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CHANGES IN BASAL METABOLIC RATE OF LAPAROSCOPIC SLEEVE GASTRECTOMY PATIENTS

MASTER'S THESIS

DAMLA DEMİRTÜRK

İstanbul – 2018

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SUPERVISOR

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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 ..10../..08../..2018.. tarih ve ..2018/14-11.. 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 acknowledgement has been made in the text.

Date

Signature

Name Surname

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LISTS OF SYMBOLS AND ABBREVIATIONS

ACC American College of Cardiology

AGB Adjustable Gastric Banding

AHA American Heart Association

BMI Body Mass Index

BMR Basal Metabolic Rate

BPD-DS Biliopancreatic Diversion with Duodenal Switch

CBC Complete Blood Test

CVD Cardiovascular Disease

CXR Chest X-ray

DALY Disability-Adjusted Life Year

DHEAS Dehidroepiondrosteron Sulfat

DVT Deep Venous Thrombosis

EBWL Excess Body Weight Loss

ECG Electrocardiogram

ER Extended Release

FDA Food and Drug Administration

GI Gastrointestinal

IFSO International Federation For The Study of Obesity

INR International Normalised Ratio

LGB Laparoscopic Gastric Banding

LRYGB Laparoscopic Roux-en-Y Gastric Bypass

LSG Laparoscopic Sleeve Gastrectomy

MBS Metabolic Bariatric Surgery

MSJE Mifflin-St. Jeor

NIH National Institutes of Health

PCOS Polycystic Ovary Syndrome

PM Promethium

RBC Red Blood Cell

RD Research and Development

RYBG Roux-en-Y Gastric Bypass

SG Sleeve Gastrectomy

SR Sustained Release

TBWL Total Body Weight Loss

TOS The Obesity Society

TSH Thyroid Stimulating Hormone

US United States

WHO World Health Organization

WLS Weight Loss Surgery

ABSTRACT

Demirtürk, D. (2018). Changes in Basal Metabolic Rate of Laparoscopic Sleeve Gastrectomy Patients. Yeditepe University, Insitute of Health Science, Department of Nutrition and Dietetics, MSc thesis, İstanbul.

The study aimed at exploring changes in basal metabolic rate (BMR) at postoperative first month by using indirect calorimetry in obese patients who undergone laparoscopic sleeve gastrectomy as a part of obesity treatment at Bariatric Surgery Clinic of American Hospital and Koc University Hospital and comparing measurements to Mifflin-St. Jeor (MSJE) equation which is recommended for overweight and obese individuals in cases where use of indirect calorimetry is impossible. Patients' preoperative and postoperative basal metabolic rates (BMR) were measured with indirect calorimetry. 36.3% of the participants (n=12) were male patients whereas 63.6% of them (n=21) were female patients and mean age was 35.8 years. According to patients' Body Mass Index (BMI) classification, 30.3% of the participants (n=10) were identified as obese (BMI=30-39.9 kg/m²), 51.5% of them (n=17) were morbid obese (BMI=40-50kg/m²) and 18.2% of them (n=6) were super morbid obese (BMI=≥50kg/m²). T test performed showed that patients' preoperative and postoperative basal metabolic rates measured with indirect calorimeter reduced significantly at postoperative first month ($p<0.05$). We found a significant correlation between Mifflin-St Jeor Formula and indirect calorimeter in terms of patients' basal metabolic rates measured separately in preoperative and postoperative periods ($p<0.05$). Significant correlation was found between patients' excess body weight loss percentages and preoperative-postoperative BMR changes ($p<0.05$). In light of these findings, while BMR is being measured, Mifflin-St Jeor Formula can be used if indirect calorimeter is not available and BMR decrease with laparoscopic sleeve gastrectomy.

Key Words. Sleeve Gastrectomy, BMI, Indirect Calorimeter, Mifflin-St Jeor.

ÖZET

Demirtürk, D. (2018). Laparoskopik Sleeve Gastrektomili Hastaların Bazal Metabolizma Hızlarındaki Değişim. Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Beslenme ve Diyetetik Bölümü, Master Tezi. İstanbul.

Bu çalışma, Amerikan Hastanesi ve Koç Üniversite Hastanesi'ne obezite tedavisi için, laparoskopik sleeve gastrektomi olan obez hastaların ameliyat öncesi ve ameliyattan 1 ay sonra dolaylı kalorimetre kullanılarak bazal metabolizma hızlarındaki değişimi saptamak, bu ölçümleri; dolaylı kalorimetrenin kullanılamadığı durumlarda, fazla kilolu ve obez bireyler için önerilen Mifflin-St. Jeor (MSJE) eşitliği ile karşılaştırılması amacıyla yürütülmüştür. Hastaların preoperatif ve postopreatif bazal metabolizma hızları (BMH), dolaylı kalorimetre kullanılarak yapılmıştır. Hastaların %36.3'ü (n=12) erkek, %63.6'sı (n=21) kadın olup, yaş ortalaması 35.8'dir. Hastaların Beden Kütle İndexi (BKİ) sınıflandırmasına göre, %30.3'ünün (n=10) obez (BKİ=30-39.9 kg/m²), %51.5'inin (n=17) morbid obez (BKİ=40-50kg/m²), %18.2 'sinin (n=6) süper morbid obez (BKİ=50kg/m² ve üzeri) olduğu belirlenmiştir. Hastaların preoperatif ve postoperatif dolaylı kalorimetre ile ölçülen bazal metabolizma hızları, yapılan t test sonucunda operasyon sonrası ilk ayda anlamlı olarak düştüğü görülmüştür ($p<0.05$). Hastaların preoperatif ve postoperatif döneminde, ayrı ayrı ölçülen bazal metabolizma hızlarının Mifflin-St Jeor Formülü ve dolaylı kalorimetre sonuçları arasında anlamlı derecede ilişki vardır ($p<0.05$). Hastaların verdiği fazla ağırlık yüzdeleriyle, bazal metabolik hızlarındaki düşüş arasında ilişki bulunmamıştır. ($p>0.05$). Bu sonuçlar doğrultusunda, BMH ölçülürken dolaylı kalorimetre olmadığında, Mifflin-St Jeor Formülünün kullanılabileceği, BMH'ın laparoskopik sleeve gastrektomi ile azaldığı, ortaya konmuştur.

Anahtar Kelimeler. Sleeve Gastrektomi, BKİ, Dolaylı Kalorimetre, Mifflin-St Jeor.

1.INTRODUCTION AND PURPOSE

Obesity is identified as an illness developing due to storage of fat at high level so much to deteriorate health (1). Body mass index (BMI), a simple and direct procedure used for finding total body fat, is the most common way to identify obesity. WHO define obesity as a BMI > 30 kg/m^2 for western societies and the United States (U.S.). Additionally, obesity-related diseases and diseases that occur with obesity contribute to this definition significantly (2,3). Obesity is the biggest epidemic in modern era (4).

Bariatric operation is an effective treatment in morbid obesity and obesity-linked diseases (cardiovascular diseases, cancer and type 2 diabetes, heart diseases, sleep apnea, gastroesophageal reflux disease, hypertension, high cholesterol, joint complaints), enhances quality of life and results in weight loss (5). Metabolic and bariatric surgery is the most effective treatment for many clinically morbid obese patients (class II and class III obesity) (6). With current metabolic bariatric surgeries, significant and long term weight loss is obtained. Numerous studies demonstrated that these changes, which may happen rapidly, contribute to minimizing type 2 diabetes drastically (7, 8, 9). These findings point that metabolic and bariatric surgeries decrease mortality and prolong lives (10).

Today, two bariatric surgery procedures –known as laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy- are used commonly (11). Demand for laparoscopic sleeve gastrectomy has been in the increase over the last decade because it is found safe and effective in weight loss (12).

The most important indicator of human metabolism is basal metabolic rate (BMR) and health problems may be caused by abnormalities in BMR (13). BMR reveals combination of fat free body mass and cardiopulmonary function with regular physical activities (14). BMR is defined as minimum metabolism rate necessary to support basic body functioning (15). Even if individuals' body weight, fat contents and thyroid hormone levels are similar their BMR may differ considerably but mechanism behind this is unknown (16). It is stated that usual differences in food intake or activity may balance

BMR changes which are considered as a risk factor in weight gain. Individual differences in BMR may chiefly be explained with differences in mitochondrial oxygen affinity (15).

Since low BMR is a risk factor for regaining weight, it is vital to look at BMR before bariatric surgery. In a study, both some formulas and indirect calorimetry were used to calculate BMR of morbid obese patients preoperatively. As a result, it was seen that Mifflin-St. Jeor equation produced the nearest measurement to indirect calorimetry (17).

Obesity has become a global health problem, triggering diseases such as type 2 diabetes and coronary artery disease. Bariatric surgery has become one of the most effective treatments for obesity-related comorbidities that heal or solve, leading to weight loss in obese and morbidly obese patients (18). Laparoscopic sleeve gastrectomy is the most common method worldwide and in particular, low complication rates have gained popularity with the resolution of comorbidities and the end result of excellent weight loss (19). BMR accounts for a large percentage of daily caloric expenditure. Obese individuals generally have high BMR and experience a significant drop in BMR with weight loss (20). A significant decline in basal metabolic rate occurs after bariatric surgery. Especially, this important decline is observed in preoperative and postoperative first month (21). Indirect calorimetry is the gold standard for evaluating energy need (22). Also, BMR is calculated using the Mifflin-St Jeor (MSJE) equation (23). The results of the indirect calorimeter and Mifflinn-St Jeor are expected to be similar (17).

To sum up, in literature there is no comprehensive study that has examined changes in BMR among patients undergoing sleeve gastrectomy during preoperative period and first postoperative month. Relevant studies mostly demonstrated the effect of bariatric surgery upon BMR -independent of surgery techniques-. This study aimed at exploring changes in basal metabolic rate in preoperative period and one month after operation with indirect calorimetry among obese patients having undergone laparoscopic sleeve gastrectomy as obesity treatment and comparing these measurements to Mifflin-St. Jeor (MSJE) equation which is recommended in overweight and obese individuals when use of indirect calorimetry is impossible.

2. LITERATURE REVIEW

2.1. Obesity

Obesity and overweight are determined as accumulation of large amounts of fat which affects health negatively according to World Health Organization (WHO). The Body Mass Index (BMI) is one of the main procedures to determine accumulation of over amounts of fat (24).

The main causes of obesity, a worldwide epidemic disease, are unhealthy environments that lead to too much caloric intake and inadequate physical activity(25).

The WHO determines obesity as the global non-infectious disease targets and risk agent for many chronic illnesses. Obesity is a big worldwide illness and cause of increasing many chronic illnesses containing diabetes, nonalcoholic fatty liver disease, cardiovascular disease (CVD), metabolic syndrome, chronic kidney failure, and many types of cancer (26).

2.1.1. Diagnosis and Classification of Obesity

Obesity epidemic has an increasing trend on the international scene (27). Also it is the second leading cause of preventable deaths in developing countries (28). The BMI is for the time being used as the central tool through which data about the obesity epidemic is received (29).

BMI is the result of calculation from weight and height of an individual (30). The calculation method of BMI is a formulated by dividing body weight (kg) by square of body height in meters (28). On the other hand, BMI is not taken as a current amount of body fat. If the calculated BMI of an adult is greater than or equal to 30, the adult is accepted as obese. An adult who has the value of BMI between 18.5 and 24.9 is defined as at normal weight and the value of BMI between 25.0 and 29.9 is defined as being overweight (30).

If one defines obesity in terms of fat, a procedure of evaluation measuring body fat percentage is required. These methods are whole body plethysmography, dual x-ray absorptiometry may or triceps skinfold thickness which are more suitable but applying these methods in practice may take more time and also costly than calculating BMI (29).

