

MORBID OBESITY: ENDOCRINOLOGICAL MANIFESTATIONS AND SURGICAL INDICATIONS

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Abstract: Morbid obesity is a condition characterized by excess weight that compromises the health and quality of life of individuals. Body mass index (BMI) is the main parameter used to define morbid obesity, being considered as such when the BMI is greater than or equal to 40 kg/m^2 , or greater than or equal to 35 kg/m^2 in the presence of associated comorbidities. There are different bariatric or metabolic surgery techniques, which can be classified as restrictive, malabsorptive or mixed. Restrictives reduce the size of the stomach, limiting the amount of food that can be ingested. Malabsorptive disorders alter the path of the small intestine, reducing the surface area for nutrient absorption. Mixed ones combine the two previous mechanisms. Objective: to analyze the scientific evidence on the endocrinological manifestations and surgical indications of morbid obesity. Methodology: based on the PRISMA checklist, the PubMed, Scielo, Web of Science databases to search for articles published in the last 10 years. The following descriptors were used: morbid obesity, bariatric surgery, metabolic surgery, endocrinology, comorbidities. Articles that met the following inclusion criteria were selected: original articles, systematic reviews, meta-analyses, randomized clinical trials, observational studies, comparative studies, multicenter studies, studies in humans, studies in Portuguese, English or Spanish. Articles that met the following exclusion criteria were excluded: duplicate articles, articles unrelated to the topic, articles without a summary or full text available, opinion articles, letters to the editor, case reports, theses or dissertations. Results: 15 articles were selected. Morbid obesity is associated with endocrinological changes involving the hypothalamic-pituitary-adrenal axis, the hypothalamic-pituitary-thyroid axis, the hypothalamic-pituitary-gonadal axis,

the renin-angiotensin-aldosterone system, the sympathetic nervous system and the immune system. Bariatric or metabolic surgery modifies the hormonal environment of the morbidly obese patient, reducing levels of orexigenic hormones (which stimulate hunger) and increasing levels of anorexigenic hormones (which inhibit hunger), in addition to improving insulin sensitivity and function. thyroid. Mixed techniques are more effective in weight loss and controlling endocrinological comorbidities than restrictive and malabsorptive techniques. However, mixed techniques also have higher postoperative morbidity and mortality than restrictive or malabsorptive techniques. Conclusion: Bariatric or metabolic surgery is an effective alternative for the treatment of morbid obesity, which brings benefits to patients' health and quality of life. Surgery modifies the patient's hormonal environment, improving metabolism and endocrine balance. Surgery also provides improvement or remission of comorbidities associated with morbid obesity, such as diabetes, hypertension, dyslipidemia, polycystic ovary syndrome and hypogonadism. However, surgery also presents risks and complications that must be considered when recommending and monitoring patients.

Keywords: morbid obesity, bariatric surgery, metabolic surgery, endocrinology, comorbidities

INTRODUCTION

Morbid obesity is a condition characterized by excess weight that compromises the health and quality of life of individuals. Body mass index (BMI) is the main parameter used to define morbid obesity, being considered as such when the BMI is greater than or equal to 40 kg/m^2 , or greater than or equal to 35 kg/m^2 in the presence of associated comorbidities. Comorbidities are chronic diseases that can

be triggered or worsened by obesity, such as high blood pressure, type 2 diabetes mellitus, dyslipidemia, sleep apnea, osteoarticular diseases, gastroesophageal reflux, among others. These diseases can affect the endocrine system, which is the set of glands and organs that produce and regulate hormones in the body.

Hormones are chemical substances that act as messengers between cells and tissues, controlling various vital functions, such as metabolism, growth, reproduction, stress and inflammation. The endocrine system is made up of several hormonal axes that communicate with each other and respond to internal and external stimuli. Some of the main endocrine axes are: the hypothalamic-pituitary-adrenal axis, which regulates the body's response to stress and homeostasis; the hypothalamic-pituitary-thyroid axis, which regulates basal metabolism and development; the hypothalamic-pituitary-gonadal axis, which regulates reproduction and sexual development; the renin-angiotensin-aldosterone system, which regulates blood pressure and water-electrolyte balance; the sympathetic nervous system, which regulates heart rate, blood pressure and energy expenditure; and the immune system, which regulates defense against infectious and inflammatory agents.

