in the postoperative 6th month triglyceride measurement compared to 1st and 3rd months measurement was statistically significant as well ((p=0.005; p=0.007; p<0.01 respectively). Other changes have not found as statistically significant. (p>0.05).

Table 3.22 Evaluation of PTH Measurements in Follow-up

		Min-Max (Median)	Mean±SD
PTH (pg/mL)	**Pre-op**	14,1-115,5 (58,4)	61,04±21,70
	Post-op 1.month	17,9-86,8 (44,8)	48,62±17,18
	Post-op 3.month	18,1-153,6 (46,5)	50,47±23,75
	Post-op 6.month	12,1-120,5 (47,6)	49,49±20,23
	[a]p	***0,001*****	
Paired comparisons;	**Pre-op – Post-op 1.month**	***0,001*****	
[b]p	**Pre-op – Post-op 3.month**	***0,049****	
	Pre-op – Post-op 6.month	***0,011****	
	Post-op 1.month- 3.month	***1,000***	
	Post-op 1.month- 6.month	***1,000***	
	Post-op 3.month- 6.month	***1,000***	

[a]Repeated Measures Test *[b]Adjustment for multiple comparisons: Bonferroni*

***p<0.01* **p<0.05*

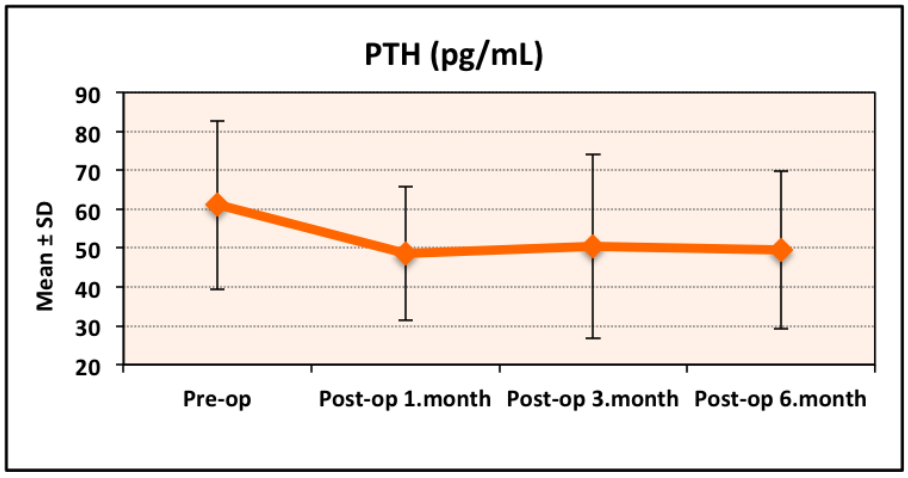

Figure 3.23 Chart of PTH Measurements in Follow-up

Preoperative and postoperative 1st, 3rd, and 6th months PTH measurements were evaluated, and the change was statistically significant (p=0.001; p<0.01) As a result of paired comparisons; the decrease in postoperative 1st month, 3rd month and 6th month PTH measurements compared to preoperative measurements were statistically significant (p=0.001; p=0.049; p=0.011; p<0.05, respectively). Other changes have not found as statistically significant. (p>0.05).

Table 3.23 Evaluation of TSH Measurements in Follow-up

		Min-Max (Median)	Mean±SD
TSH (µIU/mL)	**Pre-op**	0,1-16,5 (1,4)	1,93±2,46
	Post-op 1.month	0-11,2 (1,6)	1,82±1,77
	Post-op 3.month	0-4,3 (1,5)	1,60±0,99
	Post-op 6.month	0,4-8,5 (1,6)	1,91±1,46
	[c]p	***0,209***	

