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Follow-up care after metabolic surgery – a prospective study in the North-Eastern region of Romania

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ABSTRACT

Background. Anti-obesity therapeutic strategies are continuously evolving. Bariatric procedures or metabolic surgery are among the most effective and long-lasting therapies for obesity and its complications. Our objective was to investigate the clinical and biological evolution after metabolic surgery in a group of patients from North-Eastern Romania and to evaluate a nutritional intervention plan for this population. *Materials and Methods*. Our clinic surveyed 50 patients who received nutritional counselling before and after bariatric surgery. The patient's weight loss, metabolic markers, and lifestyle changes from January to December 2021 were recorded. SPSS Statistics v.18 was used for statistical analyses. *Results and Discussions*. Patients had a mean age of 37.70 ± 11.38 years, with an initial body mass index (BMI) of 42.98 ± 6.12 kg/m2. One month after surgery, longitudinal gastrectomy patients lost 12.6 kg (114.33 ± 19.26 vs 101.73±17.27 kg), and gastric bypass patients lost 10.86 kg (119.33 ± 20.83 vs 108.47±17.96 kg). Body composition improved in the first six months after the intervention due to adipose (mean value 37.83±6.42 from 46.38±6.63) and visceral (mean value 8.50 ± 4.42 from 13.72±5.67) tissues decrease. Muscle tissue increased from 35.54±12.63 to a mean value of 39.95±17.96. HbA1c values improved from 5.90±0.63% to 5.30±0.30% in the first month after the intervention. The nutritional intervention was safe without significant deficits after 1 and 6 months. *Conclusions*. Metabolic surgery is associated with a weight loss of 10.8 to 12.6 kg and improved body composition. Patients require follow-up and further dietary counseling to sustain long-term results.

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Introduction

According to the International Classification of Diseases [1], obesity is a chronic, complex, and relapsing illness, but it is also a substantial risk factor in the development of other chronic pathologies (see: www.worldobesityday.org), such as diabetes, cardiovascular disease, and cancer [2]. Multiple factors can influence the weight gain (https://www.worldobesityday.org/assets/downloads/World_Obesity_Atlas_2022_WEB.pdf), including the socio-cultural and economic factors, exposure to an obesogenic environment (ultra-processed foods and advertising spots that promote their consumption), limited access to health services, and insurers' failure to cover dietetic and nutrition services [3]. Furthermore, genetic predisposition and certain medications can also contribute to weight gain. It is essential to address these various factors in order to effectively make prevention and manage obesity, as it affects not only an individual's physical health but also their mental well-being. Additionally, promoting education and awareness about healthy eating habits and regular physical activity can play a crucial role in combating the obesity epidemic. Estimations indicate that by 2035, one in four individuals worldwide will be obese, and the number of pediatric obesity cases will increase by 100 percent [4]. In 2019, 10.9% of people in Romania were obese, defined as having a body mass index (BMI) above 30 kg/m2 [5]. The treatment of obesity focuses on lifestyle modifications, physical exercise, pharmaceutical compounds, and surgical interventions [6]. Lifestyle changes, including a balanced and nutritious diet, can help manage weight and prevent obesity. Regular physical exercise not only aids in weight management but also improves overall cardiovascular health and metabolism. Additionally, drugs and surgical interventions may be considered for individuals

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with severe obesity or those without significant weight loss through lifestyle changes alone. The surgical treatment of obesity encompasses Longitudinal gastrostomy (LG), Roux-en-Y gastric bypass (RYGB), Single Anastomosis Duodeno-Ileal Bypass with Sleeve gastrostomy (DIB-SG), Biliopancreatic Diversion with Duodenal Switch (BD-DS), and Adjustable Gastric Band (AGB) [7-9].

