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Metabolic Changes after the Surgical Treatment of Morbid Obesity

Azamat Aidarbekovich Seypilov*, Elina Ansarovna Akhmetzhanova, Kazbek Medzhidovich Outlev, Evgeny Viktorovich Kruchinin, Ivan Vyacheslavovich Kostenko

Tyumen State Medical University of the Ministry of Health of Russia, 54 Odesskaya str., Tyumen, 625023, Russia

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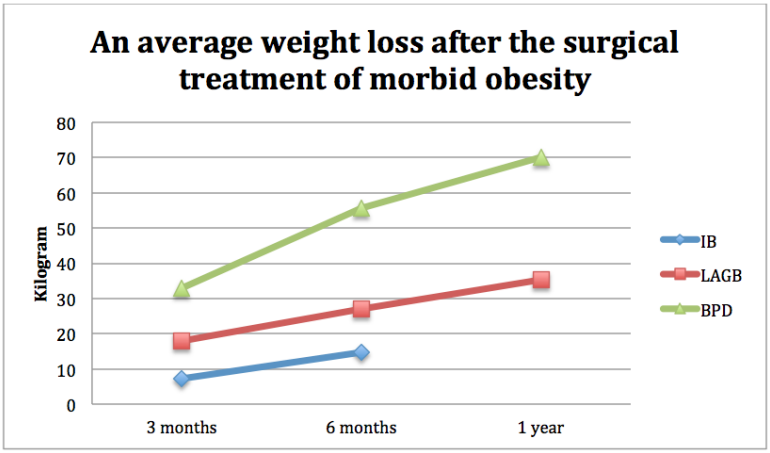
ABSTRACT

The use of bariatric surgery in the treatment of morbid obesity is most effective for metabolic syndrome. The greatest decrease in body weight occurred in the first 3 months after intragastric balloon and biliopancreatic diversion, whereas with a laparoscopic adjustable gastric band, the best effect was observed in the period from 3 months to 1 year. With an intragastric balloon, a decrease in body weight of 6.6% was observed in the first 3 months and 13.5% after 6 months, with an average decrease in body mass index of 5.7±2.3 kg/m2. After a laparoscopic adjustable gastric band, there was a 14.1% decrease in body weight at 3 months, a 21.4% decrease at 6 months, and a 27.9% decrease in body mass index at 1 year, with a 13.3±2.5 kg/m2 decrease in body mass index. Considering intragastric balloon surgery, as early as 6 months after balloon removal, almost 33% of patients showed regain of initial body weight, and 1 year later – almost 50% of patients. It should be noted only after a laparoscopic adjustable gastric band and biliopancreatic diversion, 3 months after the operation with preservation of results 1 year after treatment, a significant reduction of systolic and diastolic blood pressure and levels of total cholesterol and low-density lipoproteins was observed. If the body mass index is over 50 kg/m2 and the metabolic syndrome is present, biliopancreatic diversion surgery is the best option also for the treatment of carbohydrate and lipid metabolism disorders, blood pressure regulation, and other diseases associated with obesity.

GRAPHICAL ABSTRACT



* Corresponding author: Azamat Aidarbekovich Seypilov
✉ E-mail: a.a.seypilov@mail.ru

Introduction

According to World Health Organization (WHO) experts, obesity and overweight are a growing health and social problem that threatens not only public health but also the economies of different countries [1]. The prevalence of obesity is increasing rapidly among people of different ages, sex, social status, and different ethnicities. In Russia, this problem is as widespread as in other countries of the world. Scientists report that the prevalence of overweight in adults in Russia in the past decade was 60% for males and 59.2% for females, with a prevalence of 6.8% for males and 5.3% for females among children and adolescents under 17 years of age [2,3]. Many studies have found a clear association of body mass index (BMI) with cardiovascular risk and mortality [4-6]. Often obesity has a systemic effect on the following diseases: Arterial hypertension, type 2 diabetes, coronary heart disease, dyslipidaemia, and some types of malignancies [7-9]. The main cause of obesity has been an energy imbalance with the predominance of caloric diet over body energy expenditure, i.e. consumption of high-energy food rich in fats, simple carbohydrates, with low energy expenditure due to hypodynamy [10]. Many obese patients often show signs of metabolic syndrome (MS), which most often occurs against a background of long-term stress states, and manifests as obesity, followed by insulin resistance, dyslipidaemia, and arterial hypertension. The metabolic syndrome manifests clinically in a combination of certain functional disorders that accelerate the development and progression of atherosclerotic vascular disease and diabetes [11].