[c]Friedman Test

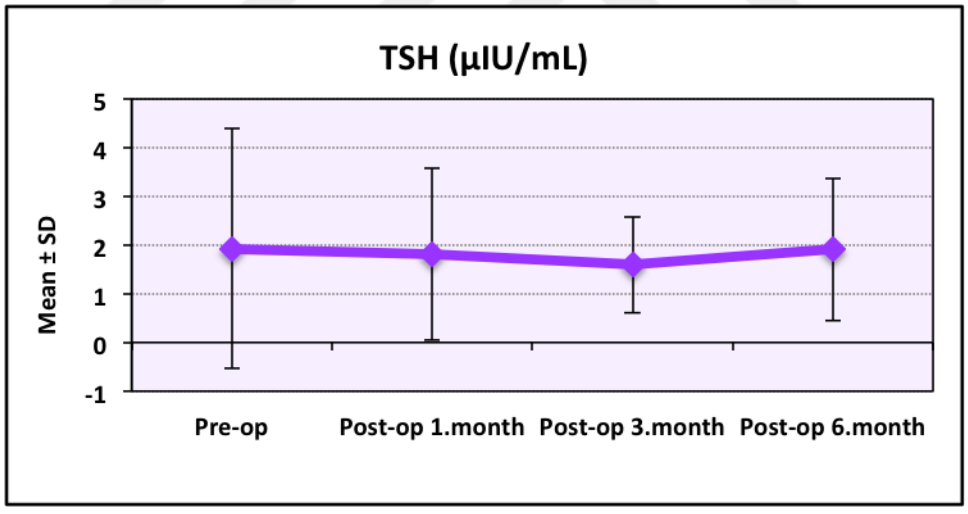

Figure 3.24 Chart of TSH Measurements in Follow-up

Preoperative and postoperative 1st, 3rd, and 6th months TSH measurements were evaluated, and the change was not statistically significant (p>0.05).

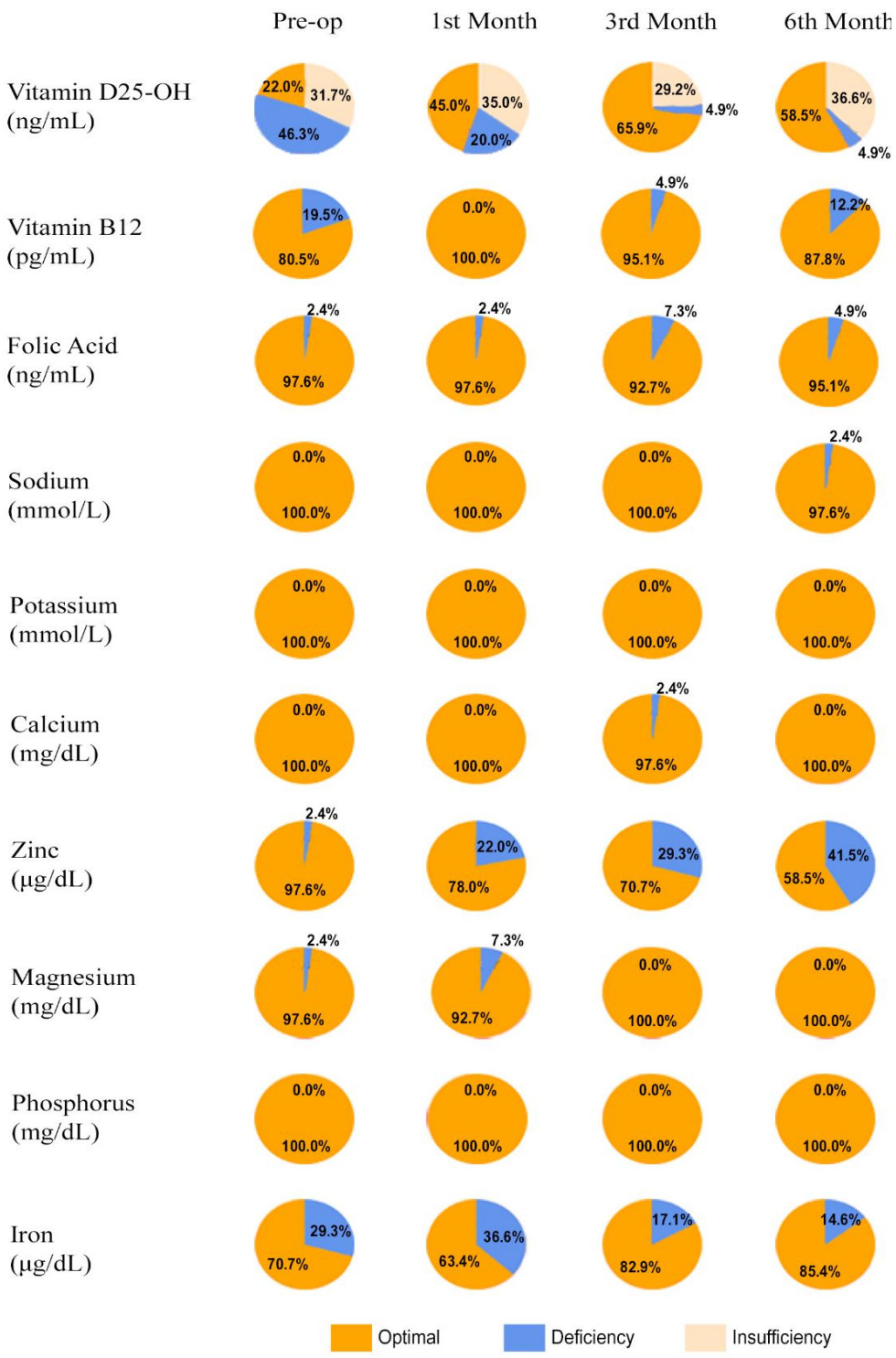

Figure 3.25 Biochemical Range Changes by Months

According to blood tests, patients were classified according to deficiency, insufficiency and optimal value ranges. The percentage was calculated according to the number of people in these value ranges. This method was evaluated separately for each measurements period.

