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INVESTIGATING THE INTERCONNECTEDNESS BETWEEN METABOLIC ABNORMALITIES AND CARDIOVASCULAR RISKS, AND THE IMPLICATIONS FOR COMPREHENSIVE PATIENT

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Abstarct:
The term metabolic syndrome (MS) has been used since its definition in 2001 by the National Cholesterol Program (NCEP: ATP III). The concept has been discussed in the scientific literature for decades. Syndrome X and other terms such as "the death quartet" and insulin resistance syndrome have been used to describe the association between metabolic and cardiovascular risk factors. In Lahore, the prevalence of MS in the National Health and Nutrition Survey (ENSANUT) was 34% in 2010 and 41% in 2022. Lifestyle modifications, increased physical activity, smoking cessation, and limiting alcohol intake are paramount for management and prevention because they play a central role in metabolic abnormalities. However, despite the impressive armamentarium of medications available for Diabetes, it has been reported that up to 50% of patients do not achieve adequate control goals, as defined by the American Diabetes Association (glycosylated hemoglobin <7%). In contrast, bariatric surgery (BMS) has been confirmed to contribute to improved beta cell function in patients with a body mass index (BMI) >35 kg/m^2, as well as the control of dyslipidemia and other metabolic disorder.

Keywords: Metabolic surgery; surgery and metabolic syndrome; syndrome X; mini gastric bypass; the bypass of an anastomosis; Roux-en-Y bypass; bariatric surgery;

INTRODUCTION

Although the term metabolic syndrome (MS) (Gagner and Billmann 2023) has been used since its definition in 2001 by the National Cholesterol Program (NCEP: ATP III), the association between metabolic disorders and cardiovascular disease has been discussed in the scientific literature for decades. (Lu, Sun et al. 2023). Reaven created the term "syndrome X" to describe the proposed relationship between insulin resistance, systemic arterial hypertension (SAH), diabetes mellitus (DM2) and cardiovascular disease. (De Luca, Zappa et al. 2023). Syndrome X, death quartet, and insulin resistance syndrome are terms used to describe the association between metabolic and cardiovascular risk factors. (Chiu, Zhou et al. 2023, Inoue, Sheedy et al. 2023, Wang, Qiao et al. 2023)The MetS identify individuals at high risk of cardiovascular disease (Gruber 2023, Wang, Qiao et al. 2023) and refer to the concurrence of various cardiovascular risk factors related to metabolic, vascular, inflammatory, fibrinolytic, and coagulation alterations, which also increase the risk of cerebrovascular disease and DM2 (Gruber 2023, Wang, Qiao et al. 2023). Insulin resistance itself is a predictor of cardiovascular disease (CVD) (Lu, Sun et al. 2023)Hanley et al. quantified insulin resistance in 2,564 non-diabetic participants with an 8-year follow-up; subjects with the highest insulin resistance had approximately 2.5 times the incidence of CVD (Lu, Sun et al. 2023), other authors have found similar results (Gruber 2023, Wang, Qiao et al. 2023) (POPENȚIU, CORNEL MOGA et al. 2022).

EPIDEMIOLOGY

The prevalence of Mets increases with age and varies according to ethnicity and race.[7]. Multiple definitions have been developed for its clinical recognition; the most widely used are those of the World Health Organization (WHO) and that of modified adenosine triphosphate (ATP) III. (Chiu, Zhou et al. 2023). The International Diabetes Federation (IDF) emphasizes *visceral obesity* as the essential component of the syndrome, identified by measuring the abdominal circumference, whose cut-off point varies according to the ethnic group (Ronen, Robbins et al. 2023). These different definitions have determined variations in the reported prevalences (Lee and Rosenthal 2023).In Lahore, 41.5% was found for the general population. There was a higher incidence in the urban area than in the rural area (42.8 vs. 35.1%), respectively, which agrees with a study carried out in the State of Oaxaca, where a prevalence of 45.4 and 27.6% was found in urban and rural areas respectively(Elbelt, Berger et al. 2022).

