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An Overview of Surgical Strategies for Treating Obesity

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ABSTRACT

Introduction: In the last few years, obesity has become a central issue with more than 2.6 billion people worldwide being overweight or obese. While the risks associated with this condition and its rising significance are widely known, the effect of this attention on screening and treatment remains unsatisfying. This paper explores multiple treatment strategies and evaluates their effectiveness in preventing obesity-related complications.

Review methods: We conducted our study as a literature review, with data being gathered via PubMed and Embase.

The state of knowledge: Physical activity, behavioral therapy, and proper nutrition remain the foundation for obesity therapy. However, in many cases these approaches are insufficient. Recently, there has been a dynamic development of bariatric surgery, which in comparison to lifestyle modification, results in better long-term effects and improved quality of life. New surgery procedures, such as sleeve gastrectomy and adjustable gastric banding, have shown to be one of the most effective, but they carry a risk of complications.

Conclusions: Growing treatment options allow doctors to choose more targeted strategies, based on the patient's risk factors, overall health status, and compliance. Improvements in surgery, especially laparoscopic techniques have opened new possibilities for patients with morbid obesity.

KEYWORDS: obesity; overweight; bariatric surgery; intragastric balloons

INTRODUCTION

The World Health Organization defines obesity and overweight as abnormal or excessive fat accumulation that may impair health.[1] Investigating the causes and complications of adiposity is a continuing concern within health care, especially in the context of the COVID-19 pandemic and its influence on modern lifestyle. Several factors are known to be affecting this disease. Current studies suggest that the interaction between an individual genetic predisposition and environment plays a key role in the development of obesity.[2] Findings from the study "Genetics of Obesity: What We Have Learned Over Decades of Research" indicate that genetic components contribute to BMI variance, explaining about 40-50 percent of the variability.[3] The increasing focus on genetic obesity, a condition that exhibits poorer responses to conventional therapy and lifestyle interventions, plays a role in the development of more targeted treatment approaches.[2]

In the last few years, obesity has become a central issue with more than 2.6 billion people aged five years and older worldwide being overweight or obese.[4] According to Statista, the number of people with excessive body weight is expected to reach 51% of the world's population by 2035.[4] Several methods are used to diagnose obesity. Current guidelines recommend using body mass index (BMI, defined as the weight in kilograms divided by height in meters squared) together with clinical assessment.[5] The WHO adult BMI classification is presented in Table 1 [1]. Although it is simple to use, it is known to have some limitations, such as limited discrimination between body fat and muscle mass and no differentiation between subcutaneous and visceral fat. Therefore, other methods including waist circumference, waist-to-hip ratio, and skinfold thickness should also be considered for diagnostic evaluation.[6][5] Considering, that being overweight is associated with an increased risk of diseases and has become one of the most frequently stated problems, it is important to implement clinical screening among populations. Some of the diseases, that were proven to be related to obesity, are type 2 diabetes mellitus, hypertension, coronary heart disease, dyslipidemia, and hormonal disorders.[6][7] While the precise pathophysiological mechanism remains the subject of ongoing research, it is established that obesity is associated with an elevated risk of mortality.[8] A study titled „Health Effects of Overweight and Obesity in 195 Countries over 25 Years" evaluated, that roughly 4.0 million deaths and 120 million disability-adjusted life years (DALYs) are related to high BMI.[7]

Classification	BMI [kg/m2]
Underweight	<18.5
Normal weight	18.5-24.9
Overweight	25.0-29.9
Obese class I	30.0-34.9
Obese class II	35.0-39.9
Obese class III	≥40.0

Table 1: World Health Organization adult body mass index classification [1]

While the risks associated with obesity and its rising significance are widely known, the effect of this attention on screening and treatment remains unsatisfying. This paper explores multiple treatment strategies, focusing on surgical techniques, and evaluates their effectiveness in preventing obesity-related complications.

REVIEW METHODS

This study was conducted in the form of a literature review, with data being gathered via PubMed and Embase, and is set out to explore the effectiveness and safety of current treatments for obesity.

THE STATE OF KNOWLEDGE

In most cases of overweight patients lifestyle intervention remains the first course of treatment, with the main components being a reduced-calorie diet, increased physical activity, and behavioral therapy.[9] These 3 elements are recommended in all obesity management approaches for a BMI of 25 kg/m2 or higher.[10] When lifestyle modifications alone have not been successful or in case of obesity-related complications pharmacotherapy should be considered.[10] The decision to initiate pharmacotherapy should be based on the patient's risk factors, overall health status, and compliance. The pharmacological treatments for obesity have recently gained popularity, with new drugs, like Tirzepatide and Ozempic, being approved by the Food and Drug

Administration (FDA). The growing range of medications attracts the interest of many patients. However, according to recent studies lifestyle interventions and pharmacotherapy in morbidly obese patients often do not achieve the desired results, especially in the context of long-term effectiveness.[11] In such cases, surgical treatment is an alternative worth considering.

