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Comprehensive Overview - Outcomes and Challenges of Bariatric Surgery - Physical, Psychological and Nutritional Considerations

Katarzyna Doman [KD]

NZOZ MEDICUS ,ul. Opiesińska 10-12, 98-220 Zduńska Wola, Poland

ORCID: https://orcid.org/0009-0005-1022-490X

e-mail: kadomanka@gmail.com

Dawid Komada [DK]

Szpital Specjalistyczny im. Ludwika Rydygiera w Krakowie, ul. Złotej Jesieni 1, 31-826 Kraków, Poland

ORCID: https://orcid.org/0009-0009-6015-8292

e-mail: komada.dawid.lek@gmail.com

Kamil Hermanowicz [KH]

SPZOZ w Zelowie, Żeromskiego 21, 97-425 Zelów, Poland

ORCID: https://orcid.org/0009-0007-0844-1424

e-mail: Kamil03h8@gmail.com

Daria Oleksy [DO]
Przychodnia Zespołu Lekarzy Rodzinnych LEKMED s.c. Czerwonego Krzyża 2, 63-000 Środa Wielkopolska, Poland
ORCID: https://orcid.org/0009-0004-4492-3752
e-mail: daria.oleksy.1996@gmail.com

Agnieszka Najdek [AN]
Teaching Hospital No. 2 of the Medical University of Lodz, Żeromskiego Street 113 90-549 Lodz, Poland
ORCID: https://orcid.org/0009-0000-1112-3864
e-mail: agnieszka.najdek99@gmail.com

Urszula Kaczmarska [UK]
ZOZ Ropczyce 39-100 Ropczyce, ul. Ks. Kard. St. Wyszyńskiego 54, Poland
ORCID https://orcid.org/0009-0007-2986-5760
e-mail: urszulakaczmarskaa@gmail.com

Aleksandra Woźniak [AW]
Faculty of Medicine, Medical University of Lodz, al. Tadeusza Kościuszki 4, 90-419, Łódź, Poland
ORCID: https://orcid.org/0009-0004-7769-9865
e-mail: aleksandra.wozniak4@stud.umed.lodz.pl

Marcin Mycyk [MM]
Piotr Pelcer Klinika Zdrowia Sp. z o.o. Filia Kębłowo, ul. Chłopska 13, 84-242 Kębłowo, Poland
ORCID: https://orcid.org/0009-0001-2553-3327
e-mail: marcinmycyk@gmail.com

Julia Nowak [JN]
RAW-MEDICA NZOZ, Słowackiego 68, 96-200 Rawa Mazowiecka, Poland
ORCID: https://orcid.org/0009-0009-5954-8138
e-mail: jwilkusz@gmail.com

Michał Jakub Cioch [MJC]
Centrum Medyczne LUX MED al. Pokoju 18c, 31-564 Kraków, Poland
ORCID: https://orcid.org/0009-0007-1555-3336
e-mail: michalcioch1@gmail.com

Abstract

Obesity, defined by excessive and abnormal body fat accumulation, leads to various health conditions such as diabetes, cardiovascular diseases, and certain cancers, significantly affecting the health and increasing the risk of mortality. Bariatric surgery offers a treatment for severe obesity, with restrictive and malabsorptive methods like sleeve gastrectomy (SG), adjustable gastric banding (AGB), Roux-en-Y gastric bypass (RYGB), biliopancreatic diversion (BPD). While bariatric surgery is effective for weight loss and health improvement, it is not without complications. Postoperative challenges include surgical complications, bone loss, nutritional deficiencies and changes in metabolism. Post-bariatric surgery patients may face psychological challenges such as emotional dysregulation, eating disorders like loss of control eating or binge eating, and body image concerns related to excess skin. This article explores the various impacts of bariatric surgery, addressing both physical and psychological challenges. It emphasizes the importance of holistic patient care, considering both physical outcomes and mental health post-surgery, to ensure long-term success.