In preoperative measurements 46.3% (n=19) of the patients had deficiency, 31.7% (n=13) had insufficiency and 22%(n=9) had optimal range for vitamin D; 19.5% (n=8) of the patients had deficiency, 80.5% (n=33) had optimal range for vitamin B12; of the patients had deficiency 2.4% (n=1), 97.6% (n=40) had optimal range for folic acid, zinc, and magnesium ; 29.3% (n=12) of the patients had deficiency, 70.7% (n=29) had optimal range for iron; 100%(n=41) of the patients had optimal range for sodium, potassium, calcium and phosphorus.

In 1st month measurements 20% (n=8) of the patients had deficiency, 35% (n=14) had insufficiency and 45% (n=19) had optimal range for vitamin D; 2.4% (n=1) of the patients had deficiency, 97.6% (n=40) had optimal range for folic acid; 22% (n=9) of the patients had deficiency, 78% (n=32) had optimal range for zinc; 7.3% (n=3) of the patients had deficiency, 92.7% (n=38) had optimal range for magnesium; 36.6% (n=15) of the patients had deficiency, 63.4% (n=26) had an optimal range for iron; 100%(n=41) of the patients had an optimal range for vitamin B12, sodium, potassium, calcium and phosphorus.

In 3rd month measurements 4.9% (n=2) of the patients had deficiency, 29.2% (n=12) had insufficiency and 65.9% (n=27) had optimal range for vitamin D; 4.9% (n=2) of the patients had deficiency, 95.1% (n=39) had optimal range for vitamin B12; 7.3% (n=3) of the patients had deficiency, 92.7% (n=38) had optimal range for folic acid; 2.4% (n=1) of the patients had deficiency, 97.6% (n=40) had optimal range for calcium; 29.3% (n=12) of the patients had deficiency, 70.7% (n=29) had optimal range for zinc; 17.1% (n=7) of the patients had deficiency, 82.9% (n=34) had optimal range for iron; 100%(n=41) of the patients had an optimal range for sodium, potassium, magnesium and phosphorus.

In 6st month measurements 4.9% (n=2) of the patients had deficiency, 36.6% (n=15) had insufficiency and 58.5% (n=24) had optimal range for vitamin D; 12.2% (n=5) of the patients had deficiency, 87.8% (n=36) had optimal range for vitamin B12; 4.9% (n=2) of the patients had deficiency, 95.1% (n=39) had optimal range for folic acid; 2.4% (n=1) of the patients had deficiency, 97.6% (n=40) had optimal range for sodium; 41.5% (n=17) of the patients had deficiency, 58.5% (n=24) had optimal range for zinc; 14.6% (n=6) of the patients had deficiency, 85.4% (n=35) had optimal range for iron; 100%(n=41) of the patients had an optimal range for calcium, potassium, magnesium and phosphorus.

Table 3.24 Evaluation of vitamin-mineral measurements for weight loss percentages of preoperative and postoperative 6th month

Differences of Preoperative - Postoperative 6th month (%)		Preoperative - Postoperative 6th month weight loss (%) ≤ %30 (n=17)	> % 30 (n=24)	*p*
Vitamin D25-OH (ng/mL)	*Min/Max (Median)*	-58,4 / 259,7 (26,6)	-69,3 / 600,9 (61,6)	***0,214***
	Mean±SD	59,88±105,52	111,84±156,31	
Vitamin B12 (pg/mL)	*Min/Max (Median)*	-48,7 / 113,3 (26,7)	-52,7 / 122,8 (4,9)	***0,634***
	Mean±SD	20,32±50,68	16,47±51,42	
Folic acid (ng/mL)	*Min/Max (Median)*	-58,4 / 541,7 (72,8)	-63,5 / 175,2 (0,7)	***0,044****
	Mean±SD	98,24±164,82	10,56±62,56	
Sodium (mmol/L)	*Min/Max (Median)*	-0,8 / 6,2 (0,9)	-10,8 / 4,4 (1,9)	***0,458***
	Mean±SD	1,24±1,69	1,01±3,11	
Potassium (mmol/L)	*Min/Max (Median)*	-17,6 / 24,8 (6,7)	-5,1 / 24,4 (6,1)	***0,483***
	Mean±SD	3,97±10,66	6,61±6,38	
Calcium (mg/dL)	*Min/Max (Median)*	-12,6 / 8,8 (1)	-5,4 / 6,2 (0,5)	***0,895***
	Mean±SD	-0,09±4,83	0,47±2,62	
Zinc (µg/dL)	*Min/Max (Median)*	-47,7 / 16,8 (-16,7)	-56,8 / 27,8 (-14,2)	***0,937***
	Mean±SD	-14,86±16,08	-14,56±20,7	
Magnesium (mg/dL)	*Min/Max (Median)*	-44,7 / 32,3 (3,2)	-19,8 / 20,9 (2)	***0,443***
	Mean±SD	4,12±17,79	1,31±9,00	
Phosphorus (mg/dL)	*Min/Max (Median)*	-21,3 / 72,8 (10,8)	-3,5 / 59,3 (18,2)	***0,308***
	Mean±SD	15,41±23,65	20,99±18,75	
Iron (µg/dL)	*Min/Max (Median)*	-64,4 / 191,3 (28,4)	-87,8 / 490 (37,1)	***0,895***
	Mean±SD	42,12±66,49	73,54±144,22	