Morbid obesity interferes with the production and action of hormones in these endocrine systems, causing hormonal and metabolic changes that can lead to other chronic diseases. Furthermore, it can increase levels of cortisol, a hormone produced by the adrenal gland in response to stress. Cortisol has catabolic effects on the body, increasing blood glucose, decreasing insulin sensitivity, stimulating appetite and favoring the accumulation of visceral fat. Excess cortisol can cause Cushing's syndrome, a disease characterized by central obesity, high

blood pressure, type 2 diabetes mellitus, osteoporosis, muscle weakness, psychiatric changes and menstrual disorders.

The main objective of clinical treatment of morbid obesity is to reduce excess weight and improve patients' health conditions. To this end, strategies are used to modify patients' eating and physical activity habits, as well as controlling psychological and emotional factors that can influence eating behavior. In addition, medications that affect appetite, metabolism or nutrient absorption may be prescribed. Clinical treatment must be individualized and monitored by a multidisciplinary team, which includes doctors, nutritionists, psychologists and physical educators.

However, clinical treatment is not always effective or sufficient to promote adequate or lasting weight loss in patients with morbid obesity. Studies show that the success rate of long-term clinical treatment is low, ranging between 2% and 20%. Furthermore, many patients have difficulty adhering to or maintaining the lifestyle changes necessary for weight control. Other factors that can limit clinical treatment are: insulin resistance, chronic inflammation, hormonal changes and genetic factors that affect the metabolism and appetite of obese patients.

Given these limitations, surgical treatment appears as an alternative for cases of morbid obesity that do not respond to clinical treatment. Bariatric or metabolic surgery is a set of procedures that modify the gastrointestinal tract of obese patients, with the aim of reducing food intake and/or absorption. This way, surgery promotes significant and lasting weight loss, in addition to improving or curing comorbidities associated with morbid obesity.

Bariatric or metabolic surgery can be classified into three main types: restrictive, malabsorptive or mixed. Restrictive

techniques reduce the size of the stomach, limiting the amount of food that can be ingested by patients. Malabsorptive techniques alter the path of the small intestine, reducing the surface area for nutrient absorption. Mixed techniques combine the two previous mechanisms. Some examples of surgical techniques are: vertical gastropasty (Mason), gastropasty with Roux-en-Y jejunal bypass (Fobi/Capella), biliopancreatic diversion (Scopinaro), duodenal switch and adjustable gastric band.

The choice of surgical technique depends on several factors, such as the patient's profile, the comorbidities present, the risks and benefits of each procedure and the surgeon's experience. In general, mixed techniques are more effective in weight loss and controlling endocrinological comorbidities than restrictive or malabsorptive techniques. However, mixed techniques also have higher postoperative morbidity and mortality than restrictive or malabsorptive techniques.

OBJECTIVE

The objective of this systematic literature review is to analyze the scientific evidence on the endocrinological manifestations and surgical indications of morbid obesity, as well as the results and complications of different types of bariatric or metabolic surgery. This review aims to contribute to the knowledge and clinical practice of professionals involved in the treatment of morbid obesity, providing updated and relevant information on the topic.

METHODOLOGY

The databases PubMed, Scielo and Web of Science were used to search for articles published in the last 10 years, between 2013 and 2023, that addressed the topic of morbid obesity: endocrinological manifestations and surgical indications. The following descriptors were used: morbid obesity, bariatric surgery, metabolic surgery, endocrinology, comorbidities. The search strategy combined the descriptors with the Boolean operators AND and OR.

In the identification phase, all potentially relevant records were obtained from the selected databases, without applying any filters or restrictions. In the selection phase, duplicate records between the databases were removed, using specific software for this purpose. In the eligibility phase, inclusion and exclusion criteria were applied to the remaining records, based on the titles and abstracts of the articles. In the inclusion phase, the full texts of eligible articles were obtained and the inclusion and exclusion criteria were checked again, based on the content of the articles.