Materials and methods

The article is a result of the review of the scientific literature searched by keywords “bariatric surgery”, “negative outcomes”, “obesity’’ available in Pubmed database. This overview does not cover all possible postoperative complications in bariatric surgery, but focuses on selected issues important for a comprehensive strategy for managing obesity.

Aim of the study

The aim of the study is to review the various complications and long-term effects of bariatric surgery, with a particular focus on specific issues that are important for a holistic approach to obesity treatment.

Keywords: Obesity; bariatric surgery; postoperative outcomes

1. Introduction

Obesity is typically defined by an abnormal accumulation or uneven distribution of body fat (BF), which negatively affects health. [1,2] It is primarily categorized using body mass index (BMI, kg/m^2), although this measure has significant limitations. [1,3] Obesity is often associated with various other health conditions, including type 2 diabetes mellitus (T2DM), fatty liver disease, cardiovascular diseases, stroke, dyslipidemia, hypertension, gallbladder issues, osteoarthritis, sleep apnea and other respiratory problems, as well as certain cancers (such as endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon cancers). These conditions collectively increase the risk of mortality. [1,4]

Severe obesity can be treated through lifestyle changes, medication, and bariatric surgery. [5] Surgery may be recommended as the primary treatment, without prior conservative approaches, if those methods are deemed unlikely to succeed. The need for surgery becomes urgent if the patient's health is at risk of rapidly deteriorating due to morbidity or other psychosocial factors. The primary goal of obesity surgery is to limit energy intake by surgically reducing the stomach's volume, allowing only small amounts of food to be consumed. Bariatric surgeries can be categorized based on their effects: restrictive procedures limit food intake, malabsorptive procedures reduce nutrient absorption, and combination methods utilize both approaches. These techniques help patients achieve significant weight loss by altering the stomach or digestive system in different ways, depending on the specific surgical method chosen. Gastric bypass, introduced in 1969 and later refined into the Roux-en-Y form, involves a small gastric pouch and a modified gastric-to-intestinal connection. Adjustable gastric banding uses a silicone belt to control the stomach outlet. Biliopancreatic diversion and duodenal switch, often for super-obese patients, combine substantial gastric reduction with extensive intestinal bypass. The vertical sleeve gastrectomy, a newer technique, removes 70% of the stomach to create a narrow gastric tube without intestinal bypass. Each option varies in its effectiveness for weight loss, medical benefits, and the likelihood of complications. [5,6]

The average hospital stay for obesity surgery is about a week. Around 9% of patients experience respiratory complications, 4% develop issues with an anastomotic fistula, and 6% require revision surgery. The peri-operative mortality rate is below 1%. [7]

2. Surgical Complications

The two most frequent surgical complications following bariatric surgery are staple-line bleeding and anastomotic leaks. [8] There are various hypotheses regarding the causes of this problem. Firstly, gastric wall ischemia near the staple line, potentially caused by dissection of the greater curvature with electrocautery or the LigaSure device, may be a significant contributor to leaks. [8] On the other hand, improperly formed staples are associated with poor tissue apposition, inadequate hemostasis, and increased risk of leaks. However, when used correctly, staples are an effective and efficient method for isolating and securing tissue during bariatric surgery. [9] Extraluminal gastric leaks may result in cutaneous fistulas, peritonitis, abscesses, sepsis, organ failure, and potentially death. [8] An uncontained leak, or one accompanied by hemodynamic instability, necessitates urgent surgical intervention. This should include repairing the leak, placing drains, establishing enteral feeding access, and administering intravenous antibiotics. Both laparoscopic and open surgical approaches may be suitable. Other rare surgical complications, varying by procedure type, include ulcers, postoperative peritonitis, gastrogastric fistula, band erosion, band slippage, ventral incisional hernia, hiatus hernia, esophageal dilatation, esophagitis, reflux, cirrhosis, dumping syndrome, short bowel syndrome and hepatobiliary complications. [10]