The frequency increases with age showing majorities of 27.9, 56.2 and 60.8% in the period ranges of 20-39, 40-59, and 60 or more, respectively. Studies worldwide have found that the estimated prevalence of MetS using the FID criteria, is slightly higher than when the NCEP-ATP III is used in the same population. Other studies have found fewer differences in the prevalence of MetS using the different definitions. (Inoue, Sheedy et al. 2023). In Lahore, the majority of MS in the National Health and Nutrition Survey (ENSANUT) was 34% for 2000.; and for 2012 41% (Wang, Qiao et al. 2023). The same increase was observed in obesity, reporting data from 1993 in the National Survey of Chronic Diseases, which revealed a prevalence of obesity of 21.5% in adults, which increased to 24% according to the Survey. National Health of the year 2000, and reached 30% for 2006 (Raverdy, Cohen et al. 2022).

When overweight and obesity were evaluated, the prevalence of MS was 71.3% (overweight 38.8% and obesity 32.4%). In comparison, abdominal obesity was 74% higher in women (82.8%) than in men (64.5%), with an average annualized increase of 1.3%, higher than in 2000-2006 (Lee and Rosenthal 2023). González-Chavez et al. found that the prevalence of MS in Lahore, defined by the FID and NCEP-ATP III criteria, was higher than that estimated by the WHO with 46.5, 43.3 and 36.5%, respectively; these observations agree with what was reported. By other authors (Gruber 2023). Different studies in different countries have evaluated the waist cut-off points for the diagnosis of abdominal obesity; the results show discrepancies, so the FID recommends that this cut-off point be individualized according to ethnicity. Rojas and collaborators (De Luca, Zappa et al. 2023)(Marchesini 2022)In a study carried out in a Mexican population, they defined the cut-off point

for abdominal obesity at ≥102 cm for men and ≥88 cm for women, considering the FID cut-off point established at 80 cm for women and 90 cm for men in the population. mexican (Chiu, Zhou et al. 2023, Gruber 2023, Inoue, Sheedy et al. 2023, Wang, Qiao et al. 2023)Regarding the individual components of MS, two studies in Lahore reported that the most prevalent components were: abdominal obesity, low high-density lipoprotein (HDL) cholesterol, and triglycerides; it was observed that most of the subjects with MS completed four classifications criteria (Chiu, Zhou et al. 2023, Inoue, Sheedy et al. 2023). In the table 1, the criteria for MS are listed; the presence of 3 or more of these factors establishes the diagnosis; in the case of blood pressure and glycemia, the establishment of the previous medical diagnosis of systemic arterial hypertension and type diabetes mellitus is also considered positive. (De Luca, Zappa et al. 2023).

Table 1 The diagnosis of metabolic syndrome is established with the presence of at least 3 of the criteria. [$^{dm\text{-}HAS}$: medical diagnosis of systemic arterial hypertension;$^{dm\text{-}DM2}$: medical diagnosis of type 2 diabetes mellitus] Obesity Canada

Criteria	Men	Women
waist circumference	≥ 102 cm	≥ 88 cm
Triglycerides	≥ 150 mg/dL	
HDL-cholesterol	< 40 mg/dL	< 50 mg/dL
systolic blood pressure$^{(dm\text{-}HAS)}$	≥ 135 mmHg	
diastolic blood pressure$^{(dm\text{-}HAS)}$	≥ 85 mmHg	
fasting blood glucose$^{(dm\text{-}DM2)}$	≥ 100 mg/dL	

PATHOPHYSIOLOGY

Evidence indicates that insulin resistance per se and the associated components of insulin resistance syndrome (MS) cause cardiovascular disease. Each element of the metabolic syndrome is characterized by insulin resistance and compromises glucose metabolic pathways. (Ronen, Robbins et al. 2023). The genetic component is aggravated by weight gain, physical inactivity, and age. Alterations have been detected in susceptibility genes such as FTO, related to obesity, and PPARG and IRS1, whose presence increases the risk of developing obesity and insulin resistance. (Gruber 2023). Obesity is the most critical factor responsible for DM2, causing insulin resistance and altering normal secretion by beta cells; It is considered that having abdominal obesity is equal to having some degree of insulin resistance, as well as a degree of persistent chronic inflammation, with the secretion of inflammatory cytokines and activation of insulin signaling pathways. The first mechanism of insulin resistance is believed to be inhibiting the insulin receptor by inflammatory cytokines, causing defects in multiple insulin signaling pathways at the receptor level. (Castera and Cusi 2023).