2.1.2. Prevalence of Obesity

Every year in the world, more than 2.8 million individuals die due to obesity and overweight, also overweight or obesity cause approximated 35.8 million (2.3%) of worldwide disability-adjusted life years (DALYs) (31).

Worldwide, obesity and overweight which can be prevented appears more than %33 percent of people. In 2030, if habbits and trend do not change, estimations show 20% of the adult population in all over the world will suffer from obesity and another 38% from overweight (32). The most pessimist predictions, made for the USA, show that in 2030, over 85% of adults will suffer from obesity and overweight. In the most developed countries obesity level increase to morbid obese level day by day, also this increase includes among children. Moreover, in developing countries obesity level seems to get closer to US level (27).

In the world, 35% of adult population older than 20 years old were overweight in 2008. The extensity of obesity increased dramatically between 1980 and 2008. In 1980, 5% of men and 8% of women were obese, otherwise 10% of men (205 million) and 14% of women (297 million) in the world were obese in 2008 (31).

In the high income and upper income countries the currency of high BMI is more than double that of low and lower middle income countries. The currency of high BMI raises according to income levels. In the high income countries the obesity (24%) is three times more than low income countries (7%). The obesity prevelance of women is importantly graeter than men's, but in the high income countries the prevelance of women and men is close. The prevalence of obesity in women is more than two times men's in lower income countries (31).

For the last 30 years, growing in the prevalence of obesity occur by doubling rates of adult and childhood obesity and tripling rates for adolescent obesity (33).

According to a study, the presence and tendency of obesity considerably raised between 1990 and 2010 in Turkey. For adults, in terms of World Health Organization (WHO) standards, the presence of obesity in 2010 was double of 1990's (34).

The raising commonness of obesity and overweight in Turkey is greater than the countries of Europe, because of presence of obesity in women increases six times and

eight times in men (35). Yet, Turkish adults and adults in USA have similar levels in terms of the presence of obesity in 2010 (36).

2.1.3. Causes of Obesity

Behavioral, social, environmental, genetic, and endocrine dimensions are independently and jointly influential factors in obesity (37). The obesity is an illness which expanded rapidly over the last decades and appears due to environmental, humoral, and genetic factors which act together. The increase of obesity is contributed by the environmental factors such as decreased physical activity, long screen time, eating big portions and high caloric food and and the increase in using medications which has adverse effect like weight gain (38,41). Although most people are affected by the environmental factors, obesity is not observed in all of individuals due to genetic reasons which affect obesity. According to the researches about eating habbits of twins many genes have been described as potentially supporting obesity (53%–84%) (42,43). The fat mass and obesity-associated (FTO) gene which is most investigated, has low effects on its own and is changed by environmental effects (44).

Cushing disease, growth hormone deficiency, pseudohypoparathyroidism, hypothyroidism, polycystic ovarian syndrome (PCOS) and hypothalamic causes are the other reasons for obesity except genetics. For the patients who have genetic or neuroendocrine causes for obesity, early referral to an endocrinologist is beneficial (33).

Physical activity and medical nutrition therapy are the main methods for avoiding and curing obesity. Yet, other dynamics like the body's stress system and cortisol release which are likely to play a role in the development of obesity must be explored. While it seems obvious that stress is a cause of obesity, whether obesity produces stress has only superficially been investigated so far (45).

2.1.4. Treatment of Obesity

Obesity is associated with diseases such as hypertension (HTN), diabetes and cardiovascular disease. To successfully cure this disease, a multidiciplinary approach must be taken which covers behavioral change, diet, and exercise, and –if necessary- anti-obesity medications. Using these procedures in a combination potentially create and maintain clinically important weight loss of 5–10% (46).

Current weight loss treatments for obese patients are composed of lifestyle interventions, drug therapy and surgical techniques. The lifestyle interventions are composed of diet, exercise, and behavior modification and should be regarded as the keystone in any obesity treatment. However, even intensive lifestyle intervention -as a single therapy- is only partially effective with an anticipated percent total body weight loss (%TBWL) <3% (47).

As it is multi-factorial disorder, a treatment approach in obesity includes all of the pathologic processes involved. Although behavioral modifications through diet and exercise are essential for obesity therapy, its efficacy alone is small and supplemental therapies are required for some patients. The potential therapies mentioned here vary from hypnosis to intragastric space-occupying devices that prevent food intake. All therapies are eventually expected to result in lowered energy intake, increased energy expenditure, and/or decreased lipogenesis so that the therapeutic tools for obesity can be improved (48).

2.1.4.1. Medical Nutrition Therapy

According to the studies, multiple dietary strategies work well to minimize body weight. Comorbid risk causes can be affected by rate of macronutrients, measure of energy deficiency and food types (49).

According to TOS/ ACC /AHA Guideline for the Management of Obesity and Overweight for adults decreasing energy intake supports weight loss. The most common methods creating energy deficiency are as follows (50):

- Daily energy intake should be between 1200-1500 kcal for women, it should be between 1500-1800 kcal for men to reach determined daily energy intake target.
- A method targeting a daily deficiency of energy approximately 500-750 kcal.

- Ad libitum methods, which cannot achieve deficiency of energy target but reduce intake of calorie by changing specific food groups.

When obese and overweight patients are treated by a weight loss diet, it provides losing weight on the top level first 6 months and these patients continues to lose weight in smaller amounts among 2 years. By decreasing daily intake of energy, individuals lose weight between 4 to 12 kg at 6 months. Afterwards, the patients may regain slowly but total amount of loss in weight would be between 4-10kg at the first and 3-4 kg at the second years (50).

In the recent studies, the effects of macronutrients which include fat, carbohydrate and protein are investigated in detail for weight loss and diet structure. 1 gram of fat contains 9 kcal and 1 gram of protein and carbohydrates have 4 kcal which is two times less than fat. Therefore, one of the main targets is reducing the rate of fat intake in diet. Thus, reduction in fat consumption may -in theory- cause a significant impact upon all burned calories. However, randomized studies fail to show that weight loss in the long run (compared to other dietary interventions) may be succeed by decreasing the rate of total enegy supplied energy by fat (51).

As a comparison with no dietary intervention over a 12-month period, higher weight loss was linked to diet programs which include limited carbohydrates and fat intake with behavioral support and exercise enhancing loss of weight. Overweight and obese people continue to lose weight when they hold to their dietary programs which do not depend on diet types (52).

A well-balanced dietary program helps reaching target weight and having healthy nutritional habits. In order to prevent from weight gain, methods for saving weight loss would be expressed to the patients. In addition, low-fat dietary programs should be preferred to provide some advantages for patients such as reducing risk factors of cardiovascular disease. Some types of diets can be used that do not affect the health of the patient in the negative direction. One of which is the hypocaloric diet. (For example, protein-based and high-fat diets may increase the patient's lipid levels). While individuals continue losing weight, it should be stated that raises in exercise and physical activity are indispensable for continuing weight loss. From a behavioral view; it is also beneficial to support patients for controlling their food consumption, physical activity and weight (53).

As a result, there is a need for guidelines for weight loss in the future. In order to make a long-term dietary changes and to protect the loss in weight by diet, there is a need to choose the best dietary type and the future studies need to demonstrate (50):

- Testing the effects of tailoring choice of dietary interventions on the patients' ability to adhere long-term.
- Testing practical procedures in dietary program among free-living patients for more than 2 years.
- Appreciating the results of limited caloric intake and maintenance procedures in terms of biological and physiological changes.

2.1.4.2. Physical Activity

Bodily movements produced by skeletal muscles by burning energy are defined as physical activity. Physical immobility is emphasized as the fourth major risk factor for mortality and results in an almost 3.2 million people death worldwide (54).

The terms training and exercise are defined as planned and iterative progress to provide physical condition, although training is often understood as a chronic exercise. Significant effects are attained by physical exercise on physical health. Likewise, it has important influences on psychological health. Therefore, physical exercise can be suggested to treat obesity (55).

In case that significant weight loss is difficult to achieve, doing regular sports will reduce lipid and blood pressure and also decrease visceral fat. Glycemic control, insulin resistance and glucose tolerance are associated with visceral fat. Leskinen et al. (56) conducted a study with 16 twins and looked at their physical activity levels and found that these twins had a high risk of excess fat in their liver, muscle and visceral regions. In short, regardless of weight loss, exercise is associated with positive results of body composition and metabolic status. Achieving and maintaining physical condition is related to health. The issue is muscle flexibility and strength out of body composition. However, bodily movements which lead to energy expenditure are defined as physical activity but physical activity does not aim at achieving or maintaining physical fitness (56).

In general, both individuals with normal weight and obese, refer to the limitation of time to do physical activity. For the protection of ideal weight, a short time or a short

time, such as 10 minutes of exercise can be done should be emphasized to practitioners. When exercise is added to a comprehensive weight loss story briefly, it can be as effective as long-term exercise. In another study, standard programmed physical activity has been found suitable for weight control, regardless of the duration and intensity of energy consumed during the day (ex: swimming, running). Since the lifestyles of the individuals are not suitable for the exercise programs created, some research specialists suggest that more studies are required to discover physical activities types that participants who experience lifestyle interventions should be engaged. Step counters are one of the most practical ways to evaluate level of exercise. Overweight and obese patients should be directed to walk more than 2000 extra steps every day, which means spend more than 100kcal. After reducing at least 10% of weight, walking an additional 6000 to 8000 steps on daily basis -that will burn the extra 300 to 400 kcal/d is necessary for maintenance of weight- should be the next step (56).

The risk of being obese is associated with various factors such as caloric intake and physical activity level. Prolonged weight loss may be possible if the caloric restriction is greater than the exercise being performed. The most effective method of controlling obesity, weight management and weight loss is the combined lifestyle changes with high physical activity combined with a controlled low calorie diet. All adults need to have at least 30 minutes of physical activity every day. Smartphone applications and pedometers can be used to measure daily steps (target is 10,000 steps per day) and some applications support motivation. Even if physical activity does not significantly alter weight loss, it helps to reduce cardiovascular disease risk and affects overall health positively (54).

In a study by Martins et al. (57), the effect of 8-week physical activity program on body composition and physical fitness in obese and non-obese female students was examined. With eight obese female students in the experimental group and eight female students in the control group. At the end of the study, it was emphasized that physical activity participation of obese students provides weight loss thus physical activity is very important for weight loss (57).

2.1.4.3. Pharmacotherapy

An accomplished cure should apply several procedures in the same time such as diet, behavioral changes and physical activity. Also, important lifestyle modifications and limited caloric intake may not provide a significant weight lose while physiologic effects counteract against them (58,59).When patients lose weight, it causes a raise in appetite and a reduction in energy burning that is out of proportion with loss in weight. These modifications are related to the changes of hormonal values (60, 61).

Scholars have argued that pharmacotherapy as a cure for obese individuals who have a BMI 27-30 kg\m², with diseases such as type 2 diabetes, obstructive sleep apnea, dyslipidemia, hypertension (62).

Anti-obesity pharmacotherapy offers several options, drawing attention to differences in action mechanisms and side effect profiles are essential in order to provide the most ideal medical treatment for every individual (63).

Patients use medications to prevent obesity for a long time since obesity is a permanent and chronical illness. Just two medicines which are orlistat and phentermine were confirmed by the Food and Drug Administration as antiobesity medicines before 2012. Afterwards, lorcaserin and phentermine/topiramate extended release were confirmed in 2012; liraglutide and naltrexone sustained release (SR)/bupropion SR were confirmed in 2014 (64).

2.1.4.4. Surgery

Critically obese individuals may not obtain significant results from dietary interventions and maintaining loss in weight, however both powerful maintenance and losing weight with decreased co-morbidity can be attained with bariatric surgery. Surgery helps dedicated patients achieve the weight loss target and health advantages. Several academic disciplines and professional specializations are necessary for surgery such as operator, nurses, dietitians, psychologists and physicians. Decreased stomach volume, feeling of satiety and modification in digestion are seen as a result of surgery. The most preferred methods of surgery are gastric bypass, adjustable gastric banding and sleeve gastrectomy (65).