The American Society for Metabolic and Bariatric Surgery (ASMBS) and the International Federation for the Surgery of Obesity and Metabolic Diseases (IFSO) suggest the following criteria for the indication of bariatric intervention: (a) For a BMI above 35 kg/m2, bariatric surgery is suggested regardless of the presence, absence, or severity of comorbidities; (b) For a BMI between 30 and 34.9 kg/m2, bariatric surgery should be considered for individuals with metabolic illnesses (such as type 2 diabetes) or for those who do not achieve significant or long-term weight loss with nonsurgical obesity therapy [10,11]. Metabolic and bariatric surgery has been shown to be more successful than diet, exercise, and other lifestyle therapies in attaining considerable and long-lasting weight loss as well as in ameliorating obesity-related health problems (such as hypertension and sleep apnea) and cancer risk [12-14]. It's important to understand that bariatric surgery is not a cure-all, but rather a tool to aid in achieving long-term weight loss and improving overall health outcomes. Additionally, patients must undergo thorough evaluation and counselling before considering bariatric surgery to ensure they understand the potential risks and benefits of the procedure. Depending on the precise technique performed, almost 60% of excess body weight may be lost [10]. Perioperative nutrition and follow-up dietary support ensure the success of the intervention by promoting healthy eating habits and providing ongoing guidance. This comprehensive approach helps patients maintain their weight loss in the long term and prevent potential complications. Regular monitoring of nutritional status and lifestyle modifications is also essential to optimizing the overall health outcomes of individuals who undergo bariatric surgery [12-14].

Our purpose was to assess the effects of metabolic surgery on clinical and biological parameters in a group of patients from the North-Eastern area of Romania. This prospective study also evaluated a tailored nutritional intervention protocol for this population.

Materials and Methods

Between January and December of 2021, a multidisciplinary medical team monitored the evolution of weight loss, body composition, lifestyle changes, and biochemical parameters in 50 Romanian adult patients. They presented consecutively in a specialized medical center in Iasi, in the North-Eastern region of Romania. Subjects received nutritional counselling about pre- and post-bariatric interventions. During each postoperative follow-up (1 and 6 months), anthropometric, blood pressure, and blood test data were gathered. The study respected the Declaration of Helsinki. The informed consent was signed before enrolling the patients.

Anthropometric and bioimpedance data

To evaluate the progression of weight loss, anthropometric data (height, weight, waist circumference, hip circumference) and body composition data (analyzed with Tanita DC-240 Total Body Composition Analyzer - adipose tissue, visceral tissue, muscle mass, total body water, bone mass, basal metabolic rate, metabolic age) were collected at each postoperative follow-up visit.

Dietary intervention

A certified dietitian created a post-bariatric regimen for every patient. This plan featured suggestions and sample menus for each week/phase [12].

Week 1.
• Participants were recommended a clear liquid diet (water, tea, clear soup, and fruit juice diluted with water).
Week 2.
• They began introducing thicker liquids (such as yogurt, milk, low-fat cottage cheese, cream soup, and broth-blended soup). • Vitamin and mineral complex, calcium citrate, and vitamin D supplements for those with deficit.
Week 3 and 4.
• Diet transitioned to blended and pureed foods (pureed chicken or turkey, fish, canned tuna fish in water, mashed baby food, mashed potatoes/sweet potatoes, porridge) and protein supplements to meet daily protein requirements. • Vitamin and mineral complex, calcium citrate, and vitamin D supplements were standard recommended.
Month 2 and 3.
• Transition to more robust diets (soft meat, fish, chicken, turkey, grains, cooked vegetables and fresh fruit).
Month 4.
• The participants were able to consume items with a regular consistency, and their individualized diet plans comprised of three balanced meals and one or two snacks.

Biochemical tests

In order to evaluate preoperative and postoperative evolution and potential nutritional deficiencies under the post-bariatric regimen, we collected the following blood tests at each follow-up visit: complete blood count (CBC), blood glucose, HbA1c, total cholesterol, HDL-cholesterol,

LDL-cholesterol, triglycerides, creatinine, alanine transaminase (ALT), aspartate aminotransferase (AST), total calcium, ionic calcium, magnesium, ferritin, sideremia, vitamin B12, folic acid, 25-hydroxy-vitamin D (25-OHD).

Statistical analysis

Data were collected from the electronic database of the nutrition clinic in Iasi, Romania, and analyzed using Excel and SPSS software v18. The results are presented as mean, standard deviation, or median (interquartile range) for non-normally distributed variables. Student t-test was used for group comparison. Hypothesis testing was 2-tailed. Statistical significance was defined in our study at p value<0.05.

Results

Our sample comprised 50 patients who presented for dietary counselling before and after bariatric procedures, of which 43 were female (86%), with longitudinal gastrectomy (LG) constituting the most prevalent intervention (Table 1). Individuals aged 19 to 64 were enrolled, with a BMI between 37.7 and 56.6 kg/m2 and an initial assessment weight between 89.8 and 175 kg.

