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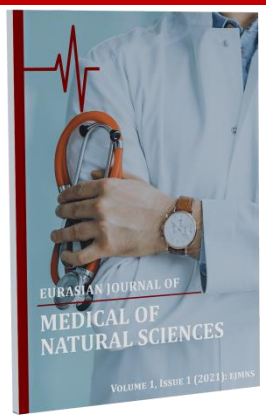

ROLE OF BILIOPANCRATIC BYPASS THERAPY FOR TYPE 2 DIABETES MELLITUS

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ABSTRACT

At present, the prevalence of type 2 diabetes mellitus (DM-2) is steadily increasing. Surgical methods of treatment (restriction and shunting operations) occupy a leading position in the treatment and correction of this pathology due to the highest metabolic efficiency. Each of the existing shunting operations (gastric gastrointestinal, biliopancreatic bypass (PBS)), in turn, is used in various modifications. Among the operations of BPS are known modifications of Scopinaro, modification of Hess-Marceau and SADI appeared in recent years (duode-iliac bypass with gastric resection and one anastomosis). The SADI modification, like other types of BPS, allows to effectively reduce excess body mass (MT), contributes to the normalization of carbohydrate and lipid exchanges, which leads to failure/decrease in the frequency of insulin therapy and sugars treatment. The potential benefits of SADI include reduced operation time, no mesentery defects, which is intended to reduce the frequency of internal herniation. According to researchers, SADI also leads to fewer complications both in the early and late postoperative period. Given the high effectiveness of this treatment, more and longer individual observations are needed to further assess the long-term effectiveness of the treatment and its compatibility with previously known methods.

The epidemic of obesity, which was initially seen as a social problem only in developed countries, is now spreading throughout the world, including developing countries. Morbidity obesity, characterized by the Body Mass Index (BMI) of 40 kg/m2, is increasing even faster than obesity at BMI of 30 to 40 kg/m2 [1, 2].

It is well known that obesity contributes to diseases such as arterial hypertension (AG), cardiovascular disease (CHD), dyslipidemia, type 2 diabetes mellitus (DM-2), obstructive apnea syndrome, degenerative joint diseases, depression, etc. As early as 1988, obesity and

especially morbidity obesity were shown to be associated with progressive increases in morbidity and mortality [7], as well as a decrease in life expectancy [8].

In patients with DM-2, AG or dyslipidemia, even a moderate reduction in MT results in a significant improvement in blood glucose control, blood pressure and lipid profile [9]. Given that MT reductions also affect other SHA risk factors [10], they may also reduce the incidence of cardiovascular catastrophes such as stroke and myocardial infarction. Epidemiological studies show that targeted reductions in MT, in particular in DM-2, are associated with increased patient survival [11].

However, long-term studies did not show the impact of lifestyle changes and non-surgical obesity treatments on major cardiovascular morbidity and mortality [12, 13, 14]while surgery plays a leading role in the treatment of this category of patients [15, 16, 17].

Modern restrictive operations aimed at reducing food consumption include regulated gastric bandage (AGB - adjustable gastric band) and became popular in recent years sleeve gastroplasty (plum resection, longitudinal resection, laparoscopic vertical gastrectomy (SG - sleeve gastrectomy)), as well as gastroplysis and various types of gastroplastics. Pure bypass operations have been abandoned due to the high frequency of complications and combined operations are now used, in addition to limiting the volume of the stomach (restriction surgery as part of combined operations) Absorption of nutrients is limited by a small intestine bypass [23, 24]. The choice of transaction depends on many factors, primarily the expected effect, incl. metabolic, at certain types of surgery, as well as from the technological level of equipment of the clinic and the qualification of the surgeon, and often - and his subjective preference. An important role is played by the choice of the patient himself, which he does after receiving comprehensive information about various surgical approaches.

Gastric bypass (GB, RYGB) in the classical version can also be attributed to restrictive surgery, but modern modifications of GSH, as a rule, include a bypass of a certain part of the small intestine, so they can be attributed to combined action operations (restrictive + shunt). The combination operations also include the mini- gastric bypass developed by R. Rutledge in 2001. [25]. This surgical intervention, the popularity of which is also growing from year to year, allows you to maintain most of the small curvature of the stomach (in comparison with classical gastric bypass).

Operations with a predominantly bypass component include biliopancreatic bypass surgery (BPD - biliopancreatic diversion, BPD-DS - biliopancreatic diversion with duodenal switch - with duodenal shutdown)which allows to provide not only a certain level of limitation of stomach volume, but also a dosed reduction of food absorption in the intestine (fig. 1).