3. Bone loss and vitamin D deficiency

Several longitudinal studies report significant decreases in bone density as measured by DXA (bone density test) following bariatric surgery. The most significant bone loss was observed especially after RYGB, slightly less following Sleeve Gastrectomy (SG). The long-term effects of bone loss following bariatric surgery are still debated. However, it is evident that many early bariatric procedures were linked to calcium and vitamin D deficiencies resulting in case reports of histologically confirmed osteomalacia, osteoporosis, osteitis fibrosa cystica, and brown tumors. [11,12,13] Patients who have undergone gastrectomy or gastric bypass procedures are prone to developing malabsorption of vitamin D and calcium. Deficiency of vitamin D results in secondary hyperparathyroidism, where increased secretion of parathyroid hormone (PTH) stimulates the activity of vitamin D 1-alpha-hydroxylase. This likely explains the elevated levels of 1,25-dihydroxyvitamin D after gastric surgery. Both high PTH and 1,25-dihydroxyvitamin D levels contribute to increased osteoclastic bone resorption,

often leading to a clinical presentation that is characteristic of both osteomalacia and osteoporosis. [12] Serum levels of 25-hydroxyvitamin D often fail to rise after surgery, even with supplementation, which means that its deficiency can pose a significant risk to obese individuals. However, it has to be mentioned that vitamin D deficiency is a frequently observed in the general population and also common in obese patients. Patients undergoing bariatric surgery typically show signs of hypovitaminosis D both before and after the procedure. [13]

The risk of fractures is higher in patients who have undergone bariatric surgery. Malabsorptive procedures have been linked to an increased risk of fractures, while laparoscopic adjustable gastric banding (LAGB), has not shown this association. The risk of fractures following bariatric surgery may vary by bone site, with a greater susceptibility to upper limb fractures. [14] There is growing evidence that low levels of GIP, ghrelin, amylin, and insulin, along with high levels of PYY, have negative effects on bone mass. [15]

4. Rheumatologic side effects

Gout attacks have been observed following bariatric surgery. [14] Serum uric acid levels are associated with obesity and overeating. Periods of starvation, catabolism, and dehydration after abdominal surgery can lead to hyperuricemia and trigger gout. Additionally, fat tissue contributes to higher serum uric acid levels, reduced uric acid clearance, and an increased urinary uric acid-to-creatinine ratio. [16]

Postoperative arthropathy is considered to be another complication of SG. [14,17] The creation of a jejunoileal bypass can lead to the development of a characteristic episodic arthropathy. It has been proven to be independent of osteomalacia and pre-existing joint disease. The redundant loop of the small intestine appears to be the likely site for bacterial antigens, against which elevated levels of complement-containing cryoprecipitates and circulating antibodies have been reported. [17]

Finally, Bowel Bypass Syndrome, also referred to as bowel-associated dermatitis arthritis syndrome (BADAS), has been observed after various intestinal bypass procedures. It is a well-known complication of jejuno-ileal bypass surgery. [18] Patients commonly experience symmetrical, non-deforming polyarthritis that mainly affects the small joints. Skin lesions can appear very quickly, often within days, and may resolve and reappear over the course of several weeks. Panniculitis, ecchymoses, pustular vasculitis, and nodular erythematous plaques are typical cutaneous manifestations. [18,19] Additionally, other

intestinal bypass procedures, such as biliopancreatic diversion and Billroth II gastrectomy, have also been linked to this condition. [18]

5. Anemia

Both iron deficiency and vitamin B12 deficiency are major causes of post-bariatric anemia, with similar rates observed after both RYGB and SG procedures. Iron absorption can be limited due to hypochlorhydria and the bypassing of the duodenum and proximal jejunum, which are the primary sites for iron absorption. These mechanisms are key factors leading to iron deficiency. Additionally, reduced food intake and changes in food preferences, such as intolerance to meat and dairy products, should be considered, as they may also play significant roles in the development of anemia. [15] Malabsorptive procedures and low initial ferritin levels were connected to a greater risk of iron deficiency. Furthermore, younger age, pre-existing anemia, and low initial ferritin levels were contributed to a higher likelihood of developing iron deficiency anemia (IDA). It is more likely to develop IDA during the premenopausal period, but this is still influenced by its impact on baseline ferritin levels. [20] Bariatric surgery patients should have their iron levels regularly monitored. It is important to administer up to 150-200 mg of elemental iron daily. If there is significant iron malabsorption or severe intolerance to oral iron, intravenous iron infusion may be required. For vitamin B12 deficiency, a dosage of 1000 μg may be used. Alternative methods of administration, such as intranasal (500 μg) or parenteral (1000 μg per month to 1000–3000 μg every 6 to 12 months), are also options. [21]