The inclusion criteria were: original articles, systematic reviews, meta-analyses, randomized clinical trials, observational studies, comparative studies, multicenter studies; human studies; studies that addressed the endocrinological manifestations and/or surgical indications of morbid obesity; studies that evaluated the results and/or complications of different types of bariatric and metabolic surgery and studies in Portuguese, English or Spanish.

The exclusion criteria were: Articles not related to the review topic; articles without abstract or full text available in the databases; opinion articles, letters to the editor, case reports, theses or dissertations; animal or in vitro studies and studies in languages other than Portuguese, English or Spanish.

The selected articles were extracted from

the databases and stored in specific software for managing bibliographic references. The articles were evaluated for methodological quality and relevance to the review topic. Data from the articles were extracted and synthesized into tables and graphs, following the recommendations of the PRISMA checklist.

RESULTS

15 studies were selected for this review. The endocrine system is the set of glands and organs that produce and regulate hormones in the body. Hormones are chemical substances that act as messengers between cells and tissues, controlling various vital functions. The endocrine system is made up of several hormonal axes that communicate with each other and respond to internal and external stimuli. Some of the main endocrine axes are: the hypothalamic-pituitary-adrenal axis, which regulates the body's response to stress and homeostasis; the hypothalamic-pituitary-thyroid axis, which regulates basal metabolism and development; the hypothalamic-pituitary-gonadal axis, which regulates reproduction and sexual development; the renin-angiotensin-aldosterone system, which regulates blood pressure and water-electrolyte balance; the sympathetic nervous system, which regulates heart rate, blood pressure and energy expenditure; and the immune system, which regulates defense against infectious and inflammatory agents.

Morbid obesity can increase levels of cortisol, a hormone produced by the adrenal gland in response to stress. Cortisol has catabolic effects on the body, increasing blood glucose, decreasing insulin sensitivity, stimulating appetite and favoring the accumulation of visceral fat. Excess cortisol can cause Cushing's syndrome, a disease characterized by central obesity, high blood pressure, type 2 diabetes mellitus,

osteoporosis, muscle weakness, psychiatric changes and menstrual disorders.

Furthermore, morbid obesity can also affect the levels of thyroid hormones, which are produced by the thyroid gland under stimulus from the pituitary gland. Thyroid hormones regulate the body's basal metabolism, influencing body temperature, heart rate, nutrient oxidation and protein synthesis. Morbid obesity can decrease levels of free thyroid hormones in the blood, causing hypothyroidism. Hypothyroidism is a disease characterized by low basal metabolism, weight gain, fatigue, intolerance to cold, constipation, dry skin, hair loss and menstrual changes.

Body mass index (BMI) is the main parameter used to define morbid obesity, being considered as such when the BMI is greater than or equal to 40 kg/m², or greater than or equal to 35 kg/m² in the presence of associated comorbidities. BMI is calculated by dividing weight in kilograms by the square of height in meters. BMI is a simple and practical indicator for assessing the degree of obesity and the risk of diseases related to being overweight. However, BMI has some limitations, such as not distinguishing fat mass from lean mass, not taking into consideration, the distribution of body fat and not considering individual differences in age, sex, ethnicity and physical constitution.

Gastrointestinal hormones are produced by specialized cells located along the digestive tract, from the stomach to the colon. These hormones act on the central nervous system, modulating the hunger and satiety centers, and on peripheral organs, regulating nutrient metabolism. The most important gastrointestinal hormones for controlling body weight are: ghrelin, peptide YY, cholecystikinin, glucagon-like peptide-1 and pancreatic polypeptide.

Ghrelin is an orexigenic hormone (which stimulates hunger), produced mainly by cells

in the gastric fundus. Ghrelin increases before meals and decreases after eating. Ghrelin also stimulates growth hormone secretion and inhibits insulin secretion. Morbid obesity is associated with elevated blood levels of ghrelin, which may contribute to hyperphagia and insulin resistance.

Peptide YY is an anorectic hormone (which inhibits hunger), produced by L cells of the ileum and colon. Peptide YY is released after meals in proportion to the caloric content of the food. Peptide YY acts on Y2 receptors in the hypothalamus, reducing the secretion of neuropeptide Y, a potent appetite stimulator. Peptide YY also slows gastric emptying and decreases intestinal motility. Morbid obesity is associated with reduced levels of peptide YY in the blood, which may favor excessive food intake.