Conservative treatment is only effective in patients who are slightly overweight, whereas morbid obesity is resistant [12]. The 2013 European Clinical Guidelines and the 2016 Russian National Clinical Guidelines for the Treatment of Morbid Obesity in Adults state that adequate treatment of obesity should be based on realistic aims to reduce body weight and, hence, health risks; it should include initiation of weight loss, maintenance of the achieved outcome, and prevention of weight gain again [13, 14]. This created a need for new therapies, and in the mid-20th century, a field devoted to the surgical treatment of obesity, termed "bariatric surgery", was established. There are 3 groups of bariatric surgeries aimed to reduce the absorption area (jejunoileostomy, jejunocoloshunt), to reduce the food intake (various types of gastroplasty, gastric band), and act as comprising the first two groups (combination of gastroplasty and jejunostomy, gastro diversion surgery, biliopancreatic diversion) [15, 16]. The use of bariatric surgery is most effective in the treatment of morbid obesity [17]. Such treatment is effective not only in reducing body weight but also in the main types of metabolism, reducing the rate of the components of the metabolic syndrome [18].

The objective of this study was to assess the metabolic effects of surgical treatment of morbid obesity.

Material and methods

In Tyumen Oblast, experience in the treatment of morbid obesity began in 2003. It began with the installation of intragastric balloons (IB) and the use of biliopancreatic diversion surgery (BDS), followed by the introduction of a laparoscopic adjustable gastric band (LAGB), and laparoscopic longitudinal gastric resection (not included in the study). We followed up 299 patients with metabolic syndrome and obesity aged 18 to 55 years. The mean age was 37±9.9 years. Women predominated (80.8%). The diagnosis was based on the WHO's International Obesity Group classification based on BMI. A BMI of 25 to 29.9 kg/m2 was the criterion for overweight. Three degrees of obesity were identified according to the WHO classification: I – 30-34.9 kg/m^2, II – 35-39.9 kg/m^2, III – 40 kg/m^2 or more.

Intragastric balloon (IB) method

Obesity treatment with IB was performed in 64 cases, including 8 patients as preoperative preparation before BPD. Among this number were 13 men and 51 women aged 18 to 57 years, with an average body weight of 109.3 kg (BMI 42.2 kg/m^2). BIB (Bioenterics Intragastic Balloon) balloons were used, consisting of a silicone balloon and a system for inserting and filling the balloon. This operation was performed

on a stationary basis, using a fibrogastroscope, under endotracheal anaesthesia, as well as monitoring of vital functions. The use of inhalation anaesthesia specifically excludes trauma to the pharynx and oesophagus. The balloons were inserted for 6-9 months.

Laparoscopic adjustable gastric band (LAGB) surgery

In LAGB, a special device (ring; bandage) is used to narrow the lumen of a part of the stomach in a way that is shaped like an hourglass. Using a specific surgical technique, conditions are created to reduce the volume of the stomach to 5-15 ml. This operation was carried out in 208 patients, 168 females and 40 males. The average age of the patients was 34 ± 7.5 years and average preoperative weight 126.5 kg (BMI 47.6 ± 3.8 kg/m^2); bandage Bioring (France) was used.

The method of biliopancreatic diversion (BPD)

It is surgical resection of the stomach according to Roux with a low interintestinal anastomosis. The small intestine is divided into three sections: the alimentary, biliopancreatic, and common loop (representing 10% of the length of the small intestine). The average body weight at BPD was 168.5 kg (BMI 64.2 kg/m^2). All patients were fully informed about the intervention and received informed voluntary consent.

Results were analyzed using STATISTICA, version 6 for MS Windows. Continuous variables were presented as mean and standard deviation (M±SD). Parameters were compared over time using the non-parametric Wilcoxon criterion for paired variables.

Result and Dissection

According to the clinical results, the manifestations of MS increased in proportion to increasing BMI. For example, the incidence of arterial hypertension in patients with established IB (BMI 42.2) was 20.3%, and in those who underwent LAGB (BMI 64.2) – 98%. The same pattern was observed for impaired glucose tolerance and diabetes. The preoperative incidence of MS was 21,8% in the 1st group before established IB; 50% in the 2nd group before established LAGB, and 85,2% in the 3rd group before BPD.

When observing all patients in dynamics, we saw that the greatest decrease in body weight occurred in the first 3 months after application of IB and BPD, whereas for LAGB, the best effect was noted in the period from 3 months to 1 year. After the use of IB, an average weight loss after 3 months was 7.2 ± 2.65 kg, and after half a year, an average weight loss of 14.8 ± 8.6 kg, with an average BMI of 5.7 ± 2.3 kg/m^2. Half a year after balloon removal, 32.8% of patients fully regained their initial body weight, and 45.3% a year later. The reduction in body weight depended on initial BMI. At a BMI below 40 kg/m^2, positive dynamics was observed in half of the cases, while BMI over 40 kg/m^2 was observed in every fifth case only.

The LAGB showed an average weight loss of 17.8 kg after 3 months, 27.1 kg after six months, and 35.3 kg at the end of one year. The greatest decrease in body weight was observed during BPD. The average weight loss at the end of the third month was 32.9 kg (19.5%), after six months – 55.7 kg (33.1%), and after one year – 70.2 kg (41.6%).

Besides weight reduction, changes in the positive side of the lipid spectrum were also observed, manifested by a decrease in total cholesterol and low-density lipoproteins already 3 months after surgery, with preservation of the results after one year only after LAGB and BPD. Blood glucose ($p<0.05$), triglycerides ($p<0.05$) decreased significantly after 6 months in the BPD group, combined with an increased concentration of high-density lipoproteins ($p<0.01$) in the blood.

