Review

Eur Arch Med Res 2018; 34 (3): 167-74

Bariatric Surgery: Outcomes and Follow-Up

Pınar Şişman[1], Mete Şişman[2], Canan Ersoy[3]

[1]Clinic of Endocrinology and Metabolism, Harakani State Hospital, Kars, Turkey
[2]Clinic of General Surgery, Muradiye State Hospital, Bursa, Turkey
[3]Department of Endocrinology and Metabolism, Uludağ University School of Medicine, Bursa, Turkey

Abstract

Nowadays, obesity is a very important public health problem due to its related comorbidities. Major treatment modalities include lifestyle modification, diet, and medical and surgical treatments. Bariatric surgery is the most successful treatment modality in obesity treatment. Owing to its ability to achieve weight loss and improve comorbidities accompanying obesity, it is now focused on metabolic control rather than weight loss. When choosing an operation method, the purpose of the surgery (weight loss and/or metabolic control) should be decided by taking into account the experience of the surgeon and the center, patient preference, and individual risk assessment results. In the past two decades, complication rates have gradually decreased because of the development of minimally invasive methods, increased experience, and adoption of a multidisciplinary approach in bariatric surgery. However, there are still complications requiring reoperation and hospitalization. Patients should be informed about the operation and postoperative diet and follow-up, realistic weight loss goals should be targeted, and operation and postoperative patient follow-up should be performed in experienced centers.

Keywords: Obesity, bariatric surgery, diabetes, weight regain

DEFINITION AND CLASSIFICATION

Today, obesity is one of the most important health problems in society and has reached epidemic proportions in many parts of the world. The cost of obesity worldwide is equivalent to the cost of war, violence, and terror (1). According to the World Health Organization, in 2015, 2.3 billion adults were overweight, and 700 million adults were obese worldwide (2). If the frequency of obesity continues to increase, 2.2 billion people will be overweight, and 1.1 billion people will be obese in 2030 (3).

Obesity is a very important public health concern due to diseases related to itself as well as due to diseases such as hypertension, hyperinsulinemia, diabetes mellitus (DM), dyslipidemia, heart disease, hyperuricemia, gallstones, cancer, and stroke (Table 1) (2). However, nowadays, it has become difficult to maintain a healthy weight and to prevent weight gain due to the consumption of high calorie foods, decreased physical activity, and sedentary lifestyle (4).

The simplest and most effective method for the determination of the level of obesity is the measurement of body mass index (BMI). While a BMI of 18.5-24.9 kg/m^2 constitutes the healthy group and a BMI of 25-29.9 kg/m^2 constitutes the overweight group, a BMI ≥30 kg/m^2 is defined as obesity and is categorized according to severity (5):

- Category 1: BMI 30-34.9 kg/m^2
- Category 2: BMI 35-39.9 kg/m^2
- Category 3 (severe obesity): BMI 40-49.9 kg/m^2
- Category 4 (super obesity): BMI 50-59.9 kg/m^2
- Category 5 (super super obesity): BMI >60 kg/m^2.

ORCID IDs of the authors:
P.Ş. 0000-0002-6561-6207;
M.Ş. 0000-0002-4595-7362;
C.E. 0000-0003-4510-6282

Cite this article as:
Şişman P, Şişman M, Ersoy C. Bariatric Surgery: Outcomes and Follow-Up. Eur Arch Med Res 2018; 34 (3): 167-74

Corresponding Author:
Pınar Şişman
E-mail:
pinar.sisman@hotmail.com

Received: 06.05.2017
Accepted: 16.10.2017
DOI: 10.5152/eamr.2018.82160

Table 1. Obesity-related health risks

Coronary artery disease and hypertension
Hyperlipidemia
Type 2 diabetes mellitus
Asthma, obesity hypoventilation syndrome, and obstructive sleep apnea
Gastroesophageal reflux and esophagitis
Fatty liver, cholelithiasis, nonalcoholic steatohepatitis, and cirrhosis
Stress urinary incontinence
Venous stasis, deep vein thrombosis, pulmonary embolism, and superficial thrombophlebitis
Hernia (inguinal, ventral, umbilical, and incisional)
Irregular menstruation, hirsutism, gynecomastia, infertility, and polycystic ovary syndrome
Cancer (colon, prostate, uterus, and breast)
Infection (cellulitis, panniculitis, and postoperative wound infections)
Degenerative joint disease and osteoarthritis
Pseudotumor cerebri (idiopathic intracranial hypertension)
Clinical depression

However, in obese patients, there are drawbacks about the measurement of BMI in the assessment of health risk. While the increase in visceral fat causes insulin resistance and cardiovascular diseases, the association of the increase in peripheral fat with these situations is unclear. Therefore, the risk of cardiovascular disease in patients with the same BMI may vary according to the localization of fat accumulation. Another drawback is that the risk can vary in patients with the same BMI according to race, gender, and age (6).