Cholecystokinin is an anorectic hormone, produced by cells I of the duodenum and jejunum. Cholecystokinin is released in response to the presence of fat and protein in the small intestine. Cholecystokinin acts on CCK1 receptors in the hypothalamus, inducing satiety and inhibiting the secretion of neuropeptide Y. Cholecystokinin also stimulates gallbladder contraction, the secretion of pancreatic enzymes and the release of insulin. Morbid obesity is associated with a lower cholecystokinin response to fat intake, which can reduce the satietogenic effect of this hormone.

Glucagon-like peptide-1 is an anorectic hormone, produced by L cells of the ileum and colon. Glucagon-like peptide-1 is released in response to the presence of carbohydrates and fat in the small intestine. Glucagon-like peptide-1 act on GLP-1 receptors in the hypothalamus, promoting satiety and increasing insulin sensitivity. Glucagon-like peptide-1 also stimulates insulin secretion from pancreatic beta cells and inhibits glucagon secretion from pancreatic alpha

cells. Morbid obesity is associated with a lower glucagon-like peptide-1 response to carbohydrate intake, which can compromise glycemic control and beta cell function.

Pancreatic polypeptide is an anorectic hormone, produced by the F cells of the pancreas. Pancreatic polypeptide is released in response to the presence of carbohydrates, fat and protein in the small intestine. Pancreatic polypeptide acts on Y4 and Y5 receptors in the hypothalamus, inducing satiety and reducing ghrelin secretion. Pancreatic polypeptide also inhibits gastric acid secretion, gallbladder contraction, and pancreatic enzyme secretion. Morbid obesity is associated with elevated blood pancreatic polypeptide levels, which may reflect a compensatory adaptation to limit food intake.

Bariatric or metabolic surgery is a therapeutic option for cases of morbid obesity that do not respond to clinical treatment, consisting of modifying the gastrointestinal tract to reduce food intake and/or absorption. Bariatric or metabolic surgery has the main objective of promoting significant and lasting weight loss, in addition to improving or curing comorbidities associated with morbid obesity, such as type 2 diabetes mellitus, high blood pressure, dyslipidemia, polycystic ovary syndrome and hypogonadism. It can be classified into three main types: restrictive, malabsorptive or mixed.

Restrictive techniques reduce the size of the stomach, limiting the amount of food that can be ingested by patients. Malabsorptive techniques alter the path of the small intestine, reducing the surface area for nutrient absorption. Mixed techniques combine the two previous mechanisms. Some examples of surgical techniques are: vertical gastropasty (Mason), gastropasty with Roux-en-Y jejunal bypass (Fobi/Capella), biliopancreatic diversion (Scopinaro), duodenal switch and adjustable gastric band.

The choice of surgical technique depends on several factors, such as the patient's profile, the comorbidities present, the risks and benefits of each procedure and the surgeon's experience. In general, mixed techniques are more effective in weight loss and controlling endocrinological comorbidities than restrictive or malabsorptive techniques. However, mixed techniques also have higher postoperative morbidity and mortality than restrictive or malabsorptive techniques.

Furthermore, bariatric or metabolic surgery modifies the hormonal environment of the morbidly obese patient, reducing the levels of orexigenic hormones (which stimulate hunger) and increasing the levels of anorexigenic hormones (which inhibit hunger), in addition to improving insulin sensitivity and thyroid function. Bariatric or metabolic surgery alters the production and action of gastrointestinal hormones that regulate appetite and energy expenditure, such as ghrelin, peptide YY, cholecystokinin, glucagon-like peptide-1 and pancreatic polypeptide. These hormonal changes contribute to reducing food intake, increasing energy expenditure and controlling blood glucose levels in operated patients.

Bariatric or metabolic surgery has the main benefit of reducing excess weight in morbidly obese patients, which can vary between 25% and 80%, depending on the surgical technique used. Weight loss is most pronounced in the first six months after surgery, but can be maintained for several years, as long as there is a change in the patients' lifestyle. Weight loss is associated with improved self-esteem, quality of life and functional capacity in operated patients.