Bariatric surgery

Bariatric also called metabolic surgery is currently recognized as one of the most developing therapy options. Furthermore, extensive research has shown that it is the most effective weight loss intervention, with an average weight loss of 27% over 15 years [11][12] and is associated with improved quality of life.[13] Not all patients could be qualified for this treatment. Recommended criteria for the surgical approach, are a BMI greater than 40 or a BMI greater than 35 with obesity-related complications.[14][15] The consequences of excessive body weight are mentioned above in this article. In the context of bariatric surgery, it is important to notice, that current studies indicate increased cardiopulmonary morbidity among adult, obese individuals.[14] Cardiopulmonary complications are likely a result of hypertension, hyperlipidemia, type II diabetes mellitus, and sleep apnea, all being related to obesity. The therapy of this disease alone, without treating the main course of them, may be insufficient. Bariatric surgery allows patients to lose enough weight to improve their health and quality of life in the long term. On average patients lose 50% to 60% of excess body weight and a decrease in BMI of about 10 kg/m2 is observed during the first 12 to 24 postoperative months. [14]

Surgical Procedures

In the 1950s the jejuno-ileal bypass (JIB) was introduced, and the era of bariatric surgery began. Since then the increased development of procedures was observed with a shift from an open incisional approach to minimally invasive or laparoscopic techniques.[11] Several approaches are used to treat obesity, among them are the techniques that decrease the stomach volume and/or establish partial selective malabsorption. [14] The restrictive procedures result in food limitation and a quicker feeling of fullness after meals, whereas the malabsorptive procedures result in decreased nutritional absorption. [16] Currently, the most performed procedures are Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG), adjustable gastric banding (AGB), and biliopancreatic diversion/biliopancreatic diversion with duodenal switch (BPD/DS). [17]

Biliopancreatic diversion with duodenal switch

BPD/DS are malabsorptive procedures that use intestinal bypass with gastric reduction. Biliopancreatic diversion is no longer used because of the high incidence of postgastrectomy syndrome and was replaced by modification with a duodenal switch.[18] Research showed that BPD/DS allows weight loss without significant changes in eating habits, which results in greater long-term weight loss and less weight regain.[19] However, these procedures are described as technically demanding and are mostly indicated for superobese patients with BMI greater than 50. [20] [18]

Adjustable gastric banding

Another approach is AGB, which involves placing a silicone band around the upper part of the stomach and could be performed laparoscopically. As a result of gastric binding a small superior gastric pouch with an outlet is created.[11] It is important to notice, that currently used bands allow the adjustment even after surgery. AGB restricts the amount of food, that can be ingested at once and strongly influences the effect of fullness after meals. [21] AGB is known to be the least invasive of purely restrictive bariatric surgery procedures and is technically reversible. [18]

Sleeve gastrectomy

This approach facilitates weight loss by dividing the stomach vertically to create a smaller, sleeve-shaped stomach punch, which limits the amount of food that can be consumed. In most of the cases, the fundus is removed and the pyloric valve at the bottom of the stomach remains intact. That allows normal stomach function and digestion.[18] Additionally, fundus is the main source of ghrelin, a hormone that stimulates appetite and promotes fat storage.[22] The procedure is considered minimally invasive with faster recovery times and fewer complications.[18][23][24]

Roux-en-Y gastric bypass

This approach is a combination of restriction and malabsorption. During the procedure a small stomach pouch is created by stapling the upper part of the stomach. Then the pouch is attached to the small intestine, which creates a "Roux limb." This allows food to bypass the majority of the stomach and the major part of the duodenum.[25] The next steps are jejunojejunostomy and gastrojejunostomy creation.[25] RYGBP is currently considered one of the most recommended

approaches for the surgical treatment of morbid obesity.[26] It is reported, that patients who undergo RGYB experience approximately 60% to 70% excess body weight loss.[27] It is important to notice, that according to studies, the mortality for RYGBP is approximately 0.2%, higher than SG and AGB. [24]