The first BPD operation was performed by N. Scopinaro et al. in 1979 and allowed to achieve a significant and long-lasting reduction of MT [27]. According to the standard «half-half stomach» method, the first stage was performed distal resection of 1/2 of the stomach with duodenal bowel cult shelter, in the subsequent application of gastroenteranastomosis by Ru on a long loop, with enteroenteroanastomosis (EEA) It was initially formed at the level of the distal iliac colon at 50 cm proximal to the ileocecal angle, and gastroenteranastomosis (GEA) at 250-300 cm from the ileocecal angle. The operation was always supplemented by a cholecystectomy, possibly an appendectomy. In the laparoscopic variant, the principles of

open surgery were observed, dislocation was carried out with a harmonic scalpel, intestinal crossing and the formation of anastomosis was carried out with the help of the GendoGIA 45 [28, 29].

Subsequently, Scopinaro proposed to vary the size of the stomach stump and the length of the intestine loops depending on the characteristics of the patients (modification «adhoc stomach» AHS-BPD). This made it possible to adapt the Scopinaro operation to the individual characteristics of patients (degree of excess MT, presence of DM-2, dyslipidemia, peculiarities of nutrition of patients living in different regions of the country). For the first time in Russia, the results of 30-year observation in a series of 3250 patients who underwent BPT surgery on different dates were published by N. Scopinaro in the monograph «Morbidity obesity», published in 2014[28]. According to Scopinaro, 80% of the patients who underwent surgery by the 10th year after the operation noted a reduction in excess MT by more than 50%. Also noted is the persistent normalization of the indicators of hydrocarbon and lipid exchanges, which Scopinaro characterized as «specific effects» of PSF. For example, of the 2,829 patients who underwent AHS BPD in at least a year after surgery, 424 (15%) had hyperglycemia, 187 (6.6%) had DM-2 and were treated with oral sugars and 51 (1.8%) a patient with pre-operative DM-2 requiring insulin therapy, a year after BPD and forever thereafter, normal glucose levels were observed in the serum without medication and with a completely free diet.

It is clear that this was accompanied by normalization of serum insulin levels [28]. Total serum cholesterol (TSC) has declined steadily on average by about 30% in patients with normal pre-operative values and 45% in patients with pre-op hypercholesterolemia. The high density lipoprotein (HDL) level remained unchanged, the TSC decrease was entirely due to low density lipoproteins (LDL) and very low density lipoproteins (LDL). These results persisted long after the operation, with a reliable increase in HDL levels in the 51-patient group six years after the BPD. In a series of 3250 (total number) obesity patients selected for BPD, with a minimum treatment period of one month, 1,721 patients were diagnosed with hypercholesterolemia. All of these patients were diagnosed with normal TSC levels one month after surgery, and TSC values remained significantly lower in all subsequent test periods. As the operation progressed, the author was able to reduce the frequency of early and late complications after BPD. The results allowed N. Scopinaro to consider BPD surgery the most effective in the treatment of obesity and metabolic syndrome [28].

The operation was later modified by D.S. Hess, D.W. Hess and P. Marceau. and was called biliopantal bypass surgery with duodenal switch-off (BPD-DS) [29, 30]. Initially, D.S. Hess, D.W. Hess and P. Marceau considered the approach to BPD by Scopinaro as a method for repeated operative interventions in case of ineffectiveness of restrictive operations. However, tight adhesions in the upper part of the stomach in patients who had previously undergone restrictive surgery created difficulties in creating anastomosis, as well as leading to the formation of edge ulcers.

The authors considered the possibility of storing the gatekeeper with the creation of anastomosis between the small intestine and duodenum outside the area of previous surgery and adapted the operation proposed by T.R. DeMeester, for the treatment of duodeno-gastric reflux [31]. The first BPD-DS operation to turn off the duodenum was performed by a man

who underwent horizontal gastroplasty in 1979. Since 1988, due to the successful application of this method to repeated operations, Hess&Hess has been used as BPD-DS and as primary surgery. In 1991, P. Marceau et al. described the results of a significant series of observations from 149 patients, and in 2015 - 2615 patients, indicating that BPD-DS exceeds the effectiveness of Scopinaro.