2.2. Bariatric Surgery in Obesity Treatment

Bariatric surgery, also named weight loss surgery, has begun to be applied in 1950s and time by time, significant outcomes in weight loss were achieved in those patients who were treated by these applications. In addition to significant weight loss, patients who have several metabolic disorders associated with obesity, such as type 2 diabetes mellitus and hyperlipidemia, have demonstrated improvement and remission in metabolic outcomes. Depending on this, method was named as "metabolic bariatric surgery (MBS)" (66).

Bariatric surgery includes a variety of methods and targets at reducing food intake and calories. The goal is decreasing stomach capacity and/or absorbing capability (67).

Significant beneficial outcomes in health such as improved glycemic control, reduced cardiovascular disease and, cancer, risk can be achieved with bariatric surgery compared to traditional treatments (68).

2.2.1. Indications and Patient Selection

Bariatric surgery is a method that applied to patients with clinically severe obesity (69). Determining patient's including criteria and multidisciplinary postoperative care are essentials in decreasing perioperative and postoperative risks (70).

Patient including criteria are reported in 1991 NIH Consensus Development Conference on Gastrointestinal Surgery for Severe Obesity (70, 71). According to this consensus, including criteria for weight loss surgery (WLS) in patients are followed to;

1. Who has BMI greater than 40kg/m²
2. BMI ≥35kg/m² with one or more significant comorbid conditions, if less invasive weight loss procedures are unsuccessful and obesity-associated morbidity and mortality put patient at high risk (72).

Patients who are selected for surgery have to be evaluated before operation for obesity-linked co-morbidities and obesity causes through a special attention canalized to those factors that may affect indication of bariatric surgery.

To minimalize postoperative complications, patients who are selected for surgery have to be evaluated in a multidisciplinary approach. Those are followed to (69):

1. Evaluate the obesity-related co-morbidities, weight loss history, commitment, exclusions related to operation risk and reasons of overweight.
2. Standard tests such as blood type, lipids, pre-prandial blood glucose and functions of the kidney.
3. Vitamin screening such as B12, 25-vitamin D and folic acid.
4. Cardiopulmonary assessment with sleep apnea test.
5. GI assessment (assessment of gallbladder and upper endoscopy if it is necessary).
6. Endocrine tests.
7. Test for Cushing's syndrome in case of clinical suspicion.
8. Nutrition evaluation by a dietitian.
9. Psychosocial-behavioral assessment.
10. Document medical necessity for bariatric surgery.
11. Informed consent form.
12. Make an effort for preoperative weight loss.
13. Maximize glycemic control.
14. Pregnancy counseling.
15. Smoking cessation counseling.
16. Perform cancer screening

2.2.2. Bariatric Surgery Methods

Sleeve gastrectomy, Roux-en-Y gastric bypass (RYGB), duodenal switch with biliopancreatic diversion and laparoscopic adjustable gastric banding (LAGB) are most widely used methods of bariatric surgery (73). Many surgeries today are peformed with minimally invasive techniques (laparoscopic surgery), in which several small cuts are performed by surgeons and thin surgical tools through the cuts are inserted (74). Also, a small scope attached to a camera that gives images onto a video monitor is inserted. Laparoscopic surgery poses fewer risks than open surgery and may produce less pain and scarring than open surgery. A faster recovery may be achieved with laparoscopic operation (75).

The choice of bariatric methods have changed in the last 5 years. The laparoscopic gastric banding (LGB) was a very popular during the last decade but is now in fast decline. More than half of all methods performed today include the laparoscopic sleeve

gastrectomy (LSG). The Roux-en-Y gastric bypass is not the most widely used method anymore but it is still the gold standard (76).

In short-term, RYGB seems to create a greater decrease in weight and is more successful in treatment of comorbid conditions than the AGB and sleeve gastrectomy (SG). SG is the next most suitable method over AGB for obesity surgery in patients who are not indicated for RYGB (77).

2.2.2.1. Roux en Y Gastric Bypass (RYGB)

Roux-en-Y gastric bypass is one of the methods of bariatric surgery that includes minimizing of stomach and making a little pouch from it, also connecting to the small bowel directly. The food, which is eaten in small portions, passes through the pouch and then into the small bowel. For this reason, bigger part of the stomach and the first part of the small bowel will be passed directly (78).

Food goes to this part of the bowel from the pouch directly. Digestive enzymes and bile are diverted to further below. Finally, food skips a part of small bowel, so it leads to malabsorption, low consumption of food and low calorie intake (73).

2.2.2.2. Sleeve Gastrectomy

In sleeve gastrectomy, with other known names such as vertical sleeve gastrectomy or gastric sleeve method, the stomach is downsized roughly to a banana size and shape to limit food intake. The remaining stomach part is removed and the pylorus is preserved. Nearly 80 percent of the stomach is removed (74). A sleeve gastrectomy is an entirely restrictive method (79).

LSG has newly been popularized as a main bariatric procedure all over the world (80). In 2014, it was also the most commonly used method in all over the world with the 45.9% of executed 579.517 obesity surgeries (81). However, various techniques might produce different results because LSG is still not standardized (82).

Strengths of this procedure is as (74):

- Amount of food that stored by stomach is limited
- It can provide fast and important amount of weight loss almost same with the Roux-en-Y gastric bypass. As a result of the data of 3-5+ year follow, weight loss is similar to result of bypass which is greater than percent of 50.

- It does not require external objects and bypass the food flow
- It can offer a comparatively short term hospitalization of about 2 days
- It can make positive modifications on the intestinal hormones which decrese appetite, carb hunger

Weaknesses of this procedure as follow:

- It is an unrecoverable method
- It can lead lack of vitamins
- There is a greater risk for early complications than the adjustable gastric banding (AGB).

2.2.2.3. Adjustable Gastric Band

In AGB, a silicone band is attached to the top of the stomach and a little pouch is created. Thus, the pouch cannot store big portions of food. Lap-band is an entirely restrictive method (83).

The invention of the AGB in 1983 by Kuzmak was a landmark in bariatric surgery. Nowadays, AGB is applied less often than other bariatric methods because of RYGB is accepted as the gold standard surgery for morbid obese people. Thus, laparoscopically placed adjustable gastric bands are rarely used today (84).

This device has a working principle that cause eating in small portions, reducing hunger and increasing satiety due to a small stomach pouch. Patients feel satiety due to proportional to size of the gap between rest of the stomach and pouch. The measure of the stomach gap can be set by filling the band with sterile saline that is injected under the skin via catheter.

The size of the gap is decreased over time progressively with fills or repeated corrections. Food go across the band fastly. Thus, satiety feeling or lack of hunger is not about the nutrients which remains in the pouch. It seems that the band can reduce hunger, which enables the patients to burn calories consumed (74). In addition, the band is modifiable easily and removable and if removal of the band becomes necessary, the stomach retakes normal shape and size (83).

Weaknesses may be stated as the method is comparatively recent in the US and efficiency of this method is still under investigation. Yet, the Europe countries and Australia use this procedure commonly and with satisfactory results (83). Patients lose weight slower with the band method and lose less weight in the early period than the other methods. The rate of reaching 50% of EBWL is less than the other methods. There is a foreign substance in the body, it could cause a possible erosion in the stomach. In addition, there would be an enlargement of the esophagus, if individuals eat over the abundant amount. Finally, band method has the highest rate of re-operation possibility (74).

2.2.2.4. Biliopancreatic Diversion with Duodenal Switch

The biliopancreatic diversion with duodenal switch (BPD-DS) is a modificated type of method named biliopancreatic diversion which is the original method and described by Scopinaro in 1979. The basic distinction between these surgeries, in the Scopinaro surgery which is the original, the pylorus is sacrificed by a distal gastrectomy, whereas the BPD-DS version, a sleeve gastrectomy is undertaken and the pylorus is maintained. In both surgeries, capacity of the stomach pocket is of 250 ml and a distal Roux-en-Y reconstruction of the intestine leads to malabsorption, via a collective channel between 50 and 100 cm and a 250 cm nutritional limb. This method provides perfect long-run weight loss, however the risk of symptoms such as marginal ulceration and excretion is higher than the risk of BPD-DS (85).

Better weight loss and better amelioration of co-morbidities can be attained than any other bariatric method (86). Strengths of this procedure are that (74):

- According to data of 5-year-follow period, it can generate better weight loss than AGB, LSG, or RYGB
- It can permit individuals to eventually eat almost “normal” foods
- It can reduce the amount of absorbed fat at least 70%
- It can create positive changes in intestinal hormones to decrease appetite and to increase feeling of fullness
- It is more successful against diabetes as compared to RYGB, LSG, and AGB

Weaknesses of this procedure are that (74):

- It can produce higher mortality and complication rate as compared to RYGB, LSG, and AGB

- It can result in a longer hospitalization than the other methods such as LSG and AGB.
- It has a bigger potential to cause lack of protein and prolonged deficits for vitamins as vitamin D and minerals such as zinc, calcium, iron.

  Patient adherence to follow-up visits and care and strict compliance with dietary and vitamin supplementation guidelines are essential in order to prevent severe complications from protein and certain vitamin deficiencies (74).

2.2.3. Complications

Complications are wide and affect an approximated 10–20% of bariatric surgery patients which are grouped as early (in 30 days of postoperative period) or late (after 30 days of postoperative period). Despite many mild and treatable complications, there are many serious complications, such as anastomotic leak from staple lines, hemorrhage, deep venous thrombosis, pulmonary embolism, and cardiovascular and pulmonary complications. These situations may lead to invasive interventions with serious outcomes such as long term hospital stay, and at worst and death (86).

Malnutrition is often inadequately reported in obese patients. BMI is still the primary criterion measured in bariatric patients and it is entirely unsuitable to evaluate nutritional status. Malnutrition is reported as a risk factor in gastrointestinal surgeries lasting with higher morbidity rate and long term hospitalization. Poor surgical wound healing occur in protein deficiency and that can also leads to worsening of obesity comorbidities. Malnutrition in morbidly obese patients is still uncertain. Obesity and protein deficiency combination may be linked to high number of surgical complications compared to normal weight and normoalbumineric patients. There are no enough evidence or data about the affect of malnutrition on length of hospitalization, morbidity and hospital readmission in patients receiving bariatric surgery (88).

By virtue of technological developments and advancements in practice, minimally invasive techniques, post-surgical complications are lower. Therefore, there is an eagerness at present for these procedures with the tripling in this type of activity (89).

2.2.3.1. Early Complications

In many of the specialist units, early complications after surgery are not commonly reported. Yet, early complications may be difficult to explore because symptoms, for instance, distension and guarding, are frequently hard to determine in

morbidly obese patients. Often the symptoms of an imminent intra-abdominal catastrophe can only be diagnosed with careful follow-up.

Persistent tachycardia should be considered as a crucial sign if not proved otherwise. Other signs are spikes of fever, abdominal heaviness, hiccups and failure to get well. Experienced bariatric surgeons will resume radiological imaging in the postoperative period of the complicating patient, and imaging of such patients is very difficult.

Most serious complications are anastomotic leak, hemorrhage, deep vein thrombosis / pulmonary embolism and gastric or small bowel perforation (87).

2.2.3.2. Delayed Complications

Late complications are specific to the type of surgery and those might be listed as gastric band complications, complications of gastric bypass or duodenal switch, complications following laparoscopic sleeve gastrectomy, gallstones, gastrointestinal hemorrhage.