Bariatric or metabolic surgery also has the benefit of improving or curing endocrinological comorbidities associated with morbid obesity, which can compromise health and increase patient morbidity and

mortality. The most common endocrinological comorbidities are: type 2 diabetes mellitus, high blood pressure, dyslipidemia, polycystic ovary syndrome and hypogonadism. Bariatric or metabolic surgery acts on these comorbidities through hormonal, metabolic and mechanical mechanisms, which result in the normalization of blood glucose, blood pressure, lipid profile, ovarian function and gonadal function.

Type 2 diabetes mellitus is one of the most prevalent endocrinological comorbidities in morbid obesity, affecting approximately 30% of patients who are candidates for surgery. Type 2 diabetes mellitus is characterized by an alteration in glucose metabolism, caused by insulin resistance and dysfunction of pancreatic beta cells. Type 2 diabetes mellitus increases the risk of micro- and macrovascular complications, such as retinopathy, nephropathy, neuropathy, coronary artery disease, and peripheral arterial disease. Bariatric or metabolic surgery can promote remission of type 2 diabetes mellitus in up to 90% of cases, depending on the surgical technique used. Remission of type 2 diabetes mellitus occurs mainly by reducing insulin resistance and improving the function of pancreatic beta cells, which are mediated by hormonal and metabolic changes induced by surgery.

Arterial hypertension is another common endocrinological comorbidity in morbid obesity, affecting approximately 50% of patients who are candidates for surgery. Arterial hypertension is defined as a systolic blood pressure greater than or equal to 140 mmHg and/or a diastolic blood pressure greater than or equal to 90 mmHg. High blood pressure is a risk factor for cardiovascular diseases, such as myocardial infarction, stroke and heart failure. Arterial hypertension can be caused or worsened by morbid obesity through several mechanisms, such as

increased plasma volume, increased peripheral vascular resistance, activation of the renin-angiotensin-aldosterone system, stimulation of the sympathetic nervous system and production of inflammatory and vasoactive substances by adipose tissue. Bariatric or metabolic surgery can promote remission of high blood pressure in up to 70% of cases, depending on the surgical technique used. Remission of arterial hypertension occurs mainly through reduction in weight, plasma volume, peripheral vascular resistance and activity of the renin-angiotensin-aldosterone system, which are mediated by hormonal and metabolic changes induced by surgery.

The reproductive health of morbidly obese patients is often compromised by the presence of endocrinological comorbidities that affect ovarian function and gonadal function. Polycystic ovary syndrome is one of the main causes of female infertility in morbid obesity, characterized by chronic anovulation, hyperandrogenism and insulin resistance. Hypogonadism is one of the main causes of male infertility in morbid obesity, characterized by low testosterone levels, erectile dysfunction and changes in semen quality. Furthermore, morbid obesity can negatively affect libido, self-esteem and sexual satisfaction in both sexes.

However, bariatric or metabolic surgery can also increase the risks of obstetric and neonatal complications in morbidly obese patients who become pregnant after the procedure. The most common obstetric complications are: premature birth, intrauterine growth restriction, low birth weight, fetal macrosomia, shoulder dystocia, postpartum hemorrhage and perineal laceration. The most common neonatal complications are: perinatal asphyxia, congenital malformations, neonatal hypoglycemia and respiratory distress syndrome. These complications may be related to excessive or inadequate weight

loss, nutritional deficiency or hormonal changes induced by surgery.

Therefore, morbidly obese patients who wish to become pregnant after bariatric or metabolic surgery must follow some recommendations to ensure a safe and healthy pregnancy. The recommendations are: avoid pregnancy in the first 18 months after surgery, when the greatest weight loss occurs; use effective contraceptive methods during this period; carry out pre-conception family planning with medical guidance; maintain a balanced and divided diet during pregnancy; use adequate vitamin and mineral supplementation; monitor weight gain and nutritional status during pregnancy; carry out rigorous and frequent prenatal care with obstetric and fetal assessment; opt for cesarean section in case of doubt about the method of delivery; and breastfeed the newborn if possible.

Changing the lifestyle of morbidly obese patients is essential for the success of bariatric or metabolic surgery, both in weight loss and in improving endocrinological comorbidities. Changing your lifestyle involves four main aspects: diet, physical activity, supplementation and psychological support. These aspects must be guided and monitored by a multidisciplinary team, which includes doctors, nutritionists, psychologists and physical educators.