The modified BPD-DS operation includes a restrictive longitudinal (plum) gastric resection (Sleeve gastrectomy - SG), as well as a bypass of the duodenum and skinny intestine to ensure reduced absorption of fats and carbohydrates, which consists in the creation of an alimentary canal 250-350 cm long with a common channel in the form of a distal part of the iliac intestine 50-100 cm long enough to ensure the absorption of nutrients. Performing gastric discharge reduces the secretion of grelin, which enhances the potential metabolic effect of the operation [32]. The shutdown of the duodenum and the initial sections of the small intestine stably stimulates the secretion of insulin, and the preservation of the gatekeeper ensures the minimization of the probability of formation of edge ulcers of the mucous membrane zone of duodenoilaostmosis [33]. The advantages of modifying D.S. Hess and D.W. Hess and P. Marceau also included the minimal probability of dumping syndrome, which again is connected with the preservation of the gatekeeper [33]. In our opinion, another advantage of BPD-DS is the possibility of dividing the operation into stages, limited at the first stage of SG in case of technical difficulties in the operation and anesthesia. In the subsequent, after losing a part of the excess MT, it is possible to perform a bypass phase of the operation to continue the weight loss. This is exactly what happened in 1993. Almogy et al. limited the SG to the first stage of treatment of a complex patient, essentially initiating a new restrictive bariatric surgery Sleeve gastrectomy as a stand alone operation. In our practice, we often use this approach, combining the second shunt of BPD with abdominoplasty.

In later articles in 2007, and then in 2015. The results of 20-year observation for 2,615 open-source patients with BPD-DSs were published between 1992 and 2010. Of the 2,615 patients, 92% were traced to at least 10 years. 91% were satisfied with the results. 38.8% of patients suffered from DM-2, in different periods after the operation of remission was reached in 93.4% (the criteria for achieving remission: blood glucose level <6.0 mmol/l; glycycircle hemoglobin (NbA1c) <6.5%), stored for more than 10 years. The prevalence of impaired lipid metabolism, initially estimated at 24.2 per cent, was normal in 80 per cent of patients, 68.4 per cent of hypertension was eliminated and 31 per cent of patients improved. The average loss of excess body weight observed between 5 and 20 years was 55.3 kg (71%) and the average decrease of BMI was 20. The post-operative mortality rate in this group of patients has been reduced from 1.3 per cent in 1992 to 0.2 per cent between 2005 and 2010. The number of post-operative deaths in this group of patients is estimated at 1.3 per cent. Cases of early relapatomies amounted to 3%, repeated operations due to the developed phenomena of excess protein, calcium, vitamins A and B, iron - 13%. The results allowed the authors of D.S. Hess and D.W. Hess and P. Marceau to consider BPD-DS a choice operation for different groups of patients, which should be performed by qualified bariatric surgeons in suitable conditions for excellent results and full long-term care of patients [34].

In Russia, the results of BPD/DS surgery for 292 patients with a 7-year term of observation were presented by the authors earlier in 2012. [23]. The maximum decrease in

MT in the majority of patients in this group was observed 2 years after the operation and was 78.1%, the incidence of early postoperative complications was 5.7%. 70 out of 292 patients suffered from DM-2, the NbA1c level decreased from an average of 7.5% (before the operation) to 5.6% 6 months after the operation and remained at this level for 5 years. After 1.5 years of surgery, normalization of lipid metabolism was registered in the whole group of patients (coefficient of atherogenity (KA) <3) [23]. The results of our observations and previously published data of foreign authors gave grounds to consider BPD the most effective operation in DM-2, provided that the functioning beta cell pool is maintained [23].

At present there is no clear opinion as to which surgery is preferable, and there is no specific algorithm for choosing the operation taking into account the clinical features of each patient [33, 35]. Some authors believe that BPD-DS should be the gold standard for bariatric surgery, as it provides more pronounced as well as the most stable body mass reduction and comorbidity reduction, compared to RYGB, while the metabolic effect of BPD-DDS is maximal compared to other bariatric operations, according to H. Buchwald [20, 30]. At the same time, to date, BPD-DS interventions continue to refer to relatively rarely performed bariatric operations [20, 36] due to technical difficulties and, according to some data, high risk of developing postoperative complications [35, 37].