2.2.3.2.1. Gastric band complications

Although the morbidity in the gastric band is low, the risk for late complications is higher. Approximately 20% of the stomach bands require re-operation. There are 2 types of complications in the gastric banding: slippage and erosion. Sometimes, intestinal obstruction can be seen with intestinal wandering. The band slippage is caused by the fundus passing through the band. This may gradually lead to acute or chronic obstruction. Acute symptoms are regurgitation, heartburn, dysphagia and pain. Other complications such as intra-abdominal sepsis, gastrointestinal haemorrhage, weight regain and inadequate weight loss can also be seen. There might also be infections in the port region. This can be seen as a cellulite or abscess around the setting port (87).

2.2.3.2.2. Complications of gastric bypass or duodenal switch

An urgent complication in bypass surgery is intestinal obstruction. The risk of obstruction can be about 5% (90). Obstruction, can be caused by internal herniation, scarring or adhesion formation, incision / port site hernia, intestinal intussusception and anastomotic stricture (91). Symptoms are nausea / vomiting, an obstruction of the alimentary limb or common channel, absolute constipation, with signs of abdominal pain, abdominal distension and nausea / vomiting (87).

2.2.3.2.3. Complications following laparoscopic sleeve gastrectomy

Laparoscopic Sleeve Gastrectomy (LSG) complications are usually seen in the early stages (87). Acute complications of sleeve gastrectomy are hemorrhage, staple line leak and abscess. Chronic complications are stricture and nutritional deficiencies. The risk of postoperative bleeding has been reported to be between 1% and 6% after LSG. The source of bleeding can be intra- or extra luminal. Intraluminal bleeding from the staple line usually presents with an upper gastrointestinal bleed. Extraluminal bleeding usually presents with a serial drop in serum hemoglobin levels or signs of tachycardia or hypotension. Gastric leak is one of the most serious and dreaded acute complications of LSG. It occurs in up to 5% of patients following LSG. Intra-abdominal abscess is another possible complication after LSG. It usually presents with symptoms of abdominal pain, fever/chills or nausea and vomiting. Formation of stricture is another potential complication occurring after LSG. It could present either acutely after surgery due to tissue edema or more commonly in a delayed fashion. Presenting symptoms include food intolerance, dysphagia or nausea and vomiting. Nutritional deficiencies are common after bariatric surgery. The etiology is multifactorial owing to impaired absorption and decreased oral intake (92).

2.2.3.2.4. Gallstones

Patients immediately lose weight after bariatric surgery (87). Due to changes in the cholesterol content of bile and in the motility of the gallbladder, the period of rapid weight loss immediately following bariatric surgery commonly results in the formation of gallstones (93).

2.2.3.2.5. Gastrointestinal hemorrhage

GI hemorrhage may also develop and is more commonly seen after laparoscopic than open gastric bypass. Contemporary series suggest that less than 1% of all post-gastric bypass patients experience postoperative bleeding requiring transfusion or intervention, likely the result of improved staple technology and selection. The majority (71.4%) of bleeding occurs early from an intraluminal or intra-abdominal source. The potential causes of an intraabdominal bleed include the staple lines (divided gastric remnant, gastrojejunostomy, or jejunojejunostomy), mesenteric vessels, or iatrogenic injury. Almost half of the patients who experience postoperative hemorrhage have undergone prior abdominal surgery requiring adhesiolysis at the time of the bariatric procedure (94).

2.2.4. Preoperative Care and Medical Nutrition Therapy

Many evaluations and interventions must be done before the bariatric patient arrives in the preoperative setting. The literature points that an interprofessional team approach is the most successful one to continue care of this patient group. In addition to the surgical team, the patient's bariatric team should include psychologists, dieticians/nutritionists, and physical therapy and exercise specialists working with this patient population in order to change the habits and behaviors that contribute to obesity. A trained bariatric team should help the patient be informed very well and be knowledgeable about every step in the bariatric surgical process and, as a result the patient becomes better prepared to decide surgical issues. Starting from six months to a year before the surgery, the bariatric team gives detailed information about lifestyle changes and assists the patient in order to help him/her make healthy choices in daily life. Exercise specialists collaborates with the patient from the very beginning of this methods to facilitate exercises that he or she can perform and -without delay- make them a part of their daily routine which, hopefully, becomes a realistic program for life. Also, a nutritionist collaborates closely with the patient about food modification and dietary supplements. Some programs require mandatory smoking cessation before the surgery due to connected health-related risks and potential for poor wound healing, while other programs may highly emphasize cessation prior to surgery and provide helpful resources and programs (95).

It is essential to prepare a patient for the physical and behavioral alterations induced by bariatric surgery. Patient familiarization with the ward and their environment can be beneficial with a visit before surgery and can give them a bigger sense of security and independence (96).

Prehabilitation starts with preparing patients against the stress of major surgery and recovery process before surgery and therefore enhances their preoperative functioning capacity. Yet, very limited data have been obtained about the efficacy and safety of prehabilitation in bariatric surgery. Prehabilitation mainly focuses on promoting preoperative physical capacity through aerobic exercise and resistance training, optimization of nutrition and smoking and alcohol cessation (96).

After the preliminary nutrition meeting, patients should do recommendations below to adopt a bariatric diet lifestyle six months to two weeks before surgery. The most

crucial advice is a diet composed of primarily low in fat and sugar and high in protein and nonstarchy vegetables (97).

An extensive list of dietary behavior recommendations for patients before bariatric surgery is presented in Table 2.2.4.1. (98).

Table 2.2.4.1. Dietary Behavior Recommendations for Patients Before Bariatric Surgery (98)

Recommendation	Example	Explanation
Use mindful eating techniques	Do not eat while watching television or using the computer or other electronic devices. Take at least 20 minutes to consume a meal.	Eating while distracted has been shown to increase calorie consumption and may lead to stomach irritation and discomfort.
Eat slowly	Take at least 20 minutes to consume a meal.	Eating too quickly may cause severe stomach discomfort and pain
Chew food thoroughly	Chew food until the texture is soft and food is easily swallowed.	Swallowing large bites of food may lead to stomach discomfort because of reduced stomach size and acids available for digestion.
Eliminate carbonated beverages	Soda water Seltzer Regular or diet soda Spritzers Beer Champagne	The carbondioxide used to carbonate beverages has been found to exacerbate gastrointestinal pressure and discomfort in some patients.
Eliminate sugar-sweetened beverages and concentrated sweets	Soda Undiluted juice Lemonade Sweet tea Any beverage with 15 g or more of sugar per serving Candy Cake Cookies Pies Chocolates Sweets	Sugar in beverages has been shown to increase limited nutritional value caloric intake, making it more difficult for patients to achieve weight loss and healthy blood glucose levels. Dumping syndrome and malabsorption also are associated with high-sugar intake
Eliminate high-fat foods	Fried foods Fatty foods Processed snack foods High-fat meats Whole milk, butter, cheese, or cream	Sugar in beverages has been shown to increase limited nutritional value caloric intake, making it more difficult for patients to achieve weight loss and healthy blood glucose levels. Dumping syndrome and malabsorption also are associated with high-sugar intake.
Reduce caffeine intake	Sugar in beverages has been shown to increase limited nutritional value caloric intake, making it more difficult for patients to achieve weight loss and healthy blood glucose levels. Dumping syndrome and malabsorption also are associated with high-sugar intake	Caffeine intake has been shown to decrease absorption of vitamins and increase resting blood pressure.
Do not drink fluids and eat within 30 or 60 minutes of the other	Drink fluids 30 to 60 minutes before and after eating.	Drinking while eating can cause the size of the food in the stomach to greatly increase in volume, thus reducing a patient's ability to consume adequate portions and may exacerbate severe stomach discomfort.

Observing the preoperative dietary recommendations will help decreasing the incidence of slow weight loss, weight regain, weight plateauing, dehydration, discomfort, abdominal pain, indigestion, heartburn, and dumping syndrome (98).

Two weeks before surgery, patients initiate a low-fat, medically controlled diet (Table 2.2.4.2) (98).

Table 2.2.4.2: Daily Bariatric Diet Specifications for Two Weeks Before Surgery

Two to Three Servings	**One Serving**	**Unlimited Servings**	**One Serving**	**Unlimited Servings**
High-protein meal replacement shakes made with water, low-fat milk, or unsweetened nondairy milk alternative	Fruit as a snack, including -Banana -Apple -Pear -Peach -Sugar-free fruit cups in water or juice	Nonstarchy raw vegetables All nonstarchy vegetables, including -Carrots -Cucumbers -Salad greens -Peppers -String beans -Spinach -Radishes -Tomatoes **Starchy vegetables to avoid:** -Potatoes -Corn -Peas -Lima beans	**Small meal** **3 to 4 oz cooked lean protein:** -Chicken -Turkey breast -Fish -Seafood -Vegetarian or protein alternative -Lean low-sodium deli meat -Lean ground meat -Pork tenderloin -Lamb	**Beverages** -Unsweetened or zero calorie or containing 15 g of sugar per serving or less: Water Unsweetened decaffeinated tea Unsweetened decaffeinated coffee Diluted juice Diet beverages
Optional: ¼ cup or less of fruit and unlimited nonstarchy raw vegetables may be added			**One-half cup of cooked whole grain or starch:** -Brown rice -Wild rice -Whole grain pasta -Quinoa -Sweet potato -Butternut squash -Acorn squash	**Optional:** 1/4 cup or less of fruit and unlimited nonstarchy raw vegetables may be added
Flavor extracts Spices Powdered peanut butter Sugar-free syrups Sugar-free drinks or pudding mixes are suggested to increase flavor variety			**1 cup cooked nonstarchy vegetables:** -Cauliflower -Broccoli -Spinach -Kale -Dark leafy greens	Flavor extracts Spices Powdered peanut butter Sugar-free syrups Sugar-free drinks or pudding mixes are recommended to increase flavor variety **Unlimited raw vegetables:** -Salad greens -Cucumbers -Tomatoes

With the diet, the goal is to enable the patient to achieve some initial weight loss and to reduce the size of the liver (98). The greater part of obese patients have nonalcoholic steatohepatitis or fatty liver. Both patients and the surgeon benefit from adaptation into the preoperative diet as it has been documented to reduce surgical time and to decrease complications during surgery because a smaller liver enables easier access to the stomach, which lies anterior to the liver (99). One day before surgery, patients are advised to go on a full liquid diet. Full liquids foods may be unlimited zero-calorie beverages or beverages containing 15 g or less of sugar per serving, protein shakes, yogurt, milk, unsweetened applesauce, broth, gelatin, and pureed soups. By midnight, patients should have no food or drink anything. The surgical scheduler or preadmissions nurse should emphasize the fasting program by observing the bariatric surgeon's orders (98).

2.2.5. Postoperative Care and Medical Nutrition Therapy

In the preoperative period to the patient and his / her family, the nutrition process after the operation should be conveyed in detail. Then, during the post-operative period, the discharge period should be given a nutrition list and explained in detail. The patient should be followed in the outpatient clinic. Patients may begin to have fluid a few hours before surgery. The patient should be educated in detail by a dietician in all the stages. Individuals should eat their meals in small postions and often. In addition, the food should be chewed good and consumed in small portions. Solids and liquids should not be consumed together. A balanced diet should be provided by providing optimal fiber intake and colon function, including consumption of vegetables and fruits on a daily 5 portions and above (100). Patients should receive between 60 and 120 grams of protein per day. Concentrated sugar intake should be restricted, especially to avoid the dumping syndrome which may be seen after gastric bypass operation (100). After the operation, multivitamin and mineral supplements containing iron, 1200-1500 mg / day calcium and B12 vitamins should be given (101). Fluid consumption should be greater than 1.5 liters per day and should be drunk slowly (102). After surgery, the disease must be biochemically and clinically tested against micro- and macro-nutrient deficiencies (103). In the early days after surgery, an emphasis on the importance of hydration should be made by care providers and the patient should be informed and trained of avoiding gulping fluids or drinking with a straw to prevent possible air swallowing. It is extremely important that

nurse evaluate the patient for signs and symptoms of dehydration before hospital discharge (98).