Table 1. Descriptive data compared by type of intervention

Variables	Indicators	Type of intervention		Total study group (no= 50)	P value
		LG (no= 35)	RYGB (no= 15)		
Gender	Female Male	32 (91.4%) 3 (8.6%)	11 (73.3%) 4 (26.7%)	43 (86.0%) 7 (14.0%)	0.105
Age	mean ± SD median (IQR)	38.29 ± 11.31 38 (45)	36.33 ± 11.83 36 (35)	37.70 ± 11.38 37 (45)	0.583
Weight, kg	mean ± SD median (IQR)	115.41 ± 21.02 116 (92.2)	121.23 ± 20.69 121 (73.7)	117.16 ± 20.89 117 (92.2)	0.373
BMI, kg/m2	mean ± SD median (IQR)	42.91 ± 6.20 42 (21)	43.15 ± 6.13 43 (19.6)	42.98 ± 6.12 42 (21)	0.901
SBP, mmHg	mean ± SD median (IQR)	143.74 ± 21.03 144 (82)	134.80 ± 16.93 135 (60)	140.83 ± 20.05 141 (92)	0.159
DBP, mmHg	mean ± SD median (IQR)	85.45 ± 13.54 144 (82)	79.93 ± 9.20 135 (60)	83.65 ± 12.47 84 (56)	0.162
HbA1c, %	mean ± SD median (IQR)	5.68 ± 0,61 5.68 (2.8)	6.12 ± 0.94 6.12 (2.91)	5.81 ± 0.74 5.81 (3.4)	0.064

Legend: LG- longitudinal gastrectomy, RYGB- Roux-en-Y gastric bypass, BMI- body mass index, SBP-systolic blood pressure, DBP- diastolic blood pressure, SD-standard deviation, IQR- interquartile range.

Weight loss and body composition

One month following surgery, patients with LG lost an average of 12.6 kg (101.73±17.27 kg), and patients with RYGB lost 10.86 kg (108.47 ± 17.96 kg), with men losing more weight. At six months after surgery, the average weight reduction for LG was 30.19 kg (84.14±15.13 kg), and for RYGB was 35.96 kg (83.37±10.37 kg) (Table 2).

In the first six months following the intervention, body composition improved due to a decrease in the percentage of adipose tissue (mean value of 37.83±6.42 from 46.38±6.63; and an increase in the percentage of muscular tissue (mean value of 39.95±17.96 from 35.54±12.63).

Glycemic profile

The glycemic profile, as measured by the HbA1c value, also improved in individuals with glucose metabolism problems, achieving an average value of 5.30 ± 0.30 % one month after the intervention, compared to an average value of 5.90±0.60 % one month prior (Table 3).

Vitamin and mineral deficit

After surgery, under medical nutritional supervision and vitamin supplementation, patients significantly increased folate and 25-OHD values at 1- and 6-months follow-up. Sideremia also increased significantly at six months (Table 3).