SURGICAL INDICATIONS

Indications in obesity surgeries were first reported in 1991 at the National Institutes of Health (NIH) Consensus Development Panel. In 2013, new criteria were determined with the common view of many different associations (7). These criteria are the following:

- Adult patients with a BMI ≥40 kg/m^2 in the absence of comorbid disease
- Patients with a BMI of 35-39.9 kg/m^2 and with at least one obesity-related comorbid disease
  - o Type 2 DM
  - o Obstructive sleep apnea (OSA)
  - o Hypertension
  - o Dyslipidemia
  - o Obesity hypoventilation syndrome (OHS)
  - o Pickwickian syndrome (in the presence of accompanying OSA and OHS)
  - o Nonalcoholic fatty liver disease (NAFLD)
  - o Nonalcoholic steatohepatitis
  - o Pseudotumor cerebri
  - o Gastroesophageal reflux disease
  - o Asthma
  - o Venous stasis
  - o Severe urinary incontinence
  - o Arthritis causing movement difficulty
  - o Deterioration in the quality of life
- Although the inadequacy of long-term evidences does not enable the support for routine practice, patients with a BMI of 30-34.9 kg/m^2 and with the following criteria:
  - o Uncontrolled diabetes
  - o Metabolic syndrome.

In 2011, the International Diabetes Federation indicated that surgical treatment will play a role in the treatment of type 2 DM in the future in patients with a BMI >30 kg/m^2, high cardiovascu-

Table 2. Preoperative evaluation

Anamnesis and physical examination (obesity-related comorbidities, causes of obesity, and history of weight loss)
Routine tests (fasting blood sugar, lipid panel, liver and kidney function tests, complete urine examination, prothrombin time/INR, blood group, and hemogram)
Iron studies and levels of vitamin B12, folic acid, and 25 OH vitamin D (optionally homocysteine, methylmalonic acid, and vitamins A and E)
Cardiovascular evaluation (ECG and ECHO in the suspicion of cardiac disease or pulmonary HT)
GIS evaluation (***Helicobacter pylori*** screening in areas with high prevalence, gallbladder, and endoscopy in the presence of clinical indications)
Endocrinological evaluation (presence of prediabetes and diabetes or HbA1c evaluation when suspected, TSH in the presence of symptoms or thyroid disease, androgen measurement in the suspicion of PCOS, 1 mg DST in the suspicion of Cushing's syndrome, and 24-hour urine cortisol or night salivary cortisol measurement
Evaluation of nutrition
Report of the medical necessity for bariatric surgery
Proposals of preoperative weight loss
Providing glycemic control in patients with diabetes
Pregnancy counseling
Smoking cessation counseling
Cancer screening tests by the primary physician
Pseudotumor cerebri (idiopathic intracranial hypertension)
Clinical depression
INR: international normalized ratio; 25 OH vitamin D: 25-hydroxyvitamin D; ECG: electrocardiography; ECHO: echocardiography; HT: hypertension; GIS: gastrointestinal system; PCOS: polycystic ovary syndrome; DST: dexamethasone suppression test; TSH: thyroid-stimulating hormone

lar risk, and uncontrolled type 2 DM. Many randomized controlled studies have demonstrated the superiority of surgery to medical treatment and/or lifestyle changes in providing glycemic control and reducing cardiovascular risk in obese patients with diabetes. Along with the current evidence, it is thought that the NIH criterion of a BMI >35 kg/m^2, which is the criterion for bariatric surgery in patients with diabetes and was determined in 1991, can be decreased in the coming years (8). However, although the latest publication of the American Diabetes Association guidelines draws attention to the glycemic benefits of bariatric surgery in the treatment of type 2 DM, there is insufficient evidence to suggest its routine use in patients with type 2 DM with a BMI of 30-35 kg/m^2 (9).

SURGICAL CONTRAINDICATIONS

Bariatric surgical procedures should not be used to provide only glycemic and lipid control or to reduce cardiovascular risks independently of BMI (7). Surgery, however, is controversial because of the severity of comorbidities in patients >65 years old and <18 years old. Although some studies report that there is no upper age limit for surgical contraindication, it is noted that both surgical complications may be severe, and adequate response may not be obtained in elderly patients (10). Other surgical contraindications are the following (11):

- Major depression and psychosis that cannot be treated
- Eating disorders that cannot be controlled (e.g., bulimia)
- Drug or alcohol addiction
- Presence of severe cardiac disease leading to risk of anesthesia
- Severe coagulopathy
- Possible problems of obedience to follow-up procedures and proposals in the postoperative period.

PREOPERATIVE EVALUATION

Before bariatric surgery decision, patients should be questioned in terms of obesity-related behavioral factors and comorbidities that may be effective in surgical decision-making. Detailed evaluation including medical and psychosocial history, physical examination, and biochemical tests should be performed preoperatively (Table 2) (7).