The patient should continue drinking clear liquids for two full days after he/she leaves the hospital; this is composed of a low sugar, clear liquid diet with fluids, electrolytes, and a limited amount of energy to support the restoration of gut activity after surgery. Clear liquid (i.e., stage 1) diets are nutritionally poor and therefore should not be done past 48 hours without the inclusion of low residue oral nutrition supplements (98).

The patient may commence a low-fat, full-liquid diet (i.e., stage 2) as much as he/she can tolerate on third postoperative day. This diet, including liquids of higher residue (e.g., milk, yogurt, pureed soup, applesauce, cottage cheese), should be maintained for approximately seven to 10 days. The focus of the full-liquid diet is to take protein, hydration, and a slow initiation of vitamin and mineral supplementation. The calories and nutrients given by an approved full-liquid diet can sufficiently answer the needs of bariatric patients (104). Patients can use protein supplements that give sufficient amount of protein to facilitate the healing process, however, protein supplements should meet recommended criteria for level of quality and purity. Full liquids in stage 2 progress healing, while the caloric restriction gives nutrition equivalent to a very low calorie diet, which includes a caloric consumption less than 800 kcal per day. Patients generally need a protein supplement once or twice a day for the first few months after surgery in order to best meet their protein needs. Protein needs are evaluated according to current height, weight, and physical activity status. The bariatric team advises patients to be guided by a registered dietitian to re-explore their individual protein needs during follow-up evaluations (98).

Within 10 to 14 days after surgery, care providers assess patients, and according to individual patient tolerance, may recommend that the patient should begin a soft foods diet (i.e., stage 3) (105). Soft, moist, chopped, ground, or mashed foods are advised. Typically, patients tolerate stage 3 well and adhere to it for two to three weeks. Between 28 and 30 days after surgery, the bariatric team re-evaluates patients in terms of their tolerance of food, hydration fluids, and vitamins and may recommend a progression to a low-sugar, low-fat, high-protein, plant-focused, solid food diet (i.e., stage 4). Table 2.2.5.1. presents more comprehensive information on dietary recommendations (98).

Table 2.2.5.1. Anticipated Dietary Progression for Patients Before and After Bariatric Surgery (98)

Diet Duration	Nutrition Plan	Samples
2 weeks preoperation	-Low fat -No concentrated sweets	-High-protein drinks -Lean protein (eg, beans, chicken, lean meat, fish, vegetarian meat) -Limitless nonstarchy vegetables -One-half cup whole grain food or starch (eg, sweet potato, squash)
24 hours to 3 days postoperation	**Phase 1** -Clear liquid -Low fat -High protein -No concentrated sweets	-Sugar-free popsicles -Meal replacement shake mixed with water -Water, decaffeinated tea/coffee -Gelatin -Broth -Zero-calorie drinks -Diluted juice -Sugar-free beverages
10 to 14 days postoperation	**Phase 2** -Full liquid foods -Low fat -High protein -No concentrated sweets	-Meal replacement shake made with low-fat milk or unsweetened -Low-fat cream soups -Nondairy milk - Unsweetened nondairy milk -Yogurt -Cottage cheese -Unsweetened applesauce -Low-fat milk -Pureed low-fat soups
14 to 28 days postoperation	**Phase 3** -Soft foods -Low fat -High protein -No concentrated sweet	-Well-cooked beans -Any food that can be easily mashed with a fork, such as o Well-cooked vegetables -Slow-cooked meats -Peaches or pears with no sugar added or in water, melon -Lean ground meats -Low-fat refried beans
28 days after surgery to 3 months postoperation	**Phase 4** -Low fat -Regular textured foods -High protein -No concentrated sweets	-Difficult foods to ingest: -Pork chops -Steak -Coconut -Celery -Membranes on citrus fruits -Chicken breast
3 or more months postoperation	-Regular textured foods -Low fat -No concentrated sweets	-Protein recommendations are 1.2 g to 1.5 g per kg of body weight

3. MATERIALS AND METHODS

3.1. Participants

A total of 33 voluntary patients who were obese and planned to undergo laparoscopic sleeve gastrectomy, aged 18-65 years, treated at American Hospital and Koç University Hospital Bariatric Surgery Clinic between February 2017 and June 2018 were included in the study after the ethical approval from Koc University Biomedical Research Ethics Committee (No: 2016.293.IRB2.150, 20.09.2017) (Appendix 1).

3.2. Data Collection

All participants were measured for basal metabolic rates (BMR) by Indirect Calorimetry (Fit mate model no: COSMED, C09066-01-99) before and at first month after surgery. Indirect calorimetry is the gold standard for evaluating energy need (22).

A written consent form was obtained from (Appendix 2) all participants before inclusion. The patients are told that they can be excluded any time if they want to leave the study.

The general characteristics (age, sex), weight, BMI, waist circumference, and comorbidities of each patient were recorded in a form (Appendix 3) in preoperative and postoperative period. Subjects were weighed using a digital scale (Tanita model no: MC-780MA). Weight was measured with the patient standing in the center of the platform wearing light clothing and no shoes. Height was determined using a stadiometer fixed to the scale, on which the patient stood barefoot, with the patient's standing straight, and eyes facing forward. Weight and height were used to calculate the BMI (weight in kilograms/height in meters squared). Waist circumference measurements, data collection and BMR by measurements were made by the researcher dietitian before and after surgery (Appendix 3). Waist circumference was be measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch-resistant tape that provides a constant 100 g tension.

3.3. Statistical Analysis

Data is analyzed by paired sample t test. Paired sample t test was used to compare two different measurements in the same group. Furthermore, corelation is evaluated by spearman. Spearman test was used to calculate the relationship between two different measurements.

4. RESULTS

36.4% of the participants (n=12) were male patients whereas 63.6% of the participants were female (n=21) (Table 4.1.). Mean age of 33 patients was 35.8 (average age 35.8±10.7years).

Table 4.1. Distribution of participants according to sex

GENDER	FREQUENCY	PERCENT%
Female	21	63.6
Male	12	36.4
Total	33	100,0

It is found that 30.3% of the patients were obese (BMI=30-39.9 kg/m²) while 51.5 were morbid obese (BMI=40-50 kg/m²) and 18.2% were super morbid obese (≥BMI=50 kg/m²) (Table 4.2).

Table 4.2. Distribution Body Mass Index (BMI) of the Patients

CLASSIFICATION OF BMI	PERCENT%
Obese (BMI 30-39.9 kg/m²)	30.3
Morbid Obese (BMI=40-50 kg/m²)	51.5
Super Morbid Obese (BMI=50 kg/m² ve over)	18.2
Total	100

Waist circumferences in preoperative and postoperative periods, were 123.4091 (Table 4.3), and 127.2727 cm respectively. The average waist circumference in the first month was 119.5455 cm; which was lower (p=0.1121, p>0.05).

Table 4.3. Mean Value of the Waist Circumference of the Patients

Two-sample t test with equal variances

	Preop mean±SD	Postop mean±SD	p-value*
Waist Circumference (cm)	127.27±19.8	119.54±19.2	0.1121
*p<0.05 is accepted as significance			

Basal metabolic rates (BMR) of patients were assessed with indirect calorimetry in preoperative and postoperative periods. It is found that patients' average BMR in preoperative period was 2455.273 while it was 2052.212 in the postoperative period (Table 4.4).

According to patients' indirect calorimetric measurements, BMR in postoperative period was found considerably to be lower than that in preoperative period (p=0.0, p<0.05).

Table 4.4. Changes that occurred in patients' basal metabolic rate in preoperative period and postoperative first month

Paired t test

	Preop mean±SD	Postop mean±SD	p-value*
Basal Metabolic Rate (kcal)	2455.27±523.7	2052.21±444.0	0.0
*p<0.05 is accepted as significance			

In addition to indirect calorimetry, BMRs were calculated using Mifflin-Jeor formula in preoperative and postoperative periods as well. Indirect calorimeter and Mifflin-Jeor measurements were significantly correlated and spearman test was significant (p=0.0, p<0.05) (Table 4.5).

Similarly, indirect calorimeter and Mifflin-Jeor measurements in the postoperative period BMR indicated a correlation found this was significant (p=0.0, p<0.05) (Table4.6).

Table 4.5. Correlation between indirect calorimeter and Mifflin-Jeor results in terms of patients' preoperative basal metabolic rates

PREOP	
Indirect calorimeter -Mifflin-St Jeor	
Number of obs=	33
Spearman's rho=	0.7713
Test of Ho: Indirect calorimeter and Mifflin-St Jeor are independents Prob > I t I =	0.0000*
*p<0.05 is accepted as significance	

Figure 4.1. shows correlation graphic between indirect calorimeter and Mifflin-Jeor results in terms of patients' preoperative basal metabolic rates.

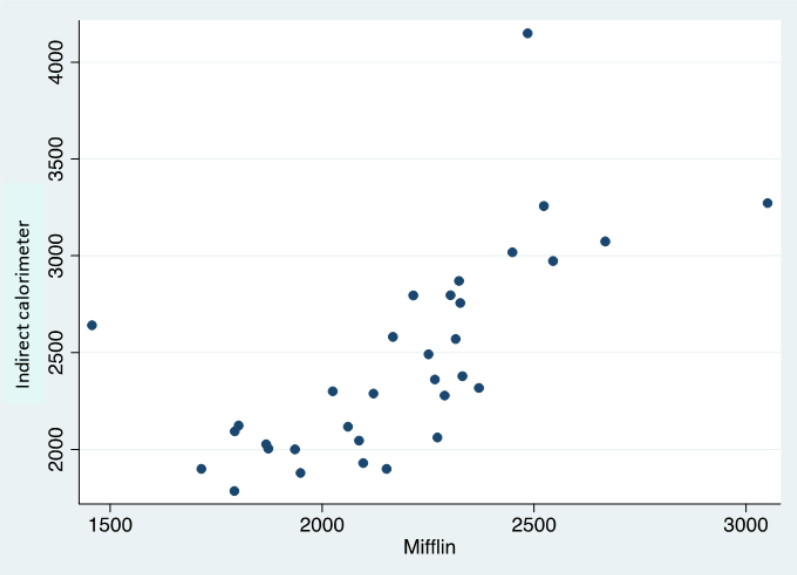

Figure 4.1. Correlation between indirect calorimeter and Mifflin-Jeor results in terms of patients' preoperative basal metabolic rates

Table 4.6. Correlation between indirect calorimeter and Mifflin-Jeor results in terms of patients' postoperative basal metabolic rates

PREOP	
Spearman Indirect calorimeter -Mifflin-St Jeor	
Number of obs=	33
Spearman's rho=	0.7718
Test of Ho: Indirect calorimeter postop and Mifflin-St Jeor postop are independents Prob > I t I =	0.0000*
*p<0.05 is accepted as significance	

Figure 4.2. shows correlation graphic between indirect calorimeter and Mifflin-Jeor results in terms of patients' postoperative basal metabolic rates.