After one year of follow-up, average systolic blood pressure (SBP) was 133±13,2 mmHg and 137±9,5 mmHg, diastolic blood pressure (DBP) was 83±8,75 mmHg and 84±5,8 mmHg, which was significantly lower than initial values ($p<0,001$) in patients with LAGB and BPD. No significant decrease in BP was found after IB. The advantages of IB are its simplicity, its use on an outpatient basis, and its multiple uses [19]. However, this technique is not effective in patients with a BMI greater than 40 kg/m^2 [20]. This technique has the potential to improve the

care of patients with a BMI below 40 kg/m^2 and in preparation for surgical treatment.

LAGB is an effective method, with the main advantages of low invasiveness, organ preservation, and absence of metabolic disorders. The maximum effect is seen in patients with a BMI of up to 45 kg/m^2.

BPD is an effective method of weight reduction (by 30-40% for 1 year), with both restrictive and malabsorptive components, which is important in the treatment of morbid obesity. This method alone significantly reduced blood glucose levels ($p<0.05$) as well as triglycerides ($p<0.05$), combined with an increase in high-density lipoprotein concentration ($p<0.01$) in the blood, with a significant effect on reducing manifestations of comorbidities (AH, diabetes). Notably, some literary sources describe the occurrence of complications after BPD [21]. In our patients, the absence of complications can be explained by a correct and comprehensive preoperative period, a careful surgical technique, and early activation. A clear example to prove the results presented above will be a clinical case: Patient I., 47 years old, sought medical help at the surgical department in 2019. He complains of excessive body weight, thirst, dry mouth, oedema in the lower extremities, polyuria, and shortness of breath with minimal daily physical activity. He had been obese for about 20 years. In the last two years, he had noted rapid weight gain of up to 215 kg, increased dyspnea, increased daily water intake, excessive appetite, as well as increased oedema. This patient had a history of hypertension diagnosed by periodic physical examination, in which he did not seek medical help. Bad habits – smoking – 20 packs/year. Physical examination included: height 178 cm, weight 215 kg, BMI = 67.85 kg/m^2, blood pressure – 164/87 mmHg, tachypneic up to 22 per minute, SpO = 98. On external examination, signs of circulatory failure –edema of the lower extremities, excessive fat deposition in the abdominal area, stretch marks were observed. Laboratory examination revealed hyperglycemia – 7.9 mmol/l, also glycemia after oral glucose tolerance test up to 12 mmol/l, Cholesterol total = 9.3 mmol/l, LDL = 5.6 mmol/l, HDL = 1.0 mmol/l. An electrocardiogram showed sinus rhythm, heart rate – 89 per minute, deviation of the electrical axis of the heart to the left. Echocardiography revealed atherosclerosis of the aorta, as well as the mitral and aortic valves, in addition, compensatory hypertrophy of all parts of the heart.

Diagnosis proved morbid obesity, hypertension degree II, stage 3, very high risk, chronic heart failure – IIa, functional class 3, impaired carbohydrate tolerance, and chronic pulmonary heart disease.

The operation of choice was BPD, because of BMI > 50 kg/m^2 and the presence of the metabolic syndrome. The operation was performed under endotracheal anesthesia for 3 hours 55 minutes. In the postoperative period, antibacterial and anticoagulant therapy, antisecretory drugs, daily bandaging, and early activation of the patient were prescribed. The patient was monitored by a surgeon in the area of residence after discharge. One month after the operation, an examination of the patient was carried out. Measurement of fasting glycaemic level showed – 4.9 mmol/l (-38.8% of the initial one), body weight – 172 kg (-20% of the initial one), blood pressure 130/75 mmHg. (-10.1% of baseline), Cholesterol total = 4.7 mmol/l, LDL level showed 1.98 mmol/l, whereas HDL = 1.31 mmol/l.

After half a year, persistent normalization of blood glycaemia and blood pressure levels was confirmed, body weight was -144.05 kg (-33% of baseline). The examination one year after the operation confirmed the normalization of blood glycaemia and blood pressure, the body weight was 126.85 kg (-41% of the initial weight). The patient also reported improved well-being, decreased dyspnea and oedema, increased tolerance to physical exertion and performance. The unpleasant symptoms of thirst, dry mouth, and frequent urination are also eliminated. In this clinical case, there was an improvement in the patient's health status, compensation for both the underlying and associated diseases, which was confirmed by the laboratory and objective examination. The described case confirms the effectiveness of biliopancreatic diversion surgery, as well as the statistics presented in the study.

Conclusion

The choice of surgery depends on BMI and the presence of metabolic syndrome in the patient. We also believe that the study of clinical and metabolic changes in these surgeries is of primary importance, as the objectives include not only weight loss but also the normalization of metabolic processes. The treatment of obese patients should be comprehensive and individualized. Metabolic syndrome and BMI over 50 kg/m^2 are the main conditions for the use of BPD, with high chances of achieving a reliable weight loss.

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Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

Conflict of Interest

We have no conflicts of interest to disclose.

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