Weight reduction in the preoperative period helps to reduce the volume of the liver and facilitate the surgical technique. It also helps to achieve preoperative glycemic targets (7). In many centers performing bariatric surgery, low calorie (1000-1200 kcal/day) or very low calorie (approximately 800 kcal/g) dieting practices are performed 2-4 weeks before the operation. A reduction in the liver volume by up to 20% can be achieved with this diet (12).

In order to reduce postoperative thromboembolic risk in women receiving preoperative estrogen therapy, estrogen therapy should be discontinued 1 cycle before surgery in those using premenopausal oral contraceptive, and 3 weeks before surgery in those receiving postmenopausal hormone replacement therapy (7).

SURGICAL TREATMENT OPTIONS

Although lifestyle modification, diet, and medical and surgical treatments are the main treatment methods of obesity, bariatric surgery has become the most successful method in obesity treatment because short- and long-term results of lifestyle modification, diet, and medical treatment are inadequate (2). An ideal bariatric surgery should be safe, effective, sustainable, repeatable, reversible, minimally invasive, and cost effective. Today, the ideal method has not yet been achieved, and new methods are being developed annually; bariatric surgery is the fastest-growing surgical branch in the global healthcare sector (12). While the number of operations performed worldwide was 140,000 in 2003, this increased to 340,000 in 2011 (13).

The history of bariatric surgery dates back to the 1950s. While open surgical procedures were performed in the beginning, minimally invasive techniques were developed over the years, and now laparoscopic methods have become available. The first laparoscopic gastric bypass surgery was performed in 1994. This method is still one of the two most common surgical methods and is the gold standard method. Sleeve gastrectomy (SG), which is the most commonly used method in the United States today, was first used in 2003 as a primary method (12). Roux-en-Y gastric bypass (RYGB) and SG constitute 75% of the bariatric surgical procedures worldwide (12). Other techniques that are routinely performed include adjustable gastric band (AGB), biliopancreatic diversion (BPD), and duodenal switch (DS) (2).

Currently, there is insufficient evidence to suggest a single type of operation in patients with severe obesity. For this reason, the choice of operation method should be made by considering the purpose of the operation (weight loss and/or metabolic control), experience of the surgeon and the center, patient preference, and results of patient-specific personal risk assessment. In general, laparoscopic method is recommended owing to its low morbidity and mortality in the early postoperative period. However, owing to the high risk of postoperative malabsorption, care should be taken when methods, such as BPD and DS, are preferred (7).

COST

In the study by Keating et al. (15) in 2015, the healthcare cost results of bariatric surgery and conventional treatment of obese patients with different preoperative baseline glucose values were compared. While the cost of bariatric surgery in patients without diabetes and with prediabetes was found to be higher than that of conventional treatment in the study in which total health expenditures were evaluated in both groups during a 15-year follow-up, there was no difference in terms of cost in patients with diabetes in both groups (14). The existing outcomes indicate that bariatric surgery is valuable in obese patients with diabetes in terms of cost (9). However, these results are based on the assumption that these surgical procedures are effective and safe (9).

SURGICAL COMPLICATIONS

In the past two decades, the development of minimally invasive methods, increased experience, and the adoption of a multidisciplinary approach in bariatric surgery have gradually reduced

the complication rates. Today, the mortality rates of bariatric surgery are similar to cholecystectomy and hysterectomy in experienced centers, which is approximately 0.1%-0.5%. With the adoption of the laparoscopic approach, a similar decrease in morbidity was observed, and lower morbidity rates were achieved with 2%-6% major complication risk and 15% minor complication risk in comparison to most elective operations (15).

However, complications requiring reoperation and hospitalization are still observed after bariatric surgery (15). In the study conducted by Birkmeyer et al. (16), the risks of reoperation and rehospitalization in a 3-year follow-up were 2.5% and 5.1% after laparoscopic RYGB, 0.6% and 2% after laparoscopic AGB (LAGB), and 0.6% and 5.5% after SG, respectively.

According to the results of the United States bariatric surgery database, the 1-year complication rates were 4.6%, 10.8%, 14.9%, and 25.7% using the methods of AGB, SG, RYGB, and BPD, respectively. The factors that increase the risk of morbidity and mortality in operations are advanced age, male gender, very high BMI, presence of chronic diseases, experience of the surgeon, and application of an open surgery instead of laparoscopy (2). The experience of the surgeon performing the operation plays a key role in early outcomes (16).

The mortality rate in the early postoperative period (<30 days) is <1%. However, it can range from 0.3% to 8% (2). Wound infection, bleeding, deep vein thrombosis, and pulmonary embolism are among the complications observed during this period. Pulmonary embolism and anastomosis leak are the most frequent causes of death (2). Late complications include stomal stenosis associated with surgical procedure, marginal ulcers, cholelithiasis, internal and incisional hernias, short bowel syndrome, nutritional deficiencies, and dumping syndrome (2). Laparoscopic approach shortens the duration of hospitalization compared with open surgery and reduces the risk of incisional hernia development. At the same time, intraoperative blood loss and postoperative pain are reduced. However, the incidence of internal hernia increases after laparoscopic surgery (12).