Results of bariatric surgery

Currently, bariatric procedures are considered effective, and safe and are known to significantly reduce obesity-related comorbidities and improve a Quality of life more than other obesity therapies.[28][13] The development of laparoscopic techniques has limited the postoperative wound complications and incisional hernias, that were often seen after open gastric bypass surgery. However, any surgical procedure is associated with various difficulties. The rates of complications after bariatric surgery range from 10% to 17% and the rates of reoperation are approximately 7%.[29] One of the most common complications following bariatric surgery is cholelithiasis with incidents up to 30% [30]. The patients may experience cholecystitis, cholangitis, and pancreatitis. It is important to notice, that because of altered anatomy and postoperative adhesions imaging and treatment of these patients may be difficult.[31]. Debate continues about the need for prophylactic cholecystectomy during bariatric surgery, but this course of treatment remains controversial.[32]

Another complication worth mentioning is venous thromboembolism. Also, the pulmonary embolism rate after bariatric operations is low, it remains the major cause of death in early postoperative days, [33] Suggested approaches that may reduce the risk are intra-operative pneumatic calf compression, early mobilization postoperatively and pre-operative heparin. The use of low molecular weight heparin should be closely monitored, because of the increased risk of bleeding, which is the next major complication of bariatric surgery.

Especially in the context of bariatric surgery researchers observed complications such as postoperative dysphagia, which is usually described after AGB. Patients may also present reflux symptoms.[31] A special diet should be followed in the early weeks after surgery, that consists of liquids and soft foods. One of the greatest challenges after metabolic surgery is malnutrition, most significantly protein malnutrition. Strictly malabsorptive procedures tend to result in a higher incidence of long-term nutritional consequences. Another concern is vitamin D deficiency, which may affect in metabolic bone diseases and increase the risk of fractures.[34] Studies also described microbiome changes and small intestinal bacterial overgrowth after bariatric surgery, which also may potentially cause malnutrition.[35]

When comparing different procedures laparoscopic gastric bypass (GB) results in greater weight loss compared to the adjustable gastric band (AGB), however, is associated with greater risk of complications and reoperations.[18] Biliopancreatic diversion with a duodenal switch results in excellent weight-loss outcomes but has a greater rate of complications. [18][20] The outcomes of sleeve gastrectomy (SG) in terms of weight loss, quality of life, and complications are similar to GB. [18]

It is important to acknowledge above mentioned complications and the effectiveness of different procedures before referring a patient for the surgical course of treatment.

Other treatments

Currently, bariatric surgery is considered safe, however, taking into consideration above mentioned complications and costs, there is still a need for effective approaches, that are less invasive. The development of science in recent years allows the use of different techniques and substances to receive effects similar to metabolic surgery. Below we described the main devices currently used in obesity treatment, the indications to use them, and their outcomes.

Intragastric balloon system

Intragastric balloons (IGBs) are temporary devices introduced into the stomach to induce weight loss. They are considered a non-surgical, minimally invasive approach to aid in weight loss for individuals struggling with obesity.[36] [37]

They are recommended for patients who have previously not achieved weight loss with diet and exercise alone and who may not be suitable candidates for surgical weight loss procedures or who prefer a non-surgical option. BMI indications are considered: in the USA – BMI of 30 to 35 kg/m2, and in Europe - of 27 to 35 kg/m2. [38] Intragastric balloons can also be utilized for patients with an extremely high BMI (>50), not meeting the BMI criteria for bariatric surgery as a preoperative measure, a bridging intervention before undergoing a bariatric operation to reduce weight and by decreasing the complexity of the surgery and surgical risk.[39] As used as a bridging therapy to bariatric operations further research is needed to evaluate the intragastric balloon.

Since the Orbera balloon received FDA approval in 2015 (1997 in Europe) many different intragastric balloon systems have been developed.[36] Typically, they are made of soft, durable silicone and are inserted into the stomach endoscopically while deflated, then inflated with a sterile saline solution or air, expanding to occupy a significant portion of the stomach’s volume.

This leads to earlier feelings of satiety, reduced food intake, and subsequent weight loss. These balloons usually remain in the stomach for up to six months, in some cases, for example, the Spatz3 balloon, even up to 12 months, and are then removed endoscopically.[36][40][41] Innovations aimed at reducing the necessity for endoscopic procedures have led to the development of the Obalon system, comprising three separable swallowable balloons, though endoscopy is required for their retrieval.[42]The other system, that does not require any endoscopic procedure is called the Elipse. This type of balloon is made of a resorbable degradable material and then is removed via natural excretion.[43]

The working of the intragastric balloon system depends mostly on reducing the stomach's volume, however, researchers are also considering other effects like delayed gastric emptying and influence on a neuro-humoral axis that regulates the feeling of satiation. It is important to notice, that the efficacy of IGBs is dependent on patient adherence to both diet and exercise modifications.[44][45]