Mann Whitney U Test **p<0.05*

In the postoperative 6th month, the patients were examined in 2 classes as patients whose weight loss percentage were equal or less than 30% and patients whose weight loss percentage were more than 30% percent. There were no statistically significant differences in vitamin D, vitamin B12, sodium, potassium, calcium, zinc, magnesium, phosphorus and iron. (P> 0.05).

The patients who lost 30% or less in the postoperative 6th month according to the preoperative period; the changes in folic acid measurements in this process ranged from 58.4% to 541.7%, with an average increase of 98.24 ± 164.82%. Patients who lost more

than 30% weight in the postoperative 6th month according to the preoperative period; The changes in folic acid measurements in this process ranged from 63.5% to 175.2%, with an average increase of 10.56 ± 62.56%. There was a statistically significant difference between the percentage changes in folic acid measurements according to the weight loss levels of the cases. (p=0.044; p<0.05) The increase in folic acid measurements of patients who lost 30% or less in the postoperative 6th month was higher than the ones who lost more than 30% weight.

Table 3.25 Relationship Between Changes in Weight Loss Percentages and Changes in Vitamin and Mineral Measurements

		Weight Loss (%)			
Differences (%)		**Preoperative - Postoperative 1. month**	**Preoperative - Postoperative 3. month**	**Preoperative - Postoperative 6. month**	**Postoperative 1. month - 6. month**
Vitamin D25-OH (ng/mL)	**r**	0,121	0,045	0,021	-0,148
	p	***0,449***	***0,781***	***0,896***	***0,355***
Vitamin B12 (pg/mL)	**r**	-0,222	0,010	0,028	0,304
	p	***0,163***	***0,953***	***0,860***	***0,054***
Folic acid (ng/mL)	**r**	-0,347	-0,080	0,180	0,205
	p	***0,026****	***0,620***	***0,259***	***0,198***
Sodium (mmol/L)	**r**	-0,250	-0,122	-0,110	0,075
	p	***0,115***	***0,448***	***0,493***	***0,642***
Potassium (mmol/L)	**r**	0,250	-0,053	-0,143	-0,049
	p	***0,114***	***0,744***	***0,372***	***0,763***
Calcium (mg/dL)	**r**	0,078	-0,062	0,083	0,053
	p	***0,626***	***0,701***	***0,607***	***0,740***
Zinc (µg/dL)	**r**	0,164	0,237	0,116	0,128
	p	***0,306***	***0,135***	***0,469***	***0,425***
Magnesium (mg/dL)	**r**	0,183	0,041	0,081	-0,093
	p	***0,252***	***0,798***	***0,615***	***0,563***
Phosphorus (mg/dL)	**r**	0,185	0,006	0,002	0,144
	p	***0,248***	***0,972***	***0,989***	***0,370***
Iron (µg/dL)	**r**	0,057	0,252	-0,036	-0,150
	p	***0,726***	***0,112***	***0,821***	***0,350***

r: Spearman's Correlation Coefficient **p<0.05*

In the above table (table 3.25), the correlation of the weight loss percentage and vitamin, mineral differences were evaluated. The correlation coefficient (r) indicates the degree of correlation between any two characters. The fact that if the coefficient sign is "-", it defines negative correlation and if coefficient sign is "+", it defines positive correlation.

There was no statistically significant correlation between the preoperative and postoperative 1st month weight loss percentages, the changes in vitamin D, vitamin B12, sodium, potassium, calcium, zinc, magnesium, phosphorus and iron measurements ($p>0.05$). There was a statistically significant negative correlation between the preoperative and postoperative 1st month weight loss percentages and the changes in folic acid measurements ($r: -0.347$; $p = 0.026$; $p <0.05$).