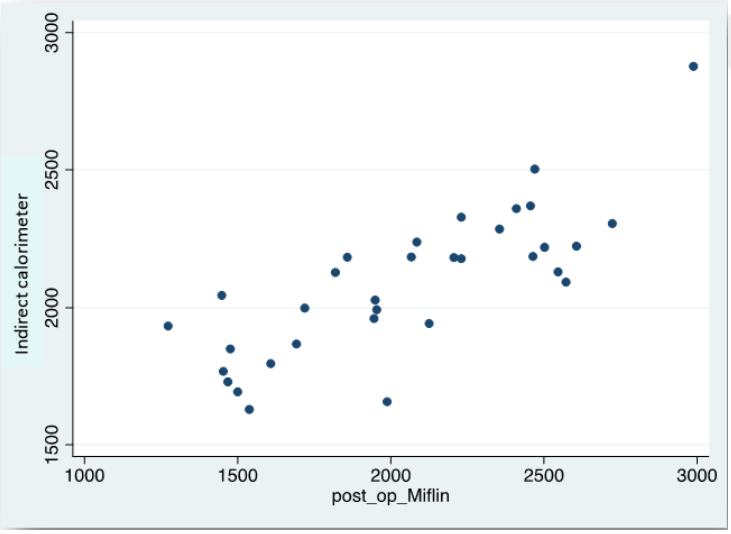

Figure 4.2. Correlation graphic between indirect calorimeter and Mifflin-Jeor results in terms of patients' postoperative basal metabolic rates

As excess body loss weight (EBLW %) climbed up, it was seen that correlation between preoperative and postoperative basal metabolism percentage as measured by indirect calorimetry was no longer significant. Owing to the fact that participating patients in the study was few (n=33), correlation analysis gave a result different from the expected one (Table 4.7).

Table 4.7. Comparison of patients' EBLW percentages and preoperative and postoperative percentages indirect calorimeter results

PREOP-POSTOP	
Spearman Excess Body Weight Loss- Indirect calorimeter	
Number of obs=	33
Spearman's rho=	0.2779
Test of Ho: Excess Body Weight Loss preop-postop and Indirect calorimeter preop-postop are independents Prob > l t l =	0.1173*
*p<0.05 is accepted as significance	

Patients' preoperative physical activity level was investigated. In the current study, since only 5 of the 33 patients (%15.1) did sports in preoperative period, we have not included this parameter in the analysis.

5. DISCUSSION AND CONCLUSION

With current treatment options providing weight loss for patients with obesity, lifestyle interventions, pharmacotherapy and bariatric surgery are required. The components of lifestyle intervention are diet, exercise, and behavior modification and should be regarded as the keystone in any obesity treatment (47). Today, two most common bariatric surgery procedures are laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy (11). Popularity of laparoscopic sleeve gastrectomy has been in the increase for the past ten years as it is safe and effective in losing weight (12). The most important indicator of human metabolism is BMR and unwanted health problems may be caused by abnormalities in BMR (13). Because, low BMR is a risk factor in regaining weight, it is compulsory to take basal metabolic rate before bariatric surgery. In a study, both some formulas and indirect calorimetry were used to calculate BMR of morbid obese patients preoperatively. As a result of the study, it was seen that Mifflin-St. Jeor equation yielded the nearest measurement results to calorimetry (17). Indirect calorimetry is the gold standard for evaluating energy need (22). The present study was done with 33 patients who were aged 18-65 years and who came to Bariatric Surgery Clinic of American Hospital and Koç University Hospital in order to explore patients' basal metabolic rate with indirect calorimetry device in preoperative period and to compare the obtained findings to BMR found at postoperative first month. The findings were discussed in light of the literature. It was identified that patients' average preoperative BMR was 2455.273 kcal while their average postoperative BMR was 2052.212 kcal (Table 4.4). BMR was decreased by 403.061 kcal. According to patients' indirect calorimeter measurements, a higher decline in postoperative BMR at the first month was found compared to preoperative BMR ($p<0.05$). In another study, similar results were obtained. In a research by Carey et al., BMR were measured preoperatively and first month after surgery. As a result, a decrease of 333 kcal (2091.0-1758.4 kcal / day) was observed preoperatively and in the first postoperative month. This result was significant ($p <0.05$). There was no significant difference in measurements of basal metabolic rate after first month (1758kcal, 1647kcal, 1651kcal, 1674kcal). A total of 417 kcal (2091 vs 1758) decline was observed as a result of the 12-month term (17). As a result, both studies was identified significant differences in preoperative period and postoperative first month. However, in the current study findings related to postoperative month 12 have not been obtained yet; therefore, these findings were not discussed and compared.

In the study of Magda et al., a total of 28 subjects were recruited for the study, 12 of whom had laparoscopic sleeve gastrectomy and 16 laparoscopic Roux-en-Y Gastric Bypass surgery. Parameters such as BMR, Fat Mass and Free Fat Mass were assessed in preoperative period and at 30 and 90 days in postoperative period. Basal metabolic rate was measured by indirect calorimetry and basal metabolic rate was adversely affected as these parameters were significantly reduced in postoperative period (106).

Giusti et al. assessed d the basal metabolic rate (BMR) in obese female patients in the first 3 year after an RYGB. According to the results, the BMR decreased from 1.12 ± 0.04 kcal/min at baseline to 0.93 ± 0.03, 0.86 ± 0.03, and 0.85 ± 0.04 kcal/min at 3, 12, and 36 months after surgery, respectively (all $p<0.05$ compared with at baseline). In sum, the BMR moderately decreased (107). Our study showed that BMR was reduced in postoperative period, as well.

Our study is in line with other studies in the literature and no different arguments were reported.

In the current study, patients' preoperative and postoperative BMR were measured with indirect calorimetry. In the same period, BMRs were calculated using Mifflin-St Jeor formula, as well.

According to patients' indirect calorimetry and Mifflin-St.Jeor measurements, preoperative BMRs were significantly correlated; which demonstrated that nearest measurements to calorimetry can be obtained with Mifflin-St. Jeor equation in case that indirect calorimeter device is unavailable. In the study of Faria et al. it was suggested that Mifflin-St Jeor formula can be used instead of indirect calorimetry. They employed indirect calorimetry (IC) to collect BMR data. Their sample population was composed of 193 patients, 130 of whom were clinically severe obese and 63 were normal/overweight individuals. BMR results were compared with such predictive formulas as Harris-Benedict (HBE), Bobbioni-Harsch (BH), Cunningham (CUN), Mifflin-St. Jeor (MSJE), and Horie-Waitzberg & Gonzalez (HW & G). Statistical analysis was done to compare and correlate variables. It is decided as the use of the MSJE formula may be helpful in those cases where use of IC is unavailable (17).

In our study, BMRs decreased in the first postoperative month decreased significantly compared to preoperative period. Yet, 31 of the 33 patients showed a decrease in BMR values at the first postoperative month, while 2 patients showed an

increase in BMR values. It might be a limitation of the study and the reason of which may have been that mask used for measurement of oxygen consumption during rest was not placed properly and led to air leakage or patients did not follow 24-hour-fasting rule.

Hady et al. showed their clinical report, in obese patients during 1-year follow-up after laparoscopic sleeve gastrectomy a reduction in waist circumference was statistically significant (108). Another short-term longitudinal study in men showed that waist circumference decreased significantly over the study period (baseline, and after three and six months laparoscopic sleeve gastrectomy) (109). In our research, there were no statistically significant differences between in preoperative period and first month in postoperative period ($p>0.05$). In our study, patients were evaluated only in the first month in postoperative period. If a longer postoperative observations (6 months or 1st year after sleeve gastrectomy) were possible, changes in waist circumference may have been statistically significant.

There are few studies examining BMR after sleeve gastrectomy with indirect calorimetry. Relevant studies mostly gave the general effects of bariatric surgery upon BMR -independent of surgery techniques-. A few studies investigated BMR of patients undergoing gastric bypass in preoperative and postoperative periods but no significant changes were found. In Turkey, rising number of sleeve gastrectomy operations have been performed. Therefore, we aimed to contribute to literature with the current study.

In light of these results;

- It was found that after sleeve gastrectomy operation, patients' basal metabolic rate at first postoperative month reduced.

- It was found that those unable to obtain indirect calorimeter device at clinics to get BMR measured can use Mifflin-St Jeor formula and can attain significant results near indirect calorimeter.

- Patients' preoperative period and postoperative month 1 waist circumferences were not found to be lower as expected.

- Physical activity level of the operated patients during preoperative period may have influenced postoperative basal metabolic rate (BMR) in the postoperative period.

6. REFERENCES

1. ASMBS Clinical Issues Committee. Bariatric surgery in class I obesity (body mass index 30–35 kg/m^2). Surgery for Obesity and Related Diseases 9 (2013): 1–10.

2. World Health Organization. Nutrition. [online]. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. Available from: http://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en. (date accessed: 02.07.2018).

3. Lung National Heart, Nih. Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adults—the evidence report. National Institutes of Health. Obes Res. US. International Medical Publishing. 1998;6:51–209.

4. Busetto L, Dixon J, De Luca M, Shikora S, Pories W, Angrisani L. Bariatric surgery in class I obesity. Obesity surgery. 2014;24(4):487-519.

5. Nguyen NT, Varela JE. Bariatric surgery for obesity and metabolic disorders: state of the art. Nature Reviews Gastroenterology & Hepatology. 2017;14(3):160.

6. Arterburn DE, Olsen MK, Smith VA, et al. Association between bariatric surgery and long-term survival. JAMA 2015;313(1):62–70.

7. Arterburn D, Bogart A, Sherwood NE, et al. A multisite study of long-term remission and relapse of type 2 diabetes mellitus following gastric bypass. Obes Surg 2013;23(1):93–102

8. Mingrone G, Panunzi S, De Gaetano A, et al. Bariatric surgery versus conventional medical therapy for type 2 diabetes. N Engl J Med 2012;366(17):1577–85.

9. Courcoulas AP, Goodpaster BH, Eagleton JK, et al. Surgical vs medical treatments for type 2 diabetes mellitus: a randomized clinical trial. JAMA Surg 2014;149(7):707–15.

10. Kim J, Eisenberg D, Azagury D, Rogers A, Campos GM. American Society for Metabolic and Bariatric Surgery position statement on long-term survival benefit after metabolic and bariatric surgery. Surgery for Obesity and Related Diseases. 2016;12(3):453-9.

11. Kozlowski T, Kozakiewicz K, Dadan J, Mysliwiec P. Innovate solutions in bariatric surgery. Gland Surg. 2016; 5(5): 529-536.

12. Corcelles R, Lacy A, Case for sleeve gastrectomy. Surg obes Relat Dis. 2016; 12(6).

13. Metsios GS, Stavropoulos-Kalinoglou A, Nevill AM, Douglas KM, Koutedakis Y, Kitas GD. Smoking significantly increases basal metabolic rate in patients with rheumatoid arthritis. Annals of the Rheumatic Diseases. 2007 May 14.

14. Hsu WH, Fan CH, Lin ZR, Hsu RW. Effect of basal metabolic rate on the bone mineral density in middle to old age women in Taiwan. Maturitas. 2013;76(1):70-74.

15. Larsen FJ, Schiffer TA, Sahlin K, Ekblom B, Weitzberg E, Lundberg JO. Mitochondrial oxygen affinity predicts basal metabolic rate in humans. The FASEB Journal. 2011;25(8):2843-2052.

16. Anthanont P, Jensen MD. Does basal metabolic rate predict weight gain?, 2. The American journal of clinical nutrition. 2016 Aug;104(4):959-963.

17. Faria SL, Faria OP, Menezes CS, de Gouvêa HR, de Almeida Cardeal M. Metabolic profile of clinically severe obese patients. Obes Surg. 2012;22(8):1257-62.

18. Kissler HJ, Settmacher U. Bariatric surgery to treat obesity. Semin Nephrol. 2013;33(1):75-89.

19. Garofalo F, Pescarus R, Denis R, et. al. Laparoscopic Sleeve Gastrectomy: A Radiological Guide to Common Postsurgical Failure. Can Assoc Radiol J. 2018;69(2):184-196

20. Carey D, Pliego G, Raymond R et al. Body composition and metabolic changes following bariatric surgery: effects on fat mass, lean mass and basal metabolic rate. Obes Surg 2006: 16: 1-9.

21. Carey DG, Pliego GJ, Raymond RL. Body composition and metabolic changes following bariatric surgery: effects on fat mass, lean mass and basal metabolic rate: six months to one-year follow-up. Obesity surgery. 2006;16(12):1602-1608.