Furthermore, fatty tissue can activate specific serine kinases. The three series strongly implicated are jun-n terminal kinase (junk), an inhibitor of nuclear factor Kb (ink), protein kinase isoforms (PKC), of which nuclear factor (FN-Kβ) is a factor that activates multiple inflammatory pathways related to atherosclerosis and the major transcription factor for insulin resistance through the release of inflammatory markers TNF-α, IL-6 and CRP and other inflammatory cytokines from adipose tissue. TNF-α is believed to be a key component in the obesity-insulin resistance relationship (Almerie, Leuratti et al. 2022).

Obesity is related to a significant increase in macrophage infiltration into the individual's fatty tissue. This process, more accentuated in visceral fat, is secondary to changes in cell phenotypes induced by a state of chronic inflammation.. There is an imbalance in the production of adipokines by adipocytes, with an increase in inflammatory cytokines (TNF alpha, IL-6, resistin, and RBP4) and a reduction in

anti-inflammatory cytokines (leptin, adiponectin, visfatin, and omentin), which are related to critical metabolic functions to maintain hemostasis. The metabolic imbalance leads to an accumulation of intracellular fat reserves in the adipocytes, endoplasmic reticulum stress, and production of free radicals; Said alterations reduce the expression of Glut-4 transporters in the cell membrane, hypertrophy of the adipose cell, reduction of the word of insulin receptors and removal of the production of lipoprotein lipase, this increases the amount of free fatty acids that are released to the systemic circulation where they are deposited abnormally in the tissues leading to adiposity that is the fundamental basis of insulin resistance in other peripheral tissues such as liver and muscle (Castera and Cusi 2023, De Luca, Zappa et al. 2023, Ronen, Robbins et al. 2023)The harmful effects of pathological fat accumulation in tissues secondary to increased fatty disease, the release of long-chain fatty acids into the systemic circulation, and elevation of toxic lipid metabolites are known as lipotoxicity.[34]. Intracellular signals activated by inflammation inhibit insulin signaling pathways (Gagner and Billmann 2023, Lu, Sun et al. 2023).

Serine phosphorylation of the insulin receptor blocks the protein kinase 3 (PI3) pathway and the intracellular cascade that activates anabolic pathways with the subsequent development of dyslipidemia and glucose intolerance, as well as the production of insulin synthase. Nitric oxide. In this way, the MAP kinase pathway, responsible for gene expression and mitosis that leads to atherosclerosis and inflammation, is overexpressed.. Increased free radical production, abnormal protein kinase production, and inflammatory cell activation and migration lead to endothelial dysfunction with foam cells and fatty streak formation, as well as progression to atherosclerotic plaque in which the endothelium loses its physiological properties of vasodilation, antiplatelet aggregation and fibrinolysis (Diao, Gao et al. 2022).

TREATMENT

In patients with metabolic syndrome, diet, and lifestyle modifications, increased physical activity, smoking cessation, and limiting alcohol intake are paramount for management and prevention because they play a central role in metabolic abnormalities. Of MetS, evidence suggests that lifestyle modifications, employing a diet and exercise regimen, improve insulin sensitivity and secretion (Kaara 2022).

Weight loss It is essential to treat all the factors of MetS; consumption should be limited to the calories needed to achieve and maintain a healthy weight. A loss of 5 to 10% of the initial weight is recommended. Various recommendations have been made about an "ideal" diet scheme; in Table 2, a schematic is presented.

Table 2 General recommendations for adequate nutrition

Recommended "healthy" diet[45]	
Saturated fatty acid intake	< 10% of intake
Fats	Replace saturated fats with polyunsaturated fatty acids
Processed foods	Avoid
Shall	< 5 g/day
Fiber (whole grains, fruits, and vegetables)	30-45g/day
Fruits	200g/day
Vegetables	20g/day
Fish	Two times a week
Alcohol	Should be limited to 20 g (males) and 10 g (females)