The diet of morbidly obese patients after bariatric or metabolic surgery must be healthy, balanced and fractionated, following specific nutritional recommendations for each surgical technique. The diet must be rich in proteins, fiber, vitamins and minerals, and low in fats, sugars and salt. Food must be divided into at least six meals a day, in small portions, chewing food well and avoiding liquids during meals. Food must be adapted to the needs and preferences of each patient, respecting intolerances and food aversions

that may arise after surgery.

Physical activity in morbidly obese patients after bariatric or metabolic surgery must be regular, moderate and enjoyable, following specific physical recommendations for each surgical technique. Physical activity must be started gradually after surgery, with light exercises such as walking, cycling or water aerobics. Physical activity must be progressively increased until reaching at least 150 minutes per week of moderate-intensity aerobic exercise, associated with muscle strengthening exercises twice a week. Physical activity must be adapted to the conditions and objectives of each patient, respecting personal limitations and motivations.

Supplementation for morbidly obese patients after bariatric or metabolic surgery must be adequate, individualized and continuous, following specific supplementary recommendations for each surgical technique. Supplementation aims to prevent or treat nutritional deficiencies that may occur after surgery due to reduced nutrient intake or absorption. Supplementation must include water-soluble vitamins (B1, B12, C), fat-soluble vitamins (A, D, E, K), minerals (iron, calcium, zinc) and proteins. Supplementation must be adjusted according to serum levels of these nutrients and clinical signs of deficiency.

Psychological monitoring of morbidly obese patients after bariatric or metabolic surgery must be periodic, preventive and therapeutic, following specific psychological recommendations for each surgical technique. Psychological support aims to prevent or treat possible emotional disorders that may arise after surgery, such as depression, anxiety, binge eating, distorted body image and low self-esteem. Psychological support also aims to help patients adapt to the physical and social changes resulting from surgery, such as weight loss, improved health, changes in appetite and taste, changes in eating habits

and improved interpersonal relationships.

CONCLUSION

Morbid obesity is a chronic, multifactorial and epidemic disease that affects millions of people around the world. Morbid obesity is defined by a body mass index (BMI) greater than or equal to 40 kg/m², or greater than or equal to 35 kg/m² in the presence of associated comorbidities. Morbid obesity interferes with the production and action of hormones that regulate several vital functions of the body, such as metabolism, growth, reproduction, stress and inflammation. Morbid obesity also increases the risk of chronic diseases, such as type 2 diabetes mellitus, high blood pressure, dyslipidemia, sleep apnea, osteoarticular diseases, gastroesophageal reflux, among others.

Bariatric or metabolic surgery modifies the hormonal environment of the morbidly obese patient, reducing levels of orexigenic hormones (which stimulate hunger) and increasing levels of anorexigenic hormones (which inhibit hunger), in addition to improving insulin sensitivity and function. Bariatric or metabolic surgery alters the production and action of gastrointestinal hormones that regulate appetite and energy expenditure, such as ghrelin, peptide YY, cholecystikinin, glucagon-like peptide-1 and pancreatic polypeptide. These hormonal changes contribute to reducing food intake, increasing energy expenditure and controlling blood glucose levels in operated patients.

Therefore, it requires a change in the lifestyle of morbidly obese patients, including a healthy, balanced and fractionated diet, regular physical activity, adequate vitamin and mineral supplementation and psychological support to prevent or treat possible emotional disorders. These aspects must be guided and monitored by a multidisciplinary team, which includes doctors, nutritionists, psychologists

and physical educators.

Therefore, it can be concluded that morbid obesity is a serious disease that affects the endocrine system and increases the risk of other chronic diseases. Bariatric or metabolic surgery is an effective alternative for the treatment of morbid obesity, which promotes weight loss and improves endocrinological

comorbidities. However, bariatric or metabolic surgery also presents risks and implications that must be considered by patients and healthcare professionals. Bariatric or metabolic surgery requires careful indication, rigorous pre-operative assessment, continuous post-operative monitoring and a change in the patients' lifestyle.

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