After bariatric operations, complications may be observed due to nutritional and vitamin mineral deficiencies, such as anemia, bone demineralization, and hypoproteinemia, depending on the type of operation. These complications are seen primarily after BPD, RYGB, LAGB, and SG operations with decreasing frequency and severity. The risk of postoperative bone fracture is unknown precisely because of different outcomes found in the literature (15).

Hypoglycemia

The relative risk of hypoglycemia increased seven-fold after gastric bypass operations (2). The duration ranges from a few weeks to 5 years after the operation, and the median duration of symptoms is 2.7 years (17). Although debates about the pathophysiology of hypoglycemia continue, accelerated passage due to dumping syndrome, increased beta-cell mass, and causes unrelated to beta-cell are possible mechanisms (2).

Dumping syndrome can be observed in 50% after surgery (18). Especially after the consumption of sugary foods, it is a condition that progresses with sweating, tachycardia, nausea, vomiting, abdominal pain, diarrhea, and hypoglycemia (19). Patients should be informed about avoiding high amounts of sugary foods (20).

Postoperative weight loss may contribute to hypoglycemia by causing an increase in insulin sensitivity (2). In the literature, there are case reports of noninsulinoma pancreatogenous hypoglycemia syndrome progressing along with postprandial neuroglycopenic symptoms that develop postoperatively. Causes, such as insulinoma, insulin or sulfonylurea use, adrenal insufficiency, autoimmune hypoglycemia, and tumor-induced insulin-like peptide production, should be considered in differential diagnosis (2).

POSTOPERATIVE FOLLOW-UP

Hospitalization Period

While patients can be discharged on postoperative day 1 after LAGB operation, they can be discharged on day 2 after laparoscopic RYGB and SG if no complications develop, and if they can tolerate a clear liquid diet. After open RYGB, patients should be hospitalized for 1 or 2 days more, or until they become mobilized after tolerating the liquid diet (20).

Nutritional Support

All patients who will undergo bariatric surgery should be assessed in terms of nutrition; vitamin and mineral measurements should be made, and the patient and family should be informed about nutritional support and meal planning after the operation (21). In the early postoperative period, the patient should be referred to a dietician, and the meal protocols should be determined according to the type of operation. Within a few hours after the operation, the clear liquid diet (stage I) without sugar, caffeine, and calories is started. After the clear liquid diet lasting for 1 or 2 days, the fluid diet (stage II) is started, and the patient is discharged (3). In this stage, there are sugar-free liquids with sweetening agent, milk, and diet yogurt (22).

Patients who underwent RYGB and SG operations should continue the liquid diet for the first 2 weeks after discharge. Puree-style foods should be consumed for the next 2 weeks and then soft foods (stage III) for 2 months. Patients may start normal nutrition (stage IV) in postoperative month 3. After gastric band operation, normal diet can be started after the liquid diet in the first week, puree in the next week, and soft foods in the following week. Patients should be informed about taking multiple small meals, chewing the food well, and not consuming fluid with food at the same time (12).

All patients should avoid concentrated sugars to reduce calorie intake and dumping symptoms especially after RYGB. Liquids should be slowly consumed, and >1.5 L of fluid/day should be taken to ensure adequate hydration and to prevent dehydration (12).

Protein Support

After malabsorptive type of surgery, the hospitalization rate due to protein malnutrition is approximately 1%, leading to significant morbidity. For this reason, protein support after all bariatric surgical procedures is very important, and daily intake of 60-120 mg protein should absolutely be provided. While protein malnutrition is prevented after malabsorptive type operations in this way, fat-free body mass is maintained after restrictive operations (12). Although the measurement of serum protein levels has a limited value in the follow-up of nutritional status, measurements of serum albumin and prealbumin are the

most frequently used parameters in clinical practice. Serum prealbumin levels in the first year after RYGB and SG were observed to be lower than preoperative levels in one-third of the patients (23).

Vitamin Mineral Supplements

Multivitamins should contain vitamin K, biotin, zinc, thiamine, vitamin B12, folic acid, iron, and copper and should be taken once or twice a day in a chewable or liquid form. While the amount of iron in multivitamins is sufficient for men and postmenopausal women, additional iron preparations of 40-65 mg/day should be started for women in the reproductive period. Calcium carbonate cannot be absorbed sufficiently due to decreased acidity after RYGB; therefore, calcium citrate is recommended in the treatment. However, the fact that calcium carbonate is cheaper and easier to find can provide a treatment advantage. A 2000 IU vitamin D3 is sufficient to prevent the development of vitamin D deficiency after RYGB. Intrinsic factor and gastric acid are required for the absorption of vitamin B12 from the stomach. Therefore, vitamin B12 treatment should be started especially after RYGB operation. Owing to the fact that folic acid is water-soluble and is not stored in the body for a long time, deficiency can be observed in inadequate oral intake, and it may cause megaloblastic anemia. It is most frequently seen after BPD and least frequently after RYGB. The daily recommended dose of folic acid is 400 µg (22).