Obesity Canada

- ***Both regular physical activity and aerobic exercise,*** Fatal and non-fatal coronary events have been associated with a decreased risk in healthy people, as well as in cardiac patients of different age groups. (Gagner, 2023 #546;Lu, 2023 #551;De Luca, 2023 #548;Castera, 2023 #549). Among the effects of exercise, the following have been described: a decrease in postprandial triglycerides, an improvement in the lipid profile and an improvement in insulin sensitivity and secretion.[7,34]. It is currently recommended that healthy adults get 2.5 to 5 hours of physical activity a week or at least moderate-intensity aerobic exercise or 1 to 2.5 hours of vigorous exercise. For their part, patients with stable cardiovascular disease should start a supervised exercise program[45](Colca and Scherer 2022).
- ***The recommended (allowable) intake of alcohol*** is one drink a day (10 g/day) in women and two glasses (20 g/day) in men to minimize chronic alcoholic disease. It is said to decrease the risk of CVD. The results of epidemiological studies suggest a protective effect of moderate alcohol consumption against the incidence of CVD. Especially, red wine seems to have a favorable outcome, which could be explained by the impact of polyphenols. (McMillan, 2023 #559) (Marchesini 2022).
- ***Smoking*** should be avoided in all its forms and types since it is a proven cause of numerous diseases, and half of the preventable deaths in smokers, half due to CVD. There is clear evidence that passive smoking also increases the risk of coronary heart disease, a non-smoker living with a smoker has a 30% increased risk of CVD, as does exposure in the workplace and workplace. (Shehu, 2023 #560) (Elbelt, Berger et al. 2022).
- ***Arterial hypertension,*** the central feature of metabolic syndrome, is a risk factor for coronary heart disease, heart failure, CVD, renal failure, and atrial fibrillation. The recommended goal is to maintain a BP lower than 140/90 mmHg, which must be individualized. Reducing BP < 130 mmHg in high-risk hypertensive patients has no advantages and may even be harmful, except for stroke (Vadivelu, 2023 #563). The initial treatment is with lifestyle modification to which pharmacological treatment can be added. The benefits of antihypertensive therapy are due to the reduction of BP and are independent of the drugs used. (Arvanitakis, 2023 #562). However, angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (Kaara) have both antihypertensive and anti-inflammatory effects. On the other hand, beta-blockers and diuretics have been associated with an increased incidence of Diabetes in people at risk.[45] (POPENȚIU, CORNEL MOGA et al. 2022).
- ***Type 2 diabetes mellitus*** increases 2 to 4 times the risk of cardiovascular disease due to oxidative stress from hyperglycemia, even in glucose intolerance. In prospective studies with follow-ups of 8 to 10 years, no benefit has been shown in cardiovascular prognosis, even with adequate glycemic control; however, some evidence suggests that early intervention may be beneficial. This has led us to consider that there is a "vascular memory," which explains the existence of a series of pathways that, in the face of chronic glycemic imbalance, self-perpetuate vascular damage despite optimal glycemic control. (Souza, 2023 #561). Treatment should be considered with individualized control goals, with 1 or 2 drugs covering the disease's primary pathophysiological defects. Medications such as metformin and pioglitazone have been shown to decrease insulin resistance and improve glycemic control. Recommended control goals are: glycosylated hemoglobin <7%; total cholesterol <200 mg/dL; triglycerides <150 mg/dL; LDL-C <100 mg/dL and at very high risk <70 mg/dL; Non-HDL cholesterol <130 mg/dL[34,49,50](Raverdy, Cohen et al. 2022).
- ***Dyslipidemia*** must be controlled by lowering LDL cholesterol. The primary line of treatment is statins for their effects on LDL, HDL, and anti-inflammatory effects. Statin should be appropriate based on individual cardiovascular risk, baseline cholesterol values, and statin efficacy (Souza, 2023 #561;El-Kassas, 2023 #558;Ochando, 2023 #557).

Goals will be adjusted according to particular cardiovascular risk, although LDL cholesterol <115 mg/dL is considered ideal. A second step of treatment to reduce cardiovascular risk are Triglycerides, whose goal value is <150 mg/dL. Different studies have shown that fibrates mitigate the risk of

myocardial infarction. (McMillan, 2023 #559) (Shehu, 2023 #560) (Vadivelu, 2023 #563). Low HDL cholesterol is an independent CV risk factor; concentrations of 40 mg/dL in men and 45 mg/dL in women will be considered. However, based on the available evidence, it is impossible to determine the efficacy of interventions on these variables to obtain additional CV risk reduction; therefore, they should be considered secondary and optional. (De Luca, Zappa et al. 2023).