22. Schoeller DA. Making indirect calorimetry a gold standard for predicting energy requirements for institutionalized patients. J Am Diet Assoc. 2007;107:390-392.

23. Olendzki BC, Ma Y, Hébert JR, et al. Underreporting of energy intake and associated factors in a Latino population at risk of developing type 2 diabetes. Journal of the American Dietetic Association. 2008;108(6):1003-8.

24. World Health Organization. Health topics. [online]. Obesity. Available from: http://www.who.int/topics/obesity/en/ (date accessed: 02.07.2018).

25. Caballero B, Finglas PM, Toldrá F. Reference Module in Food Science. *Encyclopedia of Food and Health.* 1st ed. Valencia, Spain: Academic Press. 2016: 132-138.

26. Kushner RF, Kahan S. Introduction: The state of obesity in 2017. *Medical Clinics of North America.* 2017 Oct 6.

27. Hruby A, Hu F. The epidemiology of obesity: a big picture. Pharmacoeconomics [Internet]. 2015; 33 (7): 673–689.

28. Bardia A, Holtan SG, Slezak JM, Thompson WG. Diagnosis of obesity by primary care physicians and impact on obesity management. InMayo Clinic Proceedings 2007;82, No. 8, 927-932.

29. Nicholls SG. Standards and classification: A perspective on the 'obesity epidemic'. Social Science & Medicine. 2013;87:9-15.

30. Rinehart CS, Oliver JS. A Clinical Protocol for the Assessment of Obesity: Addressing an Epidemic. Nursing Clinics. 2015;50(3):605-611.

31. World Health Organization. Global Health Observatory (GHO) data. [online]. Available from: http://www.who.int/gho/ncd/risk_factors/obesity_text/en/) (date accessed: 02.07.2018).

32. Kelly T, Yang W, Chen C-S, Reynolds K, He J. Global burden of obesity in 2005 and projections to 2030. Int J Obes 2005. 2008;32(9):1431–1437.

33. Upadhyay J, Farr O, Perakakis N, Ghaly W, Mantzoros C. Obesity as a Disease. Medical Clinics of North America. 2018;102(1): 13-33.

34. Erem C. Prevalence of overweight and obesity in Turkey. IJC Metabolic & Endocrine. 2015;8:38-41.

35. Berghöfer A, Pischon T, Reinhold T, Apovian CM, Sharma AM, Willich SN. Obesity prevalence from a European perspective: a systematic review. BMC public health. 2008;8(1):200.

36. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999-2008. Jama. 2010;303(3):235-41.

37. Phelan SM, Burgess DJ, Burke SE, et al. Beliefs about the causes of obesity in a national sample of 4th year medical students. Patient education and counseling. 2015;98(11):1446-9.

38. Church TS, Thomas DM, Tudor-Locke C, et al. Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. PLoS One 2011;6(5): 19657

39. Popkin BM, Hawkes C. Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. Lancet Diabetes Endocrinol 2016; 4(2):174–86.

40. Njike VY, Smith TM, Shuval O, et al. Snack food, satiety, and weight. Adv Nutr 2016;7(5): 866–78.

41. Medici V, McClave SA, Miller KR. Common medications which lead to unintended alterations in weight gain or organ lipotoxicity. Curr Gastroenterol Rep 2016;18(1): 2.

42. Cooke L, Llewellyn C. Nature and nurture in early feeding behavior. Nestle Nutr Inst Workshop Ser 2016;85: 155–65

43. Bray MS, Loos RJ, McCaffery JM, et al. NIH working group report-using genomic information to guide weight management: From universal to precision treatment. Obesity (Silver Spring) 2016;24(1): 14–22.

44. . Bjornland T, Langaas M, Grill V, et al. Assessing gene-environment interaction effects of FTO, MC4R and lifestyle factors on obesity using an extreme phenotype sampling design: results from the HUNT study. PLoS One 2017;12(4): 0175071.

45. Foss B, Dyrstad SM. Stress in obesity: cause or consequence?. Medical hypotheses. 2011;77(1):7-10.

46. Coulston AM, Boushey CJ, Ferruzzi MG, Delahanty LM. Nutrition in the Prevention and Treatment of Disease (Fourth Edition) 2017: 477-498.

47. Wadden TA, Bantle JP, Blackburn GL, et al. Look AHEAD Research Group. Eight-year weight losses with an intensive lifestyle intervention: the look AHEAD study. Obesity (Silver Spring) 2014;22(1): 5–13.

48. Pickett-Blakely O, Newberry C. Future Therapies in Obesity. Gastroenterology clinics of North America. 2016;45(4):705-14.

49. Ard JD, Miller G, Kahan S. Nutrition interventions for obesity. Medical Clinics. 2016;100(6):1341-56.
50. Jensen MD, Ryan D. 2013 AHA/ACC/TOS Guideline for the Management of Overweight and Obesity in Adults J Am Coll Cardiol. 2014;63(25 Pt B):2985-3023.

51. Tobias DK, Chen M, Manson JE, Ludwig DS, Willett W, Hu FB. Effect of low-fat diet interventions versus other diet interventions on long-term weight change in adults: a systematic review and meta-analysis. The lancet Diabetes & endocrinology. 2015;3(12):968-79.

52. Johnston BC, Kanters S, Bandayrel K. Comparison of Weight Loss Among Named Diet Programs in Overweight and Obese Adults. JAMA. 2014;312(9): 923-933.

53. Plodkowski RA, Jeor STS. Medical nutrition therapy for the treatment of obesity. Endocrinol Metab Clin N Am 32. 2003; 935–965.

54. Waleh MQ. Impacts of Physical Activity on the Obese Primary Care: Clinics in Office Practice. 2016; 43(1): 97-107.
55. Higuera-Hernández M.F, Reyes-Cuapio E, Gutiérrez-Mendoza M. Fighting obesity: Non-pharmacological interventions Clinical Nutrition ESPEN. 2018; 25: 50-55.
56. Wadden TA, Webb VL, Moran CH, Bailer BA. Lifestyle modification for obesity: new developments in diet, physical activity, and behavior therapy. Circulation. 2012;125(9):1157-70.

57. Salimin N, Elumalai G, Shahril MI, Subramaniam G. The effectiveness of 8 weeks physical activity program among obese students. Procedia-Social and Behavioral Sciences. 2015;195:1246-54.

58. Hinkle W, Cordell M, Leibel R, Rosenbaum M, Hirsch J. Effects of reduced weight maintenance and leptin repletion on functional connectivity of the hypothalamus in obese humans. PloS one. 2013;8(3):59114.

59. Rosenbaum M, Goldsmith R, Bloomfield D, et al. Low-dose leptin reverses skeletal muscle, autonomic, and neuroendocrine adaptations to maintenance of reduced weight. The Journal of clinical investigation. 2005;115(12):3579-86.

60. Sumithran P, Prendergast LA, Delbridge E, et al. Long-term persistence of hormonal adaptations to weight loss. New England Journal of Medicine. 2011;365(17):1597-604.

61. Goldsmith R, Joanisse DR, Gallagher D, et al. Effects of experimental weight perturbation on skeletal muscle work efficiency, fuel utilization, and biochemistry in human subjects. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. 2009;298(1):79-88.

62. Saunders KH. Pharmacotherapy for Obesity. Endocrinol Metab Clin N Am 45 (2016): 521–538.

63. Igel LI, Kumar RB, Saunders KH, Aronne LJ. Practical use of pharmacotherapy for obesity. Gastroenterology. 2017;152(7):1765-79.

64.Saunders KH, Umashanker D, Igel LI, Kumar RB, Aronne LJ. Obesity Pharmacotherapy. Medical Clinics of North America. 2018; 102 (1): 135-148.

65. Bruce DM, Mitchell AI. Surgery for obesity. Medicine. 2015;43(2):101-3.

66. Phillips BT, Shikora SA. The history of metabolic and bariatric surgery: Development of standards for patient safety and efficacy. 2018; 79: 97-107.

67. Carniel EL, Frigo A, Fontanella CG, et al. A biomechanical approach to the analysis of methods and procedures of bariatric surgery. Journal of biomechanics. 2017;56:32-41.

68. Roux CWL, Heneghan HM. Bariatric Surgery for Obesity. Med Clin N Am. 2018; 165–182.

69. Mechanick JI, Youdim A, Jones DB, Garvey WT, et al. Clinical Practice Guidelines for the Perioperative Nutritional, Metabolic and Nonsurgical Support of the Bariatric Surgery Patient-2013 Update: Cosponsored by American Association of Clinical Endocrinologists, The Obesity Society and American Society for Metabolic & Bariatric Surgery. Surgery for Obesity and Related Diseases. 2013; 159–191.

70. Saltzman E, Anderson W, Apovian CM, et al. Criteria for patient selection and multidisciplinary evaluation and treatment of the weight loss surgery patient. Obesity research. 2005;13(2):234-43.

71. Brolin RE. NIH consensus conference. Gastrointestinal surgery for severe obesity. Nutrition. 1996;12(6):403-4.

72. Pentin PL, Nashelsky J. What are the indications for bariatric surgery? J Fam Pract. 2005;54(7):633-4.

73. Mayo Clinic. Guide to types of weight-loss surgery [online]. Available from: https://www.mayoclinic.org/tests-procedures/gastric-bypass-surgery/in-depth/weight-loss-surgery/art-20045334 (date accessed: 12.06.2018).
74. American Society for Metabolic & Bariatric Surgery. Bariatric Surgery Procedures [online]. Available from:https://asmbs.org/patients/bariatric-surgery-procedures (date accessed: 25.05.2018).

75. Inge TH, Courcoulas AP, Jenkins TM, et al. Weight loss and health status 3 years after bariatric surgery in adolescents. *The New England Journal of Medicine.* 2016;374(2):113–123.

76. Azagury DE, Morton JM. Bariatric surgery: Overview of procedures and outcomes. Endocrinology and Metabolism Clinics. 2016;45(3):647-56.
77. Lee JH, Nguyen QN, Le QA. Comparative effectiveness of 3 bariatric surgery procedures: Roux-en-Y gastric bypass, laparoscopic adjustable gastric band, and sleeve gastrectomy. Surgery for Obesity and Related Diseases. 2016;12(5):997-1002.

78. Mayo Clinic. Gastric bypass (Roux-en-Y) [online]. Available from: https://www.mayoclinic.org/tests-procedures/gastric-bypass-surgery/about/pac 20385189 (date accessed: 16.06.2018).

79. University of California San Francisco. Laparoscopic Sleeve Gastrectomy [online]. Available from: https://bariatric.surgery.ucsf.edu/conditions--procedures/laparoscopic-sleeve-gastrectomy.aspx (date accessed: 16.06.2018).

80. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery worldwide 2013. Obes Surg. 2015;25:1822–32.

81. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery and endoliminal procedure: IFSO worldwide survey 2014. Obes Surg. 2017;27:2279–89.

82. Chang DM, Lee WJ, Chen JC, Ser KH, Tsai PL, Lee YC. Thirteen-Year Experience of Laparoscopic Sleeve Gastrectomy: Surgical Risk, Weight Loss, and Revision Procedures. Obesity surgery. 2018; 1-7.

83. University of California San Francisco. Laparoscopic Adjustable Gastric Band (Lap-Band) [online]. Available from: https://bariatric.surgery.ucsf.edu/conditions--

procedures/laparoscopic-adjustable-gastric-band-(lap-band).aspx (date accessed: 16.06.2018).

84. Siejka A, Jankiewicz-Wika J, Kołomecki K, et al. Long-term impact of vertical banded gastroplasty (VBG) on plasma concentration of leptin, soluble leptin receptor, ghrelin, omentin-1, obestatin, and retinol binding protein 4 (RBP4) in patients with severe obesity. Cytokine. 2013;64(2):490-3.