Glycemic Monitoring

Patients with diabetes should be monitored for serum glucose levels in 6-hour intervals postoperatively, and blood glucose should be kept between 140 and 180 mg/dL. After discharge from the hospital, close glucose monitoring should be performed due to the risk of hypoglycemia that may develop rapidly in patients with diabetes who underwent especially RYGB operation (20).

In patients with diabetes, insulin secretagogues (sulfonylureas and glinides) should be discontinued, and insulin levels should be readjusted to avoid hypoglycemia postoperatively. If metformin is used, treatment may continue until diabetes remission is biochemically proven. Metformin and incretin-based treatments may be considered in patients in whom glycemic targets cannot be achieved after discharge. Long-acting and short-acting insulin before meals in hospitalized patients and intravenous regular insulin in intensive care unit patients should be administered to maintain the targeted blood glucose levels of 140-180 mg/dL (7).

Analgesia

Liquid acetaminophen or codeine acetaminophen may be given for postoperative analgesia. Nonsteroidal anti-inflammatory drugs after RYGB operation are not recommended due to the risks of marginal ulceration. In addition, if there is no vascular or cardiac stent or history of cerebrovascular event, aspirin should not be used due to the risk of marginal ulcer. Proton-pump inhibitor treatment is recommended when aspirin or prednisolone is required (20).

Anticoagulation

Prophylaxis with unfractionated or low-molecular-weight heparin is recommended for all patients within the first 24 h after the operation in order to prevent deep vein thrombosis (7).

Cessation of Smoking and Alcohol

All smokers should stop smoking at least 6 weeks before the operation because smoking causes delayed wound healing by reducing postoperative tissue oxygenation, ulcer formation in the anastomotic region, pulmonary complications, thromboembolism, and other health risks (7, 12). Consumption of 2 alcohol equivalents/day (each containing 12 g alcohol) within a 2-week period before the operation is associated with postoperative pneumonia, sepsis, wound infection, and prolonged hospitalization risk (24).

Findings of Possible Complications

Patients should be warned about reporting to their physicians in the presence of fever >38.1°C, severe abdominal pain, reddening of the incision site, fluid drainage from the incision site, vomiting, chest pain, or shortness of breath (20).

Monitoring

During a 1-year follow-up of patients, annual biochemical evaluation should be performed in 3 and 6 months, and then, it should be performed during lifetime (22).

SURGICAL RESULTS

Follow-Up of Body Weight

A rapid weight loss is observed in patients who underwent RYGB and SG within the first few months. In the first 6 months after RYGB operation, an average of 4.5-7 kg weight loss/month is observed in patients. The average weight loss in the postoperative month 6 visit is 27-36 kg. After 6 months, weight loss slows down and decreases to an average of 2-3 kg/month. Postoperative weight loss is at the maximum level with 45-54 kg in 1 year, and a weight loss plateau begins 1-1.5 years after the operation (25). Weight loss is slower after adjustable gastric band operation. A weight loss of approximately 0.5 kg/week is observed until it becomes stabilized in year 2 (25). Weight loss, in reference to the ideal weight, is 41%-54% with gastric band, 45%-64% with SG, and 62%-75% with RYGB (2).

Follow-up of Comorbidities

In obese patients with diabetes, the rate of partial or complete recovery in diabetes is 77% after surgery. Recovery is observed in hyperlipidemia in 70% of the patients, hypertension in 62%, and OSA in 86% (26). At the same time, after bariatric surgery, a reduction is achieved in 40% of deaths due to all causes, 92% of deaths due to diabetes, 56% of deaths due to coronary artery disease, and 60% of deaths due to cancer (27).

Type 2 DM

Independent of weight loss after RYGB, metabolic improvements are seen with glucagon-like peptide-1 mechanisms within days and weeks. While this period is variable after SG, metabolic improvements begin to be observed longer after AGB (25). In a prospective multicenter study involving approximately 28,000 obese patients with diabetes, a remission or improvement in diabetes was found in 83% of the patients after RYGB, 55% of the patients after SG, and 44% of the patients after AGB operation in 12 months (28). In another study, while the rate of achieving normal or near-normal values in the glycemic control in a 2-year follow-up period was 72% after surgery, it was found to be 16% in the group receiving medical treatment and applying a lifestyle modification (29). In the ST Analysis and Monitoring of

Patients and Evaluation of a Derived Electrocardiogram (STAMPEDE) study conducted by Schauer et al. (30), bariatric surgery and medical treatment were compared only with medical treatment, and the target of 6% hemoglobin A1c (HbA1c) was reached in 38% of the patients in the RYGB group, 24% of the patients in the SG group, and 5% of the patients in the medical treatment group during a 3-year follow-up.

Young age, short duration of type 2 DM, low HbA1c, high insulin levels, and not using insulin are associated with high diabetes remission rates (30). Although it has been shown that bariatric surgery has positive effects on the metabolic parameters in morbidly obese patients with type 1 diabetes, further follow-up studies are needed to fully assess the role of bariatric surgery on these patients (9).