In an attempt to simplify the operation technique while maintaining the basic principles and advantages of BPD in 2007. A. Sánchez-Pernaute et al. introduced the technique Single-anastomosis duodenoileal by pass with sleevegastrectomy - SADI, which provides in almost 100% of cases compensation DM-2 (with preserved pancreatic function) [38, 39], elimination of comorbid states, as in the case of the original operation N. Scopinaro [39] or the version proposed by Hess-Marceau [27] (fig. 2). The authors formed a general loop, first 200 cm long and then 250 cm long from the caecum, with the addition of duodenoylanostamosis at this level, resulting in a loss of up to 80% of overweight within 6 months and an average of 100% 18 months after the operation. The extension of the total loop from 200 to 250 cm has helped to reduce the frequency of protein deficiency from 8% to a minimum [40].

The authors note that the operation, if necessary, as well as BPD-DS, it is possible to divide into two stages (sleeve gastroplasty followed by duodenal iliac bypass with one anastomosis), as it allows a significant number of patients (54-73%) avoid additional surgery after the sleeve gastrectomy [40]. Performing gastric discharge-resection reduces the secretion of grelin, which increases the potential metabolic effect of the operation, and keeping the gator minimizes the development of dumping syndrome [32, 41]. One of the advantages of the technique is the elimination of additional anastomosis, which allows to reduce the operation time and avoid the formation of a mesenteric defect, and, consequently, to reduce the frequency of internal herniation [40]. To date, the authors have not recorded any cases of internal hernia, although they acknowledge that the number of patients and the length of their observation may still be insufficient.

In the Russian Federation, the BPD operation in the SADI modification began for the first time in May 2014. (Yashkov Yu.I., Bordan N.S.), and during the first year as part of a prospective randomized study. By October 2016, the authors of this article performed 102 open access operations. The first experience showed a comparable percentage of excess MT loss compared to BPD-DS, a decrease in the frequency of early and late postoperative

complications, 0% lethality. Thus, the frequency of early postoperative complications was 2.6%, in the distant postoperative period, a year after surgery, only 1 patient had an acute spastic intestinal obstruction, which required re-intervention and reconstruction of the SADI operation in the anastomosis of Ru. During the 2-year observation period, there were no cases of protein deficiency that required rehabilitation.

All patients who have undergone bariatric surgery with a bypass component require particularly careful post-operative monitoring due to programmable malabsorption as well as lifetime supplemental vitamin and mineral support. During the first two years after the operation, the patient especially needs biochemical control of the nutritional efficiency and visit the surgeon every 3-6 months [42, 43], and 2 years after the bypass operation, the patient's condition, including biochemical tests, It is carried out once a year provided there are no remote complications.

The advantages of BPD surgery, in addition to stable weight loss and lasting effect on lipid and carbohydrate metabolism, include the absence of disconnection of the stomach from the digestion, the absence of foreign body in the upper part of the stomach, the need for additional manipulation, such as the adjustment of the brace [23, 44]. In addition, with BPD-DS and SADI modification, it is possible to keep the gatekeeper, there is no post-gastraktomic syndrome (dumping syndrome), almost no anastomosis ulcers [45]. The possibility of developing duodenogastric reflux (DGR) and gastro-esophageal reflux (GER) remains unclear, although the authors of the method do not consider this a serious by-product.

Modern bariatric surgery is considered highly safe; depending on the type of intervention, 30-day post-operative mortality after various types of bariatric surgery, despite the initial severity of the main patient population, is between 0.1 and 1.2 per cent [42, 44, 46, 47]. Long-term mortality (10.0 6.3 years of observation) is 6.1 per cent and the cumulative mortality after 30 days, 90 days and 1 year is 0.2 per cent, 0.3 per cent and 0.5 per cent respectively [46]. Similar data were obtained from the meta-analysis of 136 studies conducted [47]. The average mortality after BPD-DS does not exceed 1.1-1.2%, according to our data - 0.35%, and after RYGB - 0.3-0.5% [48, 49, 50]. In the study A. Michaud with co-author. (2015) the mortality rate 30 days after BPD-DS was 0.95%, 90 days later - 1.4% [51]. The most common causes of death following bypass bariatric surgery include pulmonary thromboembolism, sepsis, insolvent gastric and anastomosis sutures, heart failure [46, 52]. No fatalities have been identified in the literature since SADI surgery, which may be due to both the small number of patients who have been treated so far and the more secure operational technique, to reduce mortality in this operation.