There was no statistically significant correlation between the preoperative and postoperative 3rd month weight loss percentages, the changes in vitamin D, vitamin B12, folic acid, sodium, potassium, calcium, zinc, magnesium, phosphorus and iron measurements ($p>0.05$).

There was no statistically significant correlation between the preoperative and postoperative 6th month weight loss percentages and the changes in vitamin D, vitamin B12, folic acid, sodium, potassium, calcium, zinc, magnesium, phosphorus and iron measurements according to preoperative measurements ($p>0.05$).

There was no statistically significant correlation between the postoperative 1st month and postoperative 6th month weight loss percentages and the changes in vitamin D, vitamin B12, folic acid, sodium, potassium, calcium, zinc, magnesium, phosphorus and iron measurements ($p>0.05$). There was a positive correlation between vitamin B12 measurements (as percentage of weight loss increases, percentage changes in vitamin B12 also increase). Although this was not statistically significant, it was found to be close to significance ($r: 0.304$; $p = 0.054$; $p> 0.05$).

4. DISCUSSION and CONCLUSION

Study population consisted of 41 patients. %78 (n=32) of patients were female, %22 (n=9) of patients were male. The age range of the patients in this study was between 18-58 years of age. The mean age for patients was 40.66±11.10. When BMI values of the patients included in the study were examined, the lowest value was calculated as 35.3 kg/m^2 and the highest value was 68.8 kg/m^2. The mean BMI for patients was 44,08±7,17 kg/m^2.

Even though many models are present to predict successful body weight loss or absolute body weight after bariatric surgery no models are certain. Furthermore, models which aim to predict minimal weight loss are limited. Even between these models, there is a lack of a standard determination of how to measure minimal weight loss (96).

We observed that patient BMI (kg/m^2) values were 44.08 kg/m^2 at the beginning and decreased to 30.23 kg/m^2 at 6th month after surgery. Mean change in BMI (kg/m^2) was 13,85 kg/m^2. In a systematic review and meta analysis study, mean change in BMI (kg/m^2) at 6 months after SG surgery was -11.5(-8.8, -14.2). So the values were approximately similar to our values (97).

Lee et al. (98) showed that changes in weight outcomes, mean values, at 6 months after SG in the Medicare-eligible population (n=48); weight lost value is 23.5 kg, BMI reduction is 7.8 kg/m^2, percent weight loss is 18.5 (38). The results found in this study are lower than our study.

Leonetti et al. (99) found that, compared to patients (n=30) receiving conventional treatment with pharmaceutical agents and lifestyle modifications (diet and physical activity), BMI loss in the LSG group was 13.5 kg/m^2 in 18 months compared to a mean 0.17 kg/m^2 increase in the conventional treatment group.

Vitamin B12, iron, folate, calcium and vitamin D are the most frequent nutritional deficiencies after bariatric surgery. These deficiencies should be detected early and treated to prevent postoperative complications (89,90). In our study results showed that frequent follow-up and nutritional support are safe in patients with SG. On the other hand, some investigators defend that SG is not malabsorptive procedure, thus is no need nutritional supplementation for lifelong (100).

The mean value of vitamin D in our study was found to be 26.61 ± 21.26 ng / mL in the preoperative measurement. This value is in the class of inadequacy according to biochemical references. The 1st postoperative month mean value was measured as

33.22±20.05 ng/mL and the postoperative 3rd month mean value was measured as 40.32±17.60 ng/mL thus it reached the optimal level according to the preoperative period. At the 6th month mean value was measured as 33.76±11.40 ng/mL. The values decreased moderately at 6th month but did not reach the level of deficiency. Also, as result; there is no correlation between change of vitamin D levels and percentage of weight loss value. The optimization of vitamin D levels may be interpreted as the effect of weight loss or supplementation. Daily vitamin D requirement depends on body weight, season and sensitive sunlight. The recommended daily allowance (RDA) for Vitamin D according to American Endocrine Society Vitamin D guideline values while 800–2000 IU / 20.0–50.0μg in adults and seniors (18–64 years), 1600–4000 IU / 40–100 μg in obese adults. Related these changes may be considered to reduce the vitamin D requirement with weight loss process (101).

Similar to the deficiency we observed in the preoperative measurements, there are studies in which vitamin D deficiency is observed in obese patients who have not been operated. A cross-sectional study in China showed a significant adverse association between 25(OH)D levels and waist circumference and waist-to-hip ratio. Results showed that adiposity was related to low 25(OH)D levels (77,102).