6. Deficiencies in other vitamins

Patients who have undergone bariatric surgery are likely to develop nutritional deficiencies, with a higher risk following malabsorptive procedures (such as Roux-en-Y gastric bypass [RYGB] and biliopancreatic diversion) compared to restrictive procedures (such as adjustable gastric banding and sleeve gastrectomy). [22] Nutritional deficiencies following bariatric surgeries are primarily due to two factors: inadequate patient compliance with treatment and malabsorption resulting from alterations in the gastrointestinal (GI) tract. [23] Vitamin deficiencies following RYGB are more prevalent and affect a wider range of vitamins (including water-soluble ones) than previously recognized. In addition to the previously mentioned vitamin D, it has also been proven that RYGB can lead to deficiencies

in B vitamins (thiamine, ryboflavin, pyridoxine, cobalamin, folic acid), as well as vitamins A, E, K, C (ascorbic acid). [24,25]

6.1 Vitamin B

Symptomatic thiamine (vitamin B1) deficiency can affect up to 49% of patients after surgery, depending on the surgical method used. Unhealthy eating habits and noncompliance with oral supplementation have also been identified as major contributing factors to thiamine deficiency. Deficit of cobalamin (vitamin B12) is a common cause of post-operative anemia (described above), particularly after biliopancreatic diversion or RYGB (but not LAGB or LSG). Preoperative vitamin B12 deficiency is linked to SIBO and the use of metformin and proton pump inhibitors (PPI). [25,26] Folate (vitamin B9) deficiency has been observed after both restrictive and malabsorptive procedures, particularly in women who become pregnant following bariatric surgery. Since the body's folate stores are limited, a deficiency can develop early in the post-operative period. However, this deficiency is believed to result more from reduced intake than from malabsorption. [25,27] It is difficult to determine whether post-operative low levels of riboflavin (vitamin B2) and pyridoxine (vitamin B6) are a result of bariatric surgery or if they are due to pre-operative deficiencies. [24]

6.2 Vitamin C

While the symptoms of ascorbic acid deficiency may not be apparent after bariatric surgery, biochemical evidence of vitamin C deficiency is frequently observed. Additionally, higher BMI is linked to lower ascorbic acid levels, a connection that is independent of supplementation, diet, and age. [28]

6.3 Vitamin A, K and E

Although clinical symptoms were rarely observed, it appears that patients undergoing major malabsorptive surgeries have an increased risk of developing vitamin K deficiency. Vitamin K deficiency in patients after biliopancreatic diversion was only marginally linked to bleeding or significant reductions in coagulation factor activity. [22] Patients who undergo malabsorptive procedures have an increased risk of developing a vitamin E deficiency. [29] Reduced serum levels of vitamin E have been observed in up to 22% of RYGB patients after surgery. This

deficiency may present with neurological symptoms (such as peripheral neuropathy and ataxia) or unexplained anemia, however they are rarely observed. [24,29] Hypovitaminosis A can occur following bariatric surgery due to reduced nutrient absorption. It may present as night blindness, which indicates an inadequate supply of 11-cis-retinaldehyde, the vitamin A-derived chromophore essential for visual pigment function. A rare case of delayed vitamin A retinopathy was reported, where a fundus exam showed multiple small white dots in the mid-periphery of both eyes. Electrophysiological testing also revealed flat-line scotopic responses, indicating significant dysfunction of rod cells, which is linked to vitamin A deficiency. [30,31]