BARIATRIC SURGERY

Bariatric surgery results in the resolution of DM2 in a significant population of patients. Drugs to treat T2DM are aimed at improving beta cell function, increasing insulin sensitivity, or both. However, despite the wide variety of medications available for Diabetes, 50% of patients do not achieve optimal control (glycosylated hemoglobin <7%). Bariatric surgery has been shown to help improve beta cell function in patients with a BMI >35 kg/m^2 and control dyslipidemia and other metabolic diseases. More recently, Kular et al. (2015) demonstrated a high remission of DM2 in patients with BMI <35 kg/m^2 with the use of *gastric bypass* anastomosis (BAGUA). In table 3, Listed are the criteria to determine the optimal control of type 2 diabetes mellitus after a bariatric procedure. (Lee and Rosenthal 2023).

Table 3 Adequate control parameters of type 2 diabetes mellitus after bariatric surgery. (*) After discontinuing the drugs for DM2

Bariatric control in DM2[52,53]
Maintenance of average fasting blood glucose (*)
Glucosylated hemoglobin (HbA_{1c}) < 7% (*)
Reduction to <25% of the preoperative insulin dose

Bariatric surgical procedures can be: restrictive, malabsorptive, and mixed. The *restriction* reduces the stomach size, causing early satiety and decreased caloric intake. Malabsorptives reduce the absorptive capacity of the small intestine, decreasing the absorption of nutrients. The mixed ones combine both characteristics. In the figure 1, The main restrictive procedures are presented: vertical gastroplasty (VG), vertical gastrectomy (LSG), and laparoscopic adjustable gastric banding (LAGB). (Ram and Davenport 2022).

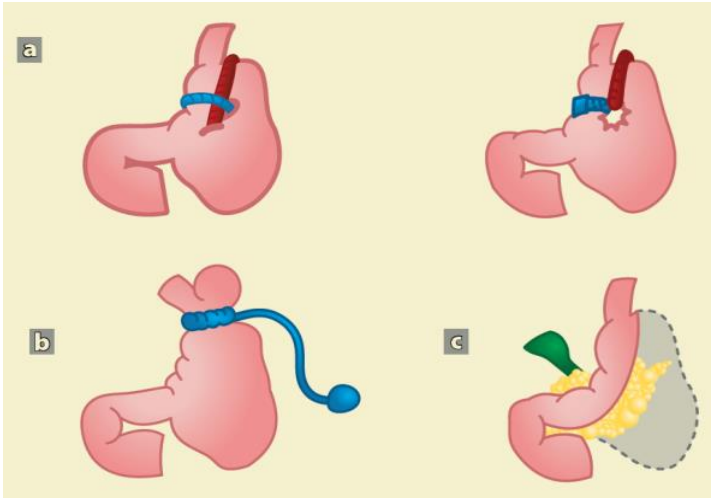

Figure 1 Universal schemes of the various (simple) restrictive techniques used in Bariatric Surgery are shown. **a)** Vertical ring gastroplasty**)** adjustable gastric band,**c)** vertical gastrectomy

In the figure, 2the mixed procedures considered most effective are shown, which are: *gastric bypass* anastomosis (BAGUA), *bypass* Roux-en-Y gastric (RYGB), biliopancreatic diversion (PBD), and duodenal switch (BPD-DS).