Studies suggest that the secondary hyperparathyroidism (SHPT) is due to vitamin D deficiency, an independent relationship has been adduced between obesity and PTH levels (103). In our study, changes in vitamin D and PTH levels showed opposite graphs. Decreased PTH level was observed when vitamin D level is increased.

There is no correlation between change of vitamin B12 levels and percentage of weight loss value. The mean value of vitamin B12 in our study was found to be 286.29±103.69 pg/ mL in the preoperative measurement. The 1st postoperative month mean value was 428.34±130.77 pg/mL and the postoperative 3rd month mean value was measured as 359,15±135,12 pg/mL. At the 6th month mean value was measured 311.49±121.26 pg/mL. There are no mean values under the biochemical range as deficiency in any month in this study. ASMBS Integrated Health Nutritional Guidelines reported that the prevalence of B12 deficiency is 2–18% in patients with obesity and the prevalence of B12 deficiency post BS at 2–5 years is <20% in RYGB and 4–20% in SG (92).

The mean value of Iron in our study was found to be 64.41±28.38 μg/dL in the preoperative measurement. The 1st postoperative month mean value was 63.40±25.27 μg/dL and the postoperative 3rd month mean value was measured 79.72±28.67 μg/dL.

At the 6th month mean value was measured 81.82±32.57µg/dL. After the 1st month measurements values increased. There are no mean values under the biochemical range as deficiency in any month.

The iron must be converted into an absorbable form by hydrochloric acid in the stomach (81, 104). Reduction of the amount of hydrochloric acid produced and the rapid passage of nutrients from the stomach can make it difficult to absorb iron in the stomach after LSG (15,105).

In a previous study (16), approximately 63% of the patients were reported to have pre-operative deficiencies in either iron or zinc or water-soluble vitamins, and these deficiencies were observed postoperatively as well. The given oral supplementation of multivitamin was effective in about 30% of patients after operation.

In a study by Gregory et al. (106), Pre-LSG weight was positively correlated with PTH ($r = 0.19$) and negatively correlated vitamin B12 ($r=-0.15$) ($p<0.05$). Post-LSG weight was negatively correlated with 25-OH-D at 6, 12, and 18 months ($r = -0.31, -0.32$, and -0.41, respectively) and calcium at 18 months ($r = -0.24$). PTH was positively correlated with weight at 6months ($r =0.19$). All significant correlations were weak except for the moderate associations with 25-OH-D.

Early gastric saturation after LSG and a stomach volume limited to approximately 15% of the actual capacity affect dietary intake (107). Although LSG does not primary cause of malabsorption, adherence to the prescribed diet and multivitamin and mineral supplements is a lifelong proposal.

The mean value of folic acid in our study was found to be 7.14±3.36 ng/mL in the preoperative measurement. The 1st postoperative month mean value was 8.11±3.28 ng/mL and the postoperative 3rd month mean value was measured as 8.27±3.81 ng/mL. At the 6th month mean value was measured as 8.75±5.03 ng/mL. Preoperative measurement and postoperative 1st, 3rd and 6st month measurements of Folic acid were evaluated and the change was not statistically significant ($p>0.05$). None of the mean values were below the reference range.

In a study conducted with 200 people, 24% deficiency in folic acid measurement was found before the operation. In the same study, 12.5 % deficiency and 6 % de novo deficiency in folic acid measurements were found after 1 year of the operation (108). When we evaluate our results; preoperative, postoperative 1st, postoperative 3rd and 6th month deficiencies of folic acid measurements were respectively; 2.4%, 2.4%, 7.3% and 4.9%. In the results of correlation analysis according to percentages of weight loss, only

folic acid change was significant in from preoperative to postoperative 1st month measurement period. A negative correlation was found among weight loss and folic acid values ($r = -0.347$, $p = 0.026$).

In conclusion, the results of this study showed that weight loss and BMI decrease were achieved expectedly when evaluated according to the literature. At the same time, the glycemic improvement was observed in patients with additional measurements other than vitamins and minerals. The triglyceride value decreased linearly for 6 months after surgery. Although it is a restrictive procedure and tends to lose a lighter micronutrient loss than malabsorptive interventions that cause changes in bowel absorption, micronutrient deficiencies might be observed in SG as well. Known reasons for the emergence of these deficiencies; increased oxidative stress and reduced nutrient intake caused by gastric modification. It is essential to examine and evaluate the biochemistry values after all bariatric surgical procedures. Detection and treatment of preoperative deficiencies are very important to prevent get worse of these pre-existing deficiencies as well. In this study, nutritional supplements recommended for patients have completed the deficiency of micronutrients, except zinc mineral, were investigated, and vitamin D, vitamin B12, folic acid, sodium, potassium, calcium, phosphorus, iron and magnesium values were increased compared to preoperative measurements. This result reveals the importance of periodic follow-up for patients undergoing SG. For the zinc element, the deficiency was 2.4% before the operation, 22% for the first month, 29.3% for the 3rd month and 41.5% for the 6th month. As observed in the measurements, the deficiency gradually increased. Regarding this decrease in zinc value, patients may not be able to use the recommended supplement correctly or the recommended dosage level may be considered. This issue should be examined in detail in more comprehensive studies about zinc.