Hypertension

Insulin resistance, hyperinsulinemia, elevated leptin levels, and sleep apnea that accompany obesity can lead to hypertension by causing hyperactivation in the sympathetic nervous system. In the STAMPEDE study, antihypertensive therapies were discontinued in 59% of the patients who underwent RYGB operation in the first year and 60% of the patients who underwent SG (31). In particular, the use of angiotensin-converting enzyme inhibitors and angiotensin receptor blockers decreased from 74% to 18% in the RYGB group and from 61% to 22% in the SG group (31).

Nonalcoholic Fatty Liver Disease

Elevated levels are observed in the liver function tests of the majority of obese patients. In the study conducted by Gholam et al. (32) in which the liver biopsy materials of obese patients were evaluated before bariatric surgery, fatty liver was found in 84% of the patients, inflammation in 20%, and fibrosis in 8%. NAFLD is the most common cause of cryptogenic cirrhosis in obese patients (33). Regression in fat deposition and inflammation and reduction in fibrous bandage have been shown in some patients following bariatric surgery (34).

Hyperlipidemia

A decrease in the levels of triglyceride and low-density lipoprotein and an increase in the levels of high-density lipoprotein are seen after bariatric surgery. Improvement in dyslipidemia is associated with both weight loss and decreased insulin resistance (34).

Bone Health

Calcium and vitamin D deficiencies due to the bypass of the duodenum and proximal jejunum, which play a major role in calcium absorption, in RYGB operation lead to secondary hyperparathyroidism and calcium resorption from the bone (34). While calcium deficiency develops in 10%-25% of the patients in 2 years and in 25%-48% in 4 years after malabsorptive bariatric surgery, vitamin D deficiency develops in 17%-52% of the patients in 2 years and in 50%-63% in 4 years. Fast and excessive weight loss can lead to bone loss, even if the levels of vitamin D are within normal ranges (35).

In morbidly obese patients and when the risk of gout is high, an improvement is observed in existing findings after weight loss, and serum uric acid levels decrease (36). However, the operation itself is a predisposing factor for acute gout. For this reason, it is recommended that prophylaxis be initiated in the early postoperative period in patients with frequent gout episodes (34).

Infertility

Obesity is associated with the risk of infertility, especially in women. If the contraceptive method is not used postoperatively, pregnancy can be achieved in patients with a history of oligomenorrhea due to polycystic ovary syndrome before the operation (34). Retrospective studies show that 70% of preoperatively infertile women have successful pregnancies postoperatively (37). For this reason, in the postoperative period, contraceptive treatment options should be discussed with the patients during the whole reproductive period. The general approach after bariatric surgery is to avoid pregnancy for 12-18 months after surgery in which weight loss becomes optimal and stabilized. If the patient becomes pregnant during the period following bariatric surgery, she should be monitored in terms of nutrition, and biochemical tests and treatments should be performed for iron, folic acid, vitamin B12, calcium, and vitamins A, D, E, and K at every trimester.

Regaining weight

Although bariatric surgery is the most effective method in obesity treatment, weight gain may be observed in some patients in the long term. In the early postoperative period, a decrease is observed in calorie intake due to the reduction in gastric capacity; a decrease in fasting and an increase in the feeling of satiety are seen due to anatomical and metabolic changes. However, this reduction in calorie intake can change over time (38).

In the study conducted by Sjostrom et al. (39), while the average calorie intake was 2900 kcal/day in the preoperative period, it was 1500 kcal/day in postoperative month 6 and increased to 1700, 1800, 1900, and 2000 kcal/day in years 1, 2, 3, and 4-10, respectively; weight gain can be frequently observed if there is no obedience to diet after year 2. In a study that evaluated 289 patients after RYGB, disobedience to diet or continuation of the preoperative eating pattern was shown to lead to inadequate weight loss, weight regain, or both in 23% of the patients. A snacking diet pattern is a common high-risk diet after bariatric surgery. Studies indicate that a snacking diet pattern before and after the operation has a negative effect on postoperative weight loss (40).