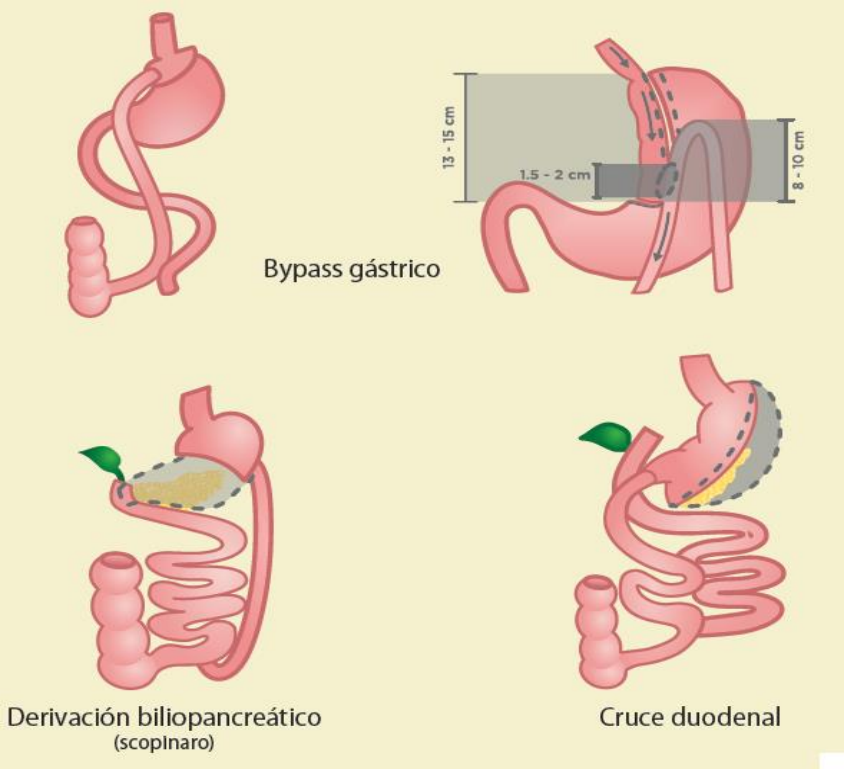

Figure 2

The universal schematic representation of the different mixed and malabsorptive (complex) techniques is shown. Bariatric surgery causes weight loss in all adults inducing a negative balance between energy intake and expenditure. Weight loss may result from reduced intake or a combination with malabsorption. Initial casualties of 20 to 21.6% have been reported with surgery, compared with 1.4 to 5.5% without surgery. After ten years, weight loss is maintained in up to 25% of patients operated on according to the technique used, compared with 1.5% of those not operated on.. Weight loss efficacy is not similar with all procedures (table 4) (Condello 2022).

Table 4 Observed effects of different bariatric procedures on the magnitude of weight loss

Weight loss at two years[52]	
Laparoscopic Adjustable Gastric Banding (LAGB)	48%
Gastroplastía vertical (GV)	53%
Bypass gastric anastomosis (BAGUA)	60%
Bypass Roux-en-Y gastric (RYGB)	62%
Biliopancreatic diversion (PBD) and duodenal switch (BPD-DS)	70%

Weight loss with sleeve gastrectomy (LSG) was similar to RYGB (Gallo-Villegas and Calderón 2023). Recent studies indicate that BAGUA has the same efficacy as RYGB, without the nutritional and metabolic complications that the latter presents (Rinella, Neuschwander-Tetri et al. 2023). Surgical treatment has shown superiority over drug therapy in DM2. Dixon et al. (2008) reported that 73% of patients with LAGB achieved diabetes remission versus 13% of patients with medical

treatment and lifestyle changes (Mamazhonov and Abdurakhmonov 2023). Schauer et al. (2012) reported that 42% of the subjects with RYGB and 37% with LSG achieved remission of DM2, compared to 12% of those treated with intensive medical therapy (Nagaich and Chaudhary 2023). Mingrone et al. (2012) reported that conventional medical therapy did not produce remission of Diabetes. In contrast, it did in 95% of BPD-treated subjects and 75% of RYGB-treated subjects, the defined goal being fasting glucose less than 100. , mg/dL and HA1c <6.5% for at least one year without treatment for diabetes (Huang, Lu et al. 2023).Improvement and resolution of Diabetes are closely related to weight loss after surgery (Harguindey, Reshkin et al. 2023); however, incretin hormone concentrations increase 3-5 fold, insulin secretion, and glucose tolerance improve; changes not seen with equivalent weight loss per diet (Shahpouri, Adili-Aghdam et al. 2023). This remission is given by improvement of the primary defects in the pathophysiology of Diabetes, which include improvement in insulin resistance and beta cell function. The review of 45 studies that evaluated HOMA-IR after RYGB, LAGB, LSG and BPD surgery found that the HOMA IR decreased within a few days and remained low for more than 18 months after surgery. Insulin sensitivity measures such as the HOMA IR improve within a few days after bariatric surgery when weight loss is minimal. This improvement is also seen early during caloric restriction, presumably caused by a rapid decline in hepatic glycogen and hepatic glucose production and increased insulin sensitivity. More considerable weight losses (>15% of initial body weight) after RYGB or LAGB surgery improve insulin sensitivity in skeletal muscle; muscle insulin sensitivity is primarily determined by the degree of weight loss. In contrast, BPD may have a unique and unexplained effect on insulin action at the skeletal muscle level manifested by rapid improvement after <10% loss of body weight (Ulugbek 2023). BS also improves dyslipidemia, and hyperlipidemia improved in about 70% of the operated patients. In particular, cholesterol, LDL, and triglycerides are around: 0.86, 0.76, and 0.90, respectively [55] (Ronen, Robbins et al. 2023).