Finally, a comprehensive statistical analysis is performed in this thesis. Correlations between the change rate of all micronutrients and the percentage change in weight loss are examined. The results showed significance for negative correlation in only between the change in folic acid levels and the change in weight loss percentages from preoperative to 1st month postoperative measurements. Folic acid levels were lower in patients with high weight loss. Considering this result, folic acid supplementation may be recommended more than the doses used in this period to eliminate the risks that may occur in people who lose weight faster. According to this result, the relationship between folic acid levels and weight loss percentages should be examined in more detail.

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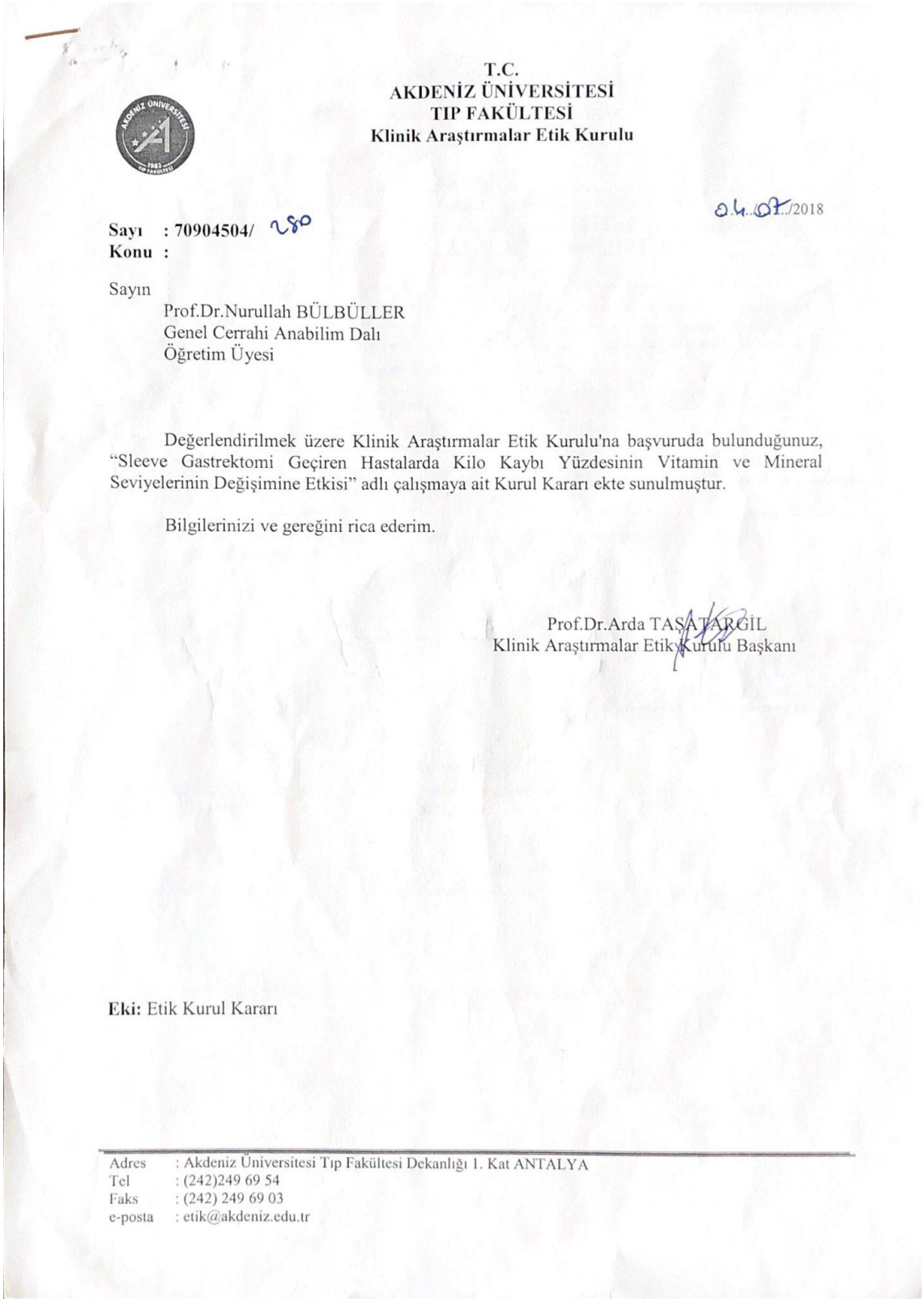
6.APPENDIX