CONCLUSION

Surgery is the most effective treatment method in obesity. Owing to the fact that bariatric surgery can provide weight loss and recovery in comorbidities, the aims are now focused on metabolic control rather than primary weight loss. During the selection of bariatric surgery patients, the criteria recommended by the guidelines should be considered; a multidisciplinary approach involving clinicians, surgeons, psychiatrists, and dietitians should be considered at every stage of the perioperative period; patients should be informed about the operation and postoperative diet and follow-up; realistic goals for postoperative weight loss should be set up; and patient follow-up should be performed in experienced centers during and after the operation.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – P.Ş.; Design – P.Ş.; Supervision – C.E.; Resources – M.Ş.; Materials – M.Ş.; Data Collection and/or Processing – P.Ş.; Analysis and/or Interpretation – C.E.; Literature Search – P.Ş., M.Ş.; Writing Manuscript – P.Ş.; Critical Review – C.E.; Other – M.Ş.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Capehorn MS, Haslam DW, Welbourn R. Obesity Treatment in the UK Health System. Curr Obes Rep 2016; 5: 320-6. [CrossRef]
2. Jammah AA. Endocrine and metabolic complications after bariatric surgery. Saudi J Gastroenterol 2015; 21: 269-77. [CrossRef]
3. Kelly T, Yang W, Chen CS, Reynolds K, He J. Global burden of obesity in 2005 and projections to 2030. Int J Obes (Lond) 2008; 32: 1431-7. [CrossRef]
4. Jensen MD, Ryan DH, Apovian CM, Ard JD, Comuzzie AG, Donato KA, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults. J Am Coll Cardiol 2014; 63: 2985-3023. [CrossRef]
5. Obesity: preventing and managing the global epidemic. Report of a WHO colsultation. World Health Organ Tech Rep Ser 2000; 894: i-xii,1-253.
6. Pories WJ, Dohm LG, Mansfield CJ. Beyond the BMI: the search for better guidelines for bariatric surgery. Obesity 2010; 18: 865-71. [CrossRef]
7. Mechanick JI, Youdim A, Jones DB, Garvey WT, Hurley DL, McMahon MM, 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. Obesity (Silver Spring) 2013; 21(Suppl 1): S1-27. [CrossRef]
8. Caravatto PP, Petry T, Cohen R. Changing guidelines for metabolic surgery: Now it's the time! Curr Atheroscler Rep 2016; 18: 47. [CrossRef]
9. American Diabetes Assosiation. Obesity management for the treatment of type 2 diabetes. Diabetes Care 2017; 40(Suppl 1): S57-63. [CrossRef]
10. Giordano S, Victorzon M. Bariatric surgery in elderly patients: a systematic review. Clin Interv Aging 2015; 10: 1627-35.
11. Lim RB. Bariatric operations for management of obesity: Indications and preoperative preparation. Available from: https.www.uptodate.com./contents/bariatric-operations-for-management-of-obesity-indications-and-preoperative-preparation?-source=search_ result&search=Bariatric%20 operations%20 for%20 management%20 of%20 obesity:%20 Indications%20 and%20 preoperative%20 preparation.&selectedTitle=1~150
12. Thorell A, MacCormick AD, Awad S, Reynolds N, Roulin D, Demartines N, et al. Guidelines for perioperative care in bariatric surgery: Enhanced Recovery After Surgery (ERAS) Society recommendations. World J Surg 2016; 40: 2065-83. [CrossRef]
13. Kozlowski T, Kozakiewicz K, Dadan J, Mysliwiec P. Innovative solutions in bariatric surgery. Gland Surg 2016; 5: 529-36. [CrossRef]
14. Buchwald H, Oien DM. Metabolic/bariatric surgery worldwide 2011. Obes Surg 2013; 23: 427-36. [CrossRef]
15. Keating C, Neovius M, Sjoholm K, Peltonen M, Narbro K, Eriksson JK, et al. Health-care costs over 15 years after bariatric surgry for patients with different baseline glucose status: results from the Sweedish Obese Subjects study. Lancet Diabetes Endocrinol 2015; 3: 855-65. [CrossRef]
16. Birkmeyer NJ, Dimick JB, Share D, Hawasli A, English WJ, Genaw J, et al. Michigan Bariatric Surgery Collaborative. Hospital complication rates with bariatric surgery in Michigan. JAMA 2010;304: 435-442. [CrossRef]
17. Yumuk V, Tsigos C, Fried M, Schindler K, Busetto L, Micic D, et al. European guidelines for obesity management in adults. Obes Facts 2015; 8: 402-24. [CrossRef]
18. Marsk R, Jonas E, Rasmussen F, Näslund E. Nationwide cohort study of post-gastric bypass hypoglisemia including 5040 patients undergoing surgery for obesity in 1986-2006 in Sweeden. Diabetologia 2010; 53: 2307-11. [CrossRef]
19. McBridge CL, Petersen A, Sudan D, Thompson J. Short bowel syndrome following bariatric surgical procedures. Am J Surg 2006; 16: 488-95.
20. Tack J, Arts J, Caenepeel P, De Wulf D, Bisschops R. Pathhophysiology, diagnosisand management of postoperative dumping syndrome. Nat Rev Gastroenterol Hepatol 2009; 6: 583-90. [CrossRef]
21. Hamad G. Bariatric surgery: Postoperative and long-term management of the uncomplicated patient. Available from: https.www.uptodate.com./contents/bariatric-surgery-postoperative-and-long-term-management-of-the-uncomplicated-patient?-source=search_ result&search=Postoperative%20 and%20 long-term%20 management%20 of%20 the%20 uncomplicated%20 patient.&selectedTitle=1~150
22. Mechanick JI, Kushner RF, Sugerman HJ, Gonzalez-Campoy JM, Collazo-Clavell ML, Guven S, et al. American Association of Cinical Endocrinologists. The Obesity Society, and American Society for Metabolic & Bariatric Surgery Medical guidelines for clinical practice fort he periperative nutritional, metabolic and nonsurgical support of the bariatric surgery patint. Endocr Pract 2008; 14(Suppl 1): 1-83. [CrossRef]
23. Kushner RF, Cummings S, Herron DM. Bariatric surgery: Postoperative nutritional management. https.www.uptodate.com./contents/bariatric-surgery-postoperative-nutritional-management?source=search_result&search=Bariatric%20 surgery:%20 Postoperative%20 nutritional%20 management.&selectedTitle=1~150
24. Ito MK, Gonçalves VSS, Faria SLCM, Moizé V, Porporatti AL, Guerra ENS, et al. Effect of protein intake on the protein status and lean mass of post-bariatric surgery patients: a systematic review. Obes Surg 2017; 27: 502-12. [CrossRef]
25. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004; 292: 1724-37. [CrossRef]
26. Telem D, Greenstein AJ, Wolfe B. Medical outcomes following bariatric surgery. https.www.uptodate.com/contents/medical-outcomes-following-bariatric-surgery?source=search_ result&search=-medical%20 outcomes%20 following%20 bariatric%20 surgery&selected Title=1~150.
27. Gloy VL, Briel M, Bhatt DL, Kashyap SR, Schauer PR, Mingrone G, et al. Bariatric surgery versus non-surgical treatment for obesity: Asystematic review and meta-analysis of randomised controlled trials. BMJ 2013; 347: f5934. [CrossRef]
28. Christou NV, Sampalis JS, Liberman M, Look D, Auger S, McLean AP, et al. Surgery decreases long-term mortality, morbidity and health care use in morbidly obese patients. Ann Surg 2004; 240: 416-24. [CrossRef]
29. Hutter MM, Schirmer BD, Jones DB, Ko CY, Cohen ME, Merkow RP, et al. First report from the American Collage of Surgeons Bariatric Surgery Center Network: laparoskopic sleeve gastrectomy has morbidity and effectiveness positioned between the band and the bypass. Ann Surg 2011; 254: 410-22. [CrossRef]
30. Schauer PR, Bhatt DL, Kirvan JP, Wolski K, Brethauer SA, Navaneethan SD, et al. STAMPEDE Investigators. Bariatric surgery versus intensive medical therapy for diabetes- 3 year outcomes. N Eng J Med 2014; 370: 2002-13. [CrossRef]
31. Kashyap SR, Bhatt DL, Schauer PR, STAMPEDE Investigators. bariatric surgery vs. advanced practice medical management in the treatment of type 2 diabetes mellitus: rationale and design of the Surgical Therapy And Medications Potentially Eradicate Diabetes Efficiently trial (STAMPEDE). Diabetes Obes Metab 2010; 12: 452-4. [CrossRef]