Promising results have also been published in specific patient populations of infants., of older adults, and super-super obese. Carbajo et al.reported a decrease in excess weight, control of DM2, and hypertriglyceridemia in a 12-year-old adolescent, highlighting that weight loss did not have negative repercussions on the development and growth of the infant. More recently, Susmallian (2019) published the results of bariatric procedures in a cohort of patients older than 65 years. In 451 patients, an average age of 67.92 years, with a range of 65 to 84 years. The average preoperative body mass index was 40.32 kg/m^{2,} and the frequency of comorbidities was 76%. Gastric sleeve was the most common procedure (76.72%), gastric band (10.64%), *bypass* gastric with Roux Y (7.32%), *mini bypass* gastric (4.43%), and *switch* duodenal (0.89%). The complication rate was 8.86%. In 1.33% of the cases, there was a need for surgical reintervention. The average loss of excess BMI was 70.76%. Regarding the subsequent results, one year after surgery, there was remission of comorbidities in 34.74%, improvement in 49.67%, and no changes in 15.59%. Zero mortality was reported (Carrano, Iossa et al. 2022).

Like other authors, he refers that bariatric surgery offers acceptable results to elderly patients, with an improvement in the quality of life, for which the authors conclude on the need to review the appropriate recommendations regarding the criteria for bariatric surgery in adults. greater (Shahpouri, Adili-Aghdam et al. 2023). Parmar et al. published the results obtained in a population of super-super obese patients (BMI >60 kg/m^2), comparing two techniques: a group with *bypass* and anastomosis against a second group with *bypass* in Roux-Y. Morbidity and mortality were not significant between both groups. In the bypass group from the anastomosis group, significantly greater weight loss was obtained at the follow-up at 18 (Harguindey, Reshkin et al. 2023, Huang, Lu et al. 2023, Nagaich and Chaudhary 2023, Shahpouri, Adili-Aghdam et al. 2023, Ulugbek 2023) and 24 months compared to the Roux-Y technique in a patient with super-super obesity. However, the authors acknowledge that larger, randomized studies are needed. Surgical techniques continue in constant innovation, in the search for better results in efficacy, efficiency, and patient safety, as in the case of the very recent modifications to the technique known as the *bypass* of an anastomosis with the addition of a band

around the gastric pouch, to increase the restriction and thus maximize weight loss and insulin resistance (Huang, Lu et al. 2023) (Care 2022).

CONCLUSIONS

"Obesity is not a recent problem, although it is now known as the epidemic of the 21st century. At the beginning of the last century, insurance companies in the United States sought to determine the relationship between weight and lower mortality in individuals, obtaining tables like the one in the *Metropolitan Life Insurance Company*. Since 1994, data from the National Health Survey in the United States show that despite efforts to reduce the prevalence of obesity, it has increased, resulting in the search for alternatives to prevent it from being considered a real problem of public health, which has allowed the development of metabolic surgery that has become a reality to achieve sustained weight loss. Since there is no effective pharmacological treatment, surgery in cases of severe or morbid obesity has demonstrated its effectiveness, achieving weight reduction in more than 80% of patients, and more recent reports report encouraging success rates for the control of Diabetes, even in patients with BMI <35 kg/m^2". While it is true that there is extensive evidence supporting the efficacy, efficiency, and safety of metabolic surgery, making it a widely recommended and standardized technique, it is necessary to continue advancing innovation and the search for better results, especially in specific populations of patients (Long, Tcheng et al. 2022).

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