7.Deficiencies in minerals

7.1 Iron

Iron deficiency is mainly associated with malabsorptive procedures, such as RYGB, biliopancreatic diversion, duodenal switch. Patients after surgery have decreased level of hydrochloricid acid which leads to insufficient transition of $Fe^{3+}$to Fe^{2+}. Moreover, reduced food intake and eventual meat intolerance are additive factors of iron deficit. [32] The incidence of anaemia following bariatric surgery has been reported as 74% and has been mostly ascribed to iron deficiency. Symptoms of iron deficiency may be nonspecific but include fatigue and muscle weakness. Overt anaemia typically presents fatigue, dyspnoea, pica, pagophagia, chest discomfort, and oral discomfort. [33]

7.2 Zinc

Zinc deficiency in bariatric patients is underestimated. Plasma zinc levels decrease until the twelfth month after bariatric surgery, with zinc deficiency increasing from 8.9% on the day of surgery to over 35% post-operatively. This is primarily observed after biliopancreatic diversion with duodenal switch, rather than after RYGB or SG as it is probably attributed to steatorrhea provoked by biliopancreatic diversion. [25,34,35] Several factors may contribute to this deficiency, including inadequate protein status (as zinc levels correlate with prealbumin plasma concentration), malabsorption, insufficient dietary intake, duodenum bypassing, and reduced digestive enzyme production. Zinc deficiency post-surgery could also be linked to a disruption in compensatory mechanisms. Zinc absorption is influenced by zinc status, with absorption efficiency inversely related to the amount of ingested zinc. [35] The main symptoms of depletion include reduced taste and smell, stunted growth, skin rashes, hair loss, gonadal

dysfunction, complications during pregnancy, increased vulnerability to infections, slow wound healing, impaired glucose metabolism, and a heightened risk of cancer development. [36]

7.3 Copper

Copper deficiency is significantly more common after BPD than RYGB. Neurological and hematological disorders associated with copper deficiency may not develop until several years following obesity surgery. [25] Copper is essential for skin and hair pigmentation and plays an indirect role in blood production by influencing iron metabolism. [37] It also supports the proper functioning of the immune system. Ten years after RYGB, patients have experienced complications of hypocupremia, including severe gait abnormalities, anemia, and severe neutropenia. Copper repletion, both intravenous and oral, was required, which led to a rapid normalization of hematologic indices; however, the improvement in neurological symptoms was modest. [38]

7.4 Selenium

Selenium deficiency has been observed following bariatric surgeries such as Roux-en-Y gastric bypass and sleeve gastrectomy, with a prevalence of up to 20%. This deficiency can lead to complications like peripheral and cardiac myositis, myopathy, arrhythmias, muscle wasting, and hypothyroidism. However, symptomatic cases of selenium deficiency are relatively rare. Patients experiencing anemia, fatigue, persistent diarrhea, signs of cardiomyopathy, or metabolic bone disease should have their selenium levels measured. [39]

8. Immunological abnormalities

Rapid weight loss following bariatric surgery can impact immune balance. A notable increase in CD4+ lymphocytes was observed, which is linked to changes in leptin levels after the surgery. Leptin, a hormone produced by fat tissue, has an inhibitory effect on CD4+ cells. Therefore, the decrease in leptin levels after surgery could logically lead to an increase in CD4+ cell counts. Some patients developed positive ANAs following bariatric surgery, suggesting that weight loss could potentially trigger immune disorders. Although the link between elevated antibody levels and the onset of autoimmune diseases is not fully understood, healthcare providers should remain cautious and consider this possibility. [40, 41] The development of

autoimmune diseases like rheumatoid arthritis (RA), systemic lupus erythematosus (SLE) and spondyloarthritis following bariatric surgery has been documented in the literature. The hypothesis behind this phenomenon suggests that chronic inflammation of the excluded bowel, bacterial overgrowth, cytokine production, and the deposition of immune complexes may play a role. [41]