85. Sudan R, Jacobs DO. Biliopancreatic diversion with duodenal switch. Surgical Clinics. 2011;91(6):1281-93.

86. Ho K, Hawa R, Wnuk S, Okrainec A, Jackson T, Sockalingam S. The Psychosocial Effects of Perioperative Complications After Bariatric Surgery. Psychosomatics. 2018 Mar 21.

87. Hawkins W, Maheswaran I. The management of bariatric surgery complications. Surgery (Oxford). 2016;34(11):563-7.

88. Major P, Małczak P, Wysocki M, et al. Bariatric patients' nutritional status as a risk factor for postoperative complications, prolonged length of hospital stay and hospital readmission: A retrospective cohort study. Int J Surg. 2018;56:210-214.

89. Mencia-Huerta M, Lindenmeyer C. From mouth to nose: Psychic effects of bariatric surgery procedures. L'Évolution Psychiatrique. 2018;83(2):1-11.

90. Husain S, Ahmed AR, Johnson J, Boss T, O'Malley W. Small-bowel obstruction after laparoscopic Roux-en-Y gastric bypass: etiology, diagnosis, and management. Archives of Surgery. 2007;142(10):988-93.

91. Hamdan K, Somers S, Chand M. Management of late postoperative complications of bariatric surgery. British Journal of Surgery. 2011;98(10):1345-55.

92. Sarkhosh K, Birch DW, Sharma A, Karmali S. Complications associated with laparoscopic sleeve gastrectomy for morbid obesity: a surgeon's guide. Canadian journal of surgery. 2013;56(5):347-352

93. Hawkins W, Maheswaran I. The management of bariatric surgery complications. Surgery (Oxford). 2016;34(11):563-7.

94. Ma IT, Madura JA. Gastrointestinal complications after bariatric surgery. Gastroenterology & hepatology. 2015;11(8):526-535.

95. Fencl JL, Walsh A, Vocke D. The bariatric patient: an overview of perioperative care. AORN journal. 2015;102(2):116-31.

96. Lemanu DP, Srinivasa S, Singh PP, Johannsen S, MacCormick AD, Hill AG. Optimizing perioperative care in bariatric surgery patients. Obesity surgery. 2012;22(6):979-90.

97. Marcason W. What are the dietary guidelines following bariatric surgery? J Am Diet Assoc. 2004;104(3):487-8.

98. Leahy CR, Luning A. Review of nutritional guidelines for patients undergoing bariatric surgery. AORN journal. 2015;102(2):153-60.

99. Luyckx FH, Lefebvre PJ, Scheen AJ. Non-alcoholic steatohepatitis: association with obesity and insulin resistance, and influence of weight loss. Diabetes and Metabolism. 2000;26(2):98-106.

100. Thorell A, MacCormick AD, Awad S, et al. Guidelines for perioperative care in bariatric surgery: Enhanced Recovery After Surgery (ERAS) society recommendations. World journal of surgery. 2016;40(9):2065-83.

101. Kushner R. Managing the obese patient after bariatric surgery: a case report of severe malnutrition and review of the literature. Journal of Parenteral and Enteral Nutrition. 2000;24(2):126-32.

102. Stocker DJ. Management of the bariatric surgery patient. Endocrinology and metabolism clinics of North America. 2003;32(2):437-57.

103. Brolin RE. Gastric bypass. Surg Clin North Am. 2001; 81:1077–1095.

104. Litchford MD. Macronutrient recommendations: protein, carbohydrate, and fat. In: The ASMBS Textbook of Bariatric Surgery. New York, NY: Springer; 2014:101-109.

105. Allied Health Sciences Section Ad hoc CommitteeAills L, Blankenship J, et al. ASMBS allied health nutritional guidelines for the surgical weight loss patient. Surg Obes Relat Dis. 2008;4(5Suppl): S73-S108. Available from: http://asmbs.org/resources/integrated-health -nutritional-guidelines. (date accessed: 22.04.2015).

106. Magda S, Athanasios M, Ioannis M, et al. Clinical Nutrition Espen. Changes in body composition and Basic Metabolic Rate (BMR) following bariatric surgery. 2016; 13: 67.

107. Giusti V., Theytaz F., Di Vetta V., Clarisse M., Suter M., Tappy L. Energy and macronutrient intake after gastric bypass for morbid obesity: a 3-y observational study focused on protein consumption. Am J Clin Nutr. 2016;103(1):18-24.

108. Hady HR, Dadan J, Luba M. The influence of laparoscopic sleeve gastrectomy on metabolic syndrome parameters in obese patients in own material. Obesity surgery. 2012;22(1):13-22.

109. Adamczyk P, Buzga M, Holeczy P, et al. Bone mineral density and body composition after laparoscopic sleeve gastrectomy in men: A short-term longitudinal study. Int J Surg. 2015;23:101-7.

7. APPENDICES

APPENDIX 1: Koç University Biomedical Research Ethics Committee Decision

Rumelifeneri Yolu Sarıyer 34450 İstanbul T: 0212 338 10 00 F: 0212 338 12 05 www.ku.edu.tr

KOÇ
ÜNİVERSİTESİ

ETİK KURUL KARARI

Toplantı Tarihi:	18.09.2017
Karar No:	2016.293.IRB2.150
Sorumlu Araştırıcı:	Damla Demirtürk
Araştırma Başlığı:	Laparoskopik Sleeve Gastrektomili hastaların ameliyat öncesi ve sonrası bazal metabolizma hızlarındaki değişim
Başlangıç tarihi:	20.09.2017
Etik Kurul izninin süresi:	1 yıl (Uzatma hakkı mevcut olarak)

Koç Üniversitesi Etik Kurulu'na değerlendirilmek üzere başvuruda bulunduğunuz yukarıda künyesi yazılı projenizin başvuru dosyası ve ilgili belgeleri, Üniversitemiz **"Biyomedikal Araştırmalar Etik Kurulu"** tarafından araştırmanın gerekçe, amaç, yaklaşım ve yöntemleri dikkate alınarak incelenmiştir.

Yapılan inceleme sonucunda çalışmanın gerçekleştirilmesinde etik ve bilimsel sakınca bulunmadığına karar verilmiştir.

Notlar:

- Araştırma başlangıç tarihinin 6 aydan daha fazla gecikmesi durumunda Etik Kurul'a başvurularak tarihlerin değiştirilmesi gereklidir.
- Etik Kurul incelemesi ve onayı olmadan bu araştırmada kullanılan prosedürler, formlar ya da protokollerde herhangi bir değişiklik yapılamaz.
- Etik bakımdan sorun çıkması ya da şüpheli bir olay/beklenmeyen etki görülmesi durumunda derhal etik kurul bilgilendirilmelidir.
- Araştırmanın gerçekleştirileceği birimlerin yöneticilerinden de ayrıca izin alınması gerekli olabilir.

Saygılarımla,

Hakan S. Orer
Başkan

Koç Üniversitesi Etik Kurulları Sekreteryası T: 0212 338 11 30 ekr@ku.edu.tr

APPENDIX 2: Informed Consent Form

Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü Yüksek Lisans öğrencisi Damla Demirtürk tarafından yürütülen "Laparoskopik Sleeve Gastrektomili hastaların ameliyat öncesi ve sonrası bazal metabolizma hızlarındaki değişim" konusunda yürütülen araştırmaya katılımınız rica olunmaktadır. Bu çalışmada katılımınız tamamen gönüllülük esasına dayanır. Lütfen aşağıdaki bilgileri okuyunuz ve katılmaya karar vermeden önce anlamadığınız her hangi bir şey varsa çekinmeden sorunuz.

ÇALIŞMANIN ADI: LAPAROSKOPİK SLEEVE GASTREKTOMİLİ HASTALARIN AMELİYAT ÖNCESİ VE SONRASI BAZAL METABOLİZMA HIZLARINDAKİ DEĞİŞİM.

ÇALIŞMANIN AMACI

Bu çalışmanın amacı, laparoskopik sleeve gastrektomili hastaların ameliyat öncesi ve ameliyat sonrası 1.ay, indirekt kalorimetre kullanılarak bazal metabolizma hızlarındaki değişimi görmektir.

PROSEDÜRLER

Bu çalışmaya gönüllü katılmak istemeniz halinde yürütülecek çalışmalar şöyledir; sizlere verilen anket formu ile bariatrik cerrahinin bazal metabolizma hızınıza etkisi belirlenecektir. İndirekt kalorimetrede çıkan sonucunuza göre ameliyat sonrasındaki beslenmeniz tekrar değerlendirmek düşünülebilir.

OLASI RİSKLER VE RAHATSIZLIKLAR

Bu çalışmada sizin için herhangi risk ve rahatsızlık bulunmamaktadır.

TOPLUMA VE/VEYA DENEKLERE OLASI FAYDALARI

Sizin yaşadığınız beslenme sorunlarınızı belirleyip, ameliyat sonrası süreçlerde sizlere verilecek daha kapsamlı eğitim ve danışmanlık programlarının düzenlenmesinde katkı sağlayacaktır.

GİZLİLİK

Bu çalışmayla bağlantılı olarak elde edilen ve sizinle özdeşleşmiş her bilgi gizli kalacak, kişilerle paylaşılmayacak ve yalnızca sizin izniniz veya kanunun gerektirdiği ölçüde ifşa edilecektir. Gizlilik tanımlanmış bir kodlama prosedürüyle sağlanacak ve kod çözümüne

erişim yalnızca çalışmanın sorumlusu araştırmacıyla sınırlı kalacaktır. Tüm veriler, sınırlı erişime sahip güvenli ve şifreli bir veritabanında tutulacaktır.

KATILIM VE AYRILMA

Bu çalışmanın içinde olmak isteyip istemediğinize tamamı ile bağımsız ve etki altında kalmadan karar verebilirsiniz. Bu çalışmaya gönüllü olarak katılmaya karar vermeniz halinde dahi, sahip olduğunuz her hangi bir hakkı kaybetmeden veya herhangi bir cezaya maruz kalmadan istediğiniz zaman çekilebilirsiniz. Çalışmadan çekilmek isterseniz bir cezası yoktur ve sahip olduğunuz faydaları kaybetmezsiniz.

ARAŞTIRMACILARIN KİMLİĞİ

Bu araştırma ile ilgili herhangi bir sorunuz veya endişeniz varsa, lütfen iletişime geçiniz:

Damla Demirtürk

Amerikan Hastanesi ve Koç Üniversitesi Hastanesi

Diyetisyen

T: 444 3 777-7946

E: damlad@amerikanhastanesi.org

Yukarıda açıklanan prosedürleri anladım. Sorularım tatmin olacağım şekilde yanıtlandı ve dilediğim zaman ayrılma hakkım saklı kalmak koşulu ile bu çalışmaya katılmayı onaylıyorum. Bu formun bir kopyası da bana verildi.

_____

Katılımcı Adı-Soyadı

_____ _____

Katılımcı İmzası Tarih

_____

_____

Araştırmacının İmzası Tarih

_____

_____

Şahit İmzası Tarih

APPENDIX 3: FORMS

FORM 1

PREOPERATİF DÖNEMDE HASTA DEĞERLENDİRME FORMU

İsim:			
Soyisim			
T.C.			
Yaş			
Boy			
Kilo			
Beden Kütle İndeksi(BKİ)			
Mevcut Hastalıklar			
Bel Çevresi			
Fit Mate Sonucu			

FORM 2

1.AYDA HASTA DEĞERLENDİRME FORMU

İsim:			
Soyisim			
T.C.			
Yaş			
Boy			
Kilo			
Beden Kütle İndeksi(BKİ)			
Mevcut Hastalıklar			
Bel Çevresi			
Fit Mate Sonucu			