In recent decades, there has also been a progressive decrease in the incidence of complications during the first 30 days after surgery due to an increase in the share of laparoscopic interventions and an increase in the technical qualifications of surgeons [51]. The incidence of early complications after bariatric surgery is generally <10% [53] and is lower after restriction surgery compared to combined (shunt) operations [47, 53]. According to studies, the most common early complications are insomnia gastric suture and anastomosis, which occurs in 0.9-2.5% of cases of BPD-DS (in our group of patients - 0.6%), 1.27% after RYGB and 0.6% after SADI; bleeding (0.9% for BPD-DS, 0.89-1.84% after RYGB, 2% after SADI) [47, 51, 53, 54, 55]. Our experience of the first 102 BPD operations in the SADI

modification showed 0% lethality for 4 (3.9%) non-hazardous complications (wound suppuration 2, skin suture divergence postoperative wound 1, pneumonia 1).

The prevalence of complications such as gastrointestinal stenosis or gastroenteranastomosis varies widely depending on the technique of anastomosis in operations such as RYGB, SG and BPD-DS. There was no evidence of the development of gastric stenosis after SADI. The prevalence of anastomosis ulcers in RYGB ranges from 0.6% to 25% [56], with BPD in Scopinaro modification in different periods of observation varies from 12.5% to 3.4% [27, 39]. When performing piloro-preserving modifications BPD frequency of ulcers does not exceed 1% [39, 40, 45]. The main factors in the development of ulcers are the abandonment of a large stomach stump, the presence of diabetes, smoking, taking acetylsalicylic acid and other nonsteroidal anti-inflammatory drugs [56, 57, 58].

Effect on the course of diabetes mellitus

More than 20 years ago W.J. Pories et al. [59] based on earlier studies by H.J. Sugerman et et al. [60] focused on one of the most important effects of bariatric surgery - the effect on carbohydrate metabolism. It has been proven that obesity surgery can achieve remission of DM-2 long before significant loss of MT. Further research by F. Rubino, M. Gagner and other researchers confirmed this hypothesis and further developed the concept of metabolic surgery [61, 62]. As a result, over the past 10 years, bariatric surgery has become an active treatment for AD2, not only in patients with severe obesity [63]. After the operation, patients with DM-2 undergo a complete remission or a significant improvement in their course, as well as a significant reduction in mortality from DM-2-related causes [19]. Among all bariatric surgeries, BPD has the most pronounced antidiabetic effect [23, 44].

Of the 36 patients with DM-2 included in the D.S. Hess and D.W. Hess series, 18 were suffering from insulin-consuming DM-2. At the time of discharge, patients who had previously taken oral sugars were discharged without the need for sugaring therapy. In the case of patients who required insulin treatment prior to surgery (up to 500 units per day for one of them, an average of 40-50 Ed per day), there was a sharp decrease in the need for insulin, with a subsequent withdrawal within 2 months of the intervention [29].

In the study M. Frenken with co-author. (2011) 16 patients with DM-2 and BMI<35 kg/m2 (average age 56) were conducted BPD-DS (n=7), BPD (n=5) and RYGB (n=4). The average duration of sugars treatment before surgery was 16 years (4-40 years), 13 patients had insulin on average 6 years (1-12 years) at an average dosage of 92 IU per day (30-140 IU). At the time of discharge, only 3 out of 13 patients were required to continue administering small doses of insulin (an average of 21 IU per day, 15 to 30 IU) to maintain blood glucose levels on fasting and after eating below 200 mg/dl. One year after the operation, none of the patients used sugars or insulin. The HbA1c level in the surveyed population decreased from 8.6% (from 5.8 to 12.1%) to 6.0% (from 4.3 to 7.8%), 5.7% (from 4.1 to 7.6%) and 5.6% (from 4.1 to 7.8%) after 3, 6 and 12 months, respectively. HbA1c levels 1 year after surgery were significantly lower after BPD-DS and BPD compared to RYGB (5.2%, 4.1% to 6.4% compared to 6.7%, 5.8 to 7.8%, $p<0.01$, HbA1c 1%, 95%, 0.4-2%). The authors concluded that small intestine metabolic bypass in DM-2 patients with low BMI is effective, providing a significant decrease in HbA1c after BPD-DS and BPD compared to RYGB [41].

In the study E.V. Ershova and Y.I. Yashkov were included and traced in more than 5 years 70 patients with DM-2 and average BMI 47.9 kg/m2 aged from 28 to 63 years, which was conducted BPD-DS. It was shown that in the first year after the operation, body weight decreased by 38%, and after 3 years no patients had morbidity obesity. Normalization of blood glucose levels was noted after only 3 months (up to 5.6 mmol/l) after the operation, and by the 6th month the level of glycemia was 5.1 mmol/l ($p<0.05$). After five years of observation, all patients had an indigestion (4.5 mmol/l). In addition, there was a significant decline in HbA1c from the 3rd month after the operation and normalization of this indicator a year later. HbA1c levels were normal for five years. By the end of the observation period, all patients were phased out of insulin therapy and only 1.4 per cent of patients continued to receive oral sugars (compared to the initial 44 per cent) [44].