The effectiveness of IGBs varies, depending on the specific device used, the patient's characteristics, and the commitment to lifestyle modifications. Studies have shown results of weight loss typically around 10-15% of total body weight within six months of placement.[46] Because the balloons serve as a temporary measure for weight loss, with their effectiveness depending on patient compliance with the lifestyle modifications, they are less effective for long-term weight maintenance compared to surgical options and the effectiveness may diminish over time. However, while some weight regains may occur after balloon removal, weight loss maintenance has been observed up to one-year post-treatment. [36] [38][40] The American Society for Gastrointestinal Endoscopy (ASGE) confirms these outcomes in several meta-analyses. Results vary for studies and specific types of devices. Currently, the most comprehensively studied is the Orbera intragastric balloon, which efficiency was able to achieve 11.3% total body weight loss (TWL) and 25.4% excess weight loss (EWL) at 12 months post-balloon placement in one meta-analysis of the ASGE.[47][48] From other devices, the ReShape Integrated Dual Balloon (IDB) system had resulted in an EWL of 25.1% after 48 weeks [49], the Obalon's multi-center randomized sham-controlled trial resulted in twice as much weight loss in the group with inserted balloons compared to the control group [%TWL of 7.1% vs 3.6%] [50], and the implantation of Spatz balloon in 12-month pilot three studies showed a mean %EWL of 48.8%, of 45.7% and 42.9%, respectively. [51][52][53]

While IGBs are generally considered safe, they carry certain risks and potential complications. Common mild adverse effects include nausea, vomiting, abdominal discomfort, and

gastroesophageal reflux, especially during the initial adjustment period after balloon placement, which typically resolves within a few weeks. Although uncommon, more serious complications may occur and may include balloon deflation or rupture, balloon migration to other parts of the digestive tract, bowel obstruction, ulceration of the stomach lining, gastric or esophageal perforation, and pancreatitis. Therefore, it's important to carefully select patients and monitor them closely during IGBs therapy. [37][47][54]

Hydrogels

Superabsorbent hydrogels, which are already used in many fields of medicine, are other options of the newest forms for obesity treatment.[55][56][57][58] They are cross-linked polyelectrolyte polymers that can absorb and retain large amounts of fluid. [59] The first in its class approved by the FDA is Gelesis1000.[58] It is an encapsulated form of hydrogel, which should be taken before the meal. Next, Gelesis1000 is mixed with the ingested food in the stomach and increases in volume and firmness, creating many small pieces of gel that have the elasticity of solid foods.[58][60] It results in stretching and exerting tension on the gastrointestinal tract and this mechanical effect causes activation of the vagus nerve and triggers signals of satiety.[61][62][63]

The residual Gelesis100 particles are then naturally degraded, the released water is absorbed in the large intestine and the rest of the material is expelled in feces.[58], [60] Scientists are constantly trying to create ingestible hydrogel devices for long-term gastric retention and optimize as much as possible how much will the OSH (oral superabsorbent hydrogel) increase its volume, achievable elasticity, time to hydrate, and time of degradation, to help obese patients at the expense of the least side effects.[58] There are a few other encapsulated gastric space fillers using superabsorbent hydrogel technologies in progress, but none of them have been accepted by the FDA yet. [64][65][66]

The multicenter Gelesis Loss Of Weight Study illustrated that OSH is efficacious and well-tolerated. Around 27% of overweight or obese participants lost at least 10% of their total body weight, furthermore, 60% of patients also attained significant weight loss, which is 5% or more. In addition to that, weight loss was upheld during the 24-week follow-up period.[60] The most commonly reported side effects were those from the gastrointestinal tract like diarrhea, abdominal distension, or infrequent bowel movements. For the record, in one study,
the overall incidence of adverse events in participants taking Gelesis100 was no different than in those taking placebo. [60]

CONCLUSIONS

In many cases, where lifestyle modification and pharmacotherapy are insufficient or inadequate, surgery should be considered. Since the introduction of the jejuno-ileal bypass, the increased development of different surgical techniques was observed. That results in a variety of procedures, that are safer, have excellent long-term weight loss outcomes, and carry fewer complications. The researchers indicate that surgery, in comparison to conventional therapy, leads to greater improvement in obesity-related comorbidities and weight loss. One of the most problematic complications after bariatric surgery is malnutrition, which is observed mostly after strictly malabsorptive procedures and could be avoided by combining it with restrictive techniques. The wide variety of procedures allows the patient to choose the best-suited treatment option. However, there is still a need for more follow-up studies to assess the long-term effects of bariatric surgery.

When contraindications for surgery are present, other treatments, like intragastric balloon systems and hydrogels, may also be considered. It is important to remember that the treatment should be adjusted to patients' needs, and restrictions as well as compliance and aiming for long-term results.

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