32. Gholam PM, Kotler DP, Flancbaum LJ. Liver pathology in morbidly obese patients undergoing Roux-en-Y gastric bypass surgery. Obes Surg 2002; 12: 49-51. [CrossRef]
33. Clark JM, Diehl AM. Nonalcoholic fatty liver disease an under recognized cause of cryptogenic cirrhosis. JAMA 2003; 289: 3000-4. [CrossRef]
34. Heber D, Greenway FL, Kaplan LM, Livingston E, Salvador J, Still C, et al. Endocrine and nutritional management of the post-bariatric surgery patient: An Endocrine Society Clinical Practice Guideline. J Clin Endocrinol Metab 2010; 95: 4823-43. [CrossRef]
35. Pugnale N, Giusti V, Suter M, Zysset E, Héraïef E, Gaillard RC, et al. Bone metabolism and risk of secondary hyperparathyroidism 12 months after gastric banding in obese pre-menopausal women. Int J Obes Relat Metab Disord 2003; 27: 110-6. [CrossRef]
36. Nevitt MC. Obesity outcomes in disease management: clinical outcomes for ostroarthritis. Obes Res 2002; 10(Suppl 1): S33-7. [CrossRef]
37. Musella M, Milone M, Bellini M, Sosa Fernandez LM, Leongito M, Milone F. Effect of bariatric surgery on obesity releated infertility. Surg Obes Relat Dis 2012; 8: 445-9. [CrossRef]
38. Kushner RF, Sorensen KW. Prevention of weight regain following bariatric surgery. Curr Obes Rep 2015; 4: 198-206. [CrossRef]
39. Sjostrom L, Lindroos AK, Peltonen M, Torgerson J, Bouchard C, Carlsson B, et al. Lyfesytle, diabetes and cardiovascular risk factors 10 years after bariatric surgery. N Eng J Med 2004; 351: 2683-93. [CrossRef]
40. Colles SL, Dixon JB, O'Brien PE. Grazing and loss of control related to eating: two high risk factors following bariatric surgery. Obesity 2008; 16: 615-6. [CrossRef]