6.1 Ethical Approval



T.C.
AKDENİZ ÜNİVERSİTESİ
TIP FAKÜLTESİ
Klinik Araştırmalar Etik Kurulu

04.07.2018

Sayı : 70904504/ 280
Konu :

Sayın
Prof.Dr.Nurullah BÜLBÜLLER
Genel Cerrahi Anabilim Dalı
Öğretim Üyesi

Değerlendirilmek üzere Klinik Araştırmalar Etik Kurulu'na başvuruda bulunduğunuz, "Sleeve Gastrektomi Geçiren Hastalarda Kilo Kaybı Yüzdesinin Vitamin ve Mineral Seviyelerinin Değişimine Etkisi" adlı çalışmaya ait Kurul Kararı ekte sunulmuştur.

Bilgilerinizi ve gereğini rica ederim.

Prof.Dr.Arda TAŞATARGİL
Klinik Araştırmalar Etik Kurulu Başkanı

Eki: Etik Kurul Kararı

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2018

KARAR

ETİK KURUL BİLGİLERİ	ETİK KURULUN ADI	Akdeniz Üniversitesi Tıp Fakültesi Klinik Araştırmalar Etik Kurulu
	AÇIK ADRESİ:	Akdeniz Üniversitesi Tıp Fakültesi Dekanlığı Morfoloji Binası A Blok 1. Kat No: A1-05 Kampüs /ANTALYA
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	ETİK KURUL KODU	2012-KAEK-20
PROJE YÜRÜTÜCÜSÜ UNVANI/ADI/SOYADI		Prof.Dr.Nurullah BÜLBÜLLER
ARAŞTIRMANIN AÇIK ADI		Sleeve Gastrektomi Geçiren Hastalarda Kilo Kaybı Yüzdesinin Vitamin ve Mineral Seviyelerinin Değişimine Etkisi
DESTEKLEYİCİ		
KARAR BİLGİLERİ	**Karar No: 458**	**Tarih: 27.06.2018**
	Yukarıda bilgileri verilen çalışmanın yapılmasında bilimsel ve etik açısından sakınca olmadığına oy birliği ile verilmiştir.	

Prof.Dr. Atilla TAŞATARGİL
Klinik Araştırmalar Etik Kurul Başkanı

Dr.Öğr.Üyesi M.Levent ÖZGÖNÜL
Başkan Yardımcısı

Prof.Dr.Murat CANPOLAT
Üye

Prof.Dr.Dilara İNAN
Üye (İzinli)

Prof.Dr.Veli YAZISIZ
Üye

Prof.Dr.Bilge KARSLI
Üye

Prof.Dr.Oğuz DURSUN
Üye

Doç.Dr.Gürkan Ozge BAYSAL
Üye

Doç.Dr.Dijle KİPMEN KORGUN
Üye (İzinli)

Doç.Dr.Banu NUR
Üye

Dr.Öğr.Üyesi Mehtap TÜRKAY
Üye

Dr.Ünal HÜLÜR
Üye (İzinli)

Turgut ALTUN
Üye

Av.Mustafa AÇIKEL
Üye (İzinli)

6.2 Curriculum Vitae

Personal Information

Name	Buse	**Surname**	Yazan
Place of Birth	Antalya	**Place of Date**	11.07.1994
Place of Birth	Antalya	**Place of Date**	11.07.1994
Nationally	T.C.	**Identify Number**	12493629040
E-mail	bb.yazan@gmail.com	**Phone Number**	5467136386

Education

Degree	Department	Institute	Graduation year
Master	Nutrition and Dietetics	Yeditepe University	-
Undergraduate	Nutrition and Dietetics	Istanbul Bilim University	2016
High School	-	Antalya Levent Aydın Anadolu Lisesi	2012

Foreign Language	Score (YOKDIL)
English	73.5

Work Experience

Position	Foundation	Year
Dietitian	30-70 Beslenme Hizmetleri	2018-2019
Dietitian	Diyet Kapımda Antalya	2017-2018

Computer Programs

Program	Level
Microsoft Office Programs	Advance
Nutrition Data Systems (BEBIS)	Advance
SPSS	Beginner

Scientific Studies

Examining of Apoptotic and Autophagic Effects of Cynarin Polyphenol in Artichoke Plant in MDA-MB 231 Breast Cancer Cell (Enginar Bitkisinde Bulunan Cynarin Polifenolünün MDA-MB 231 Meme Kanseri Hücresinde Apoptotik ve Otofajik Etkilerinin İncelenmesi) – 2016