E.Y. Cho et al. (2011) BPD-DS was conducted to 86 patients with DM-2 (average age 50 (26 to 68 years), BMI 47 kg/m2 (26 to 71 years). Patients were retrospectively divided into 4 groups depending on the treatment and the length of insulin before surgery: 1st group (n=18) patients received only oral sugars; 2nd group (n=32) received insulin for <5 years; 3rd group received oral sugars only (n=24) - from 5 to 10 years and the 4th group (n=12) - >10 years. At the time of discharge, all patients in Group 1 and Group 2 did not receive insulin, 30% and 75% of patients in Group 3 and Group 4 received up to 48 ED of insulin per day (on average 24, n=16). One year after the operation, only 4 patients in group 4 required low doses of insulin (17 IU per day on average) to maintain blood glucose levels below 200 mg/dl. These four patients had insulin before surgery for 13, 15, 22 and 25 years respectively. Three of the four patients had low levels of C-peptide on an empty stomach (<1.2 ng/ml). The overall rate of total diabetes remission for the total population surveyed was 91%. The authors concluded that BPD-DS causes rapid and complete remission in all DM-2 patients receiving oral sugars and in patients with insulin therapy for less than 5 years. In patients with an insulin therapy lasting more than 5 years and more than 10 years, the rate of complete remission decreases to 88% and 66% respectively. A low level of C-peptide before surgery (<1.0 ng/ml) may be a specific prognostic parameter of low probability of diabetes remission [64].

A. Sánchez-Pernaute et al. (2015) conducted an evaluation of DM-2 in patients after SADI. The study included 97 patients with BMI of 44.3 kg/m2. The HbA1c level before the operation was 7.6%, 5.1% after 1 year, 5.07% after 2 years and 5.25% after 3 years. The HOMA index before the transaction was 7.9, and after the transaction - 0.96, 1.45 and 0.87 after 1, 2 and 3 years respectively. C2 remission in the first year after the operation was observed in 92.5% of patients receiving oral sugaring therapy and 47% of patients receiving insulin [32].

All the mechanisms involved in compensating DM-2 after the creation of the duodenal shunt and the initial sections of the small intestine remain unclear, but it is clear that this is not only due to a decrease in body weight. In most cases, remission occurs a few days or weeks after surgery, before there is a significant decrease in body weight [61]. This effect was demonstrated in a pilot study on rats of the DM-2 model Goto-Kaki zaki (GK). It was also shown for the first time that the shutdown of the duodenum and the initial scrawny bowel significantly improves fasting glycemia and glucose tolerance regardless of body weight loss and/or reduced caloric intake. The gastrointestinal tract produces more than 100 biologically

active peptides, which is associated with such a drastic change in glucose metabolism. One such hormone is a glucagon-like peptide-1 (GLP-1), which affects pancreatic b cells and causes replenishment of a pool of insulin-ready granules. Studies show a significant increase in GLP-1 levels following the imposition of duodenal anastomosis on the ilium. There is also a decrease in the level of grelin, an appetite-stimulating hormone [65] after performing RYGB surgery compared to the pre-operative level [66]. The decrease in the grelin level occurs immediately after the operation and persists for more than a year [60]. DM-2 remission rates range from 80% at RYGB to 95% after BPD-DS [67, 68], and according to E.V. Yershova and Y.I. Yashkov - 98.6% [44]. It should be noted that surgical intervention in patients with short DM-2 history gives a higher rate of remission compared to patients with a longer term of the disease [68], which should probably be explained by progressive apoptosis b-pancreatic cells during the development of the disease.

Conclusion

Therefore, due to the high prevalence of morbidity obesity, often combined with DM-2, the use of bariatric surgery has become increasingly relevant and frequently used treatment method, showing high efficacy. Among all bariatric operations BPD in various modifications has the most pronounced and stable effect on reducing excess MT and eliminating comorbid states, as well as on correcting DM-2.

One of the promising methods of bariatric surgery is BPD in a modification of SADI, which with greater simplicity to date has shown its high efficiency comparable to other types of BPD with a lower frequency of side effects and complications. However, an increase in the number and duration of remote observations is required to further judge the long-term effectiveness of the operation.

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