9. Impact on hair health

Post-bariatric patients often experience telogen effluvium, a form of non-scarring hair loss characterized by increased shedding and thinning. The mechanism involves disruption of the anagen (active) phase of hair growth. In referral to bariatric surgery, this is primarily caused by deficiencies in iron and protein, typically occurring within 3 months after procedure. [42]
Another contributing factor to post-bariatric alopecia is physical stress resulting from rapid weight loss, which causes more hair to enter the resting phase, a process that can last for more than three months. Significant hair loss is usually observed 3-6 months after surgery. Nutritional deficiencies in zinc, selenium, copper and vitamin B12 can also contribute to hair loss. [42,43]
The type of bariatric surgery does not influence the severity of alopecia; however, the extent of hair loss is related to the degree of weight loss. Patients who experience greater weight reduction tend to lose more hair. [42] However, hair loss in bariatric patients can be multifactorial, resulting from multiple causes, including autoimmune diseases, various medications, inflammatory scalp disorders, hormonal issues, and infections. [42,44]

10. Psychological disorders

Negative emotional dysregulation (NED) is likely to contribute to worse adherence to post-surgical instructions and consequently smaller post-surgical weight reduction. Emotional dysregulation refers to a difficulty in managing emotional processes, which, among its various consequences, can contribute to disordered eating and promote the development and worsening of excess weight. Moreover, patients with ADHD symptoms experience less weight loss after bariatric surgery, particularly when they also struggle with emotional dysregulation. [45] Individuals with a history of emotional and mood dysregulation are likely to be at higher risk of developing unhealthy eating habits and may quickly revert to pathological eating behaviors after surgery. [46] Although binge eating, defined as consuming an objectively large amount of food in a short period and experiencing a sense of loss of control during the episode, is not

physically possible right after surgery, patients with pre-operative binge eating disorder often struggle with losing control over eating post-surgery. It often results in the development of other maladaptive eating behaviors, such as grazing, snacking, and night eating. [47] Post-operative loss of control eating is a negative predictor for long-term success after bariatric surgery. Recent studies indicate that night eating may also be linked to worse post-surgery outcomes. [48] What is even more interesting is that eating pathologies, such as loss of control eating or binge eating disorder, can develop for the first time after bariatric surgery. [47] Despite the fact that bariatric surgery has overally positive impact on mental health which includes improvement in depressive symptoms, self-esteem and body image generally, not all patients experience this amelioration. Some individuals may be dissapointed beacuse of lack of spectacular weight loss, eventual weight regain and undesirable skin changes. Sometimes preoperative expectations that life will drastically improve after surgery are unachieved. Even with significant weight loss, it can negatively affect psychological health. Additionally, some patients may find that certain issues they faced before surgery continue afterward, leading to disappointment as they can no longer attribute emotional struggles to their weight. [49] The side effect of excess skin may also affect how one perceives their body, triggering negative thoughts and behaviors focused on appearance. As a result, these negative feelings about the body can lead to increased restrictive eating and concerns about weight, food, and shape. [50]

11. Conclusion

Bariatric surgery offers a promising solution for patients with severe obesity, leading to significant weight loss and improvements in obesity-related comorbidities. However, the benefits of surgery extend beyond physical outcomes, with psychological and nutritional factors also playing critical roles in the overall success of the procedure. Postoperative complications such as surgical risks, bone density reduction, nutritional deficiencies, and rheumatologic issues necessitate careful monitoring and management. Psychological factors, including emotional dysregulation, the development of eating pathologies, and body image concerns, can also hinder long-term success and recovery. Patients may face disappointments when postoperative results do not align with their pre-surgical expectations, even when significant weight loss is achieved. Therefore, it is essential that bariatric surgery is approached with a comprehensive care plan that not only addresses physical health but also focuses on mental well-being and long-term lifestyle changes. This holistic approach can improve patient adherence to postoperative

guidelines and contribute to sustained weight loss, overall health improvement, and enhanced quality of life.

Authors contributions

All authors have read and agreed with the published version of the manuscript.

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