Table 2. Post-intervention weight and body composition evolution

	Statistic data		Type of intervention		Total study group
			LG	RYGB	
Weight					
Initial weight	No Mean ± SD		35 114.33 ± 19.26	15 119.33 ± 20.83	50 115.41 ± 21.02
1 month	No Mean ± SD Weight loss, kg P		34 101.73 ± 17.27 12.60 0.001	12 108.47 ± 17.96 10.86 0.001	46 103.49 ± 17.51 11.92 0.001
6 months	No Mean ± SD Weight loss, kg P		18 84.14 ± 15.13 30.19 0.001	6 83.37 ± 10.37 35.96 0.001	24 83.95 ± 13.88 31.46 0.001
Weight loss, kg					
Initial weight	Male	No Mean ± SD	3 131.1 ± 22.74	4 135.12 ± 22.51	7 133.4 ± 21.98
	Female	No Mean ± SD	32 113.94 ± 21.08	11 116.39 ± 21.02	43 114.56 ± 20.84
1 month	Male	No Mean ± SD	3 116.56 ± 18.44	3 124.16 ± 18.73	6 120.36 ± 18.36
	Female	No Mean ± SD	31 100.29 ± 17.97	9 101.27 ± 17.93	40 100.51 ± 17.76
6 months	Male	No Mean ± SD	2 105.05 ± 14.24	1 98,1 ± 14.28	3 102.73 ± 14.28
	Female	No Mean ± SD	9 81.53 ± 14.24	4 82.35 ± 14.30	13 81.69 ± 13.98
Adipose tissue (%)					
Initial	No Mean ± SD		32 47.03 ± 5.97	15 44.99 ± 7.92	47 46.38 ± 6.63
1 month	No Mean ± SD Adipose tissue loss, % P		34 44.19 ± 6.34 2.84 0.001	12 42.21 ± 7.90 2.64 0.001	46 43.67 ± 6.75 2.69 0.001
6 months	No Mean ± SD Adipose tissue loss, % P		18 38.74 ± 6.15 8.29 0.001	6 35.08 ± 6.97 5.62 0.019	24 37.83 ± 6.42 5.90 0.002
Visceral fat tissue (%)					
Initial	No Mean ± SD		32 13.25 ± 4.98	15 14.73 ± 6.99	47 13.72 ± 5.67
1 month	No Mean ± SD Visceral tissue loss, % P		32 11.38 ± 4.52 1.80 0.001	13 12.54 ± 5.44 2.23 0.127	45 11.71 ± 4.77 1.93 0.001
6 months	No Mean ± SD Visceral tissue loss, % P		17 8.65 ± 4.83 4.35 0.001	5 8.00 ± 2.92 5.60 0.046	22 8.50 ± 4.42 4.64 0.001
Muscle tissue (%)					
Initial	No Mean ± SD		32 36.38 ± 13.96	15 33.50 ± 9.36	47 35.54 ± 12.63

1 month	No Mean ± SD Muscular tissue increase,% P	34 38.07 ± 14.61 1.30 0.007	12 33.52 ± 10.37 0.25 0.830	46 36.88 ± 13.67 1.02 0.029
6 months	No Mean ± SD Muscular tissue increase,% P	17 39.21 ± 17.90 6.09 0.001	5 42.48 ± 20.01 12.96 0.050	22 39.95 ± 17.96 7.56 0.001
Legend. LG- longitudinal gastrectomy, RYGB- Roux-en-Y gastric bypass, BMI- body mass index, SBP-systolic blood pressure, DBP- diastolic blood pressure, SD-standard deviation, IQR- interquartile range				

Table 3. Biological variables evolution in the whole sample (no=50)

Variable	Initial (no)	First month (no)	Sixth month (no)
Glucose	106.74 ± 3.12 (50)	92.54 ± 1.94 (43) p<0.001	85.64 ± 1.35 (22) p<0.001
HbA1c (%)	5.90 ± 0.63 (50)	5.30 ± 0.30 (9) p=0.003	-
Folate (ng/ml)	6.53 ± 2.77 (38)	8.61 ± 3.56 (33) p=0.002	9.12 ± 4.32 (21) p=0.001
Vitamin B12 (pg/ml)	363 ± 109 (36)	434 ± 199 (31) p=0.066	372 ± 135 (20) p=0.868
Ferritin (ng/ml)	84.02 ± 57.18 (43)	111.63 ± 84.01 (32) p=0.003	98.32 ± 68.63 (10) p=0.409
Sideremia (ug/dl)	71.80 ± 37.71 (29)	77.92 ± 32.49 (23) p=0.567	91.38 ± 31.60 (19) p=0.016
25-hydroxy-vitamin D (ng/ml)	18.60 ± 6.47 (36)	22.32 ± 7.35 (31) p=0.001	31.29 ± 8.16 (21) p=0.001
Legend. Normal values according to laboratory: sideremia 50-170 ug/dl; Ferritin 15-160 ng/ml; 25-OHD > 30 ng/ml; folate 3.1-20.5 ng/ml; vitamin B12 187-883 pg/ml			

Discussions

Bariatric or metabolic surgery is one of the most successful and long-lasting treatments for obesity and its associated complications. It involves surgically altering the digestive system to promote weight loss and improve overall health despite post-surgical complications [10-12]. Bariatric surgery is typically recommended for individuals with a body mass index (BMI) of 40 or higher or a BMI of 35–39.9 with obesity-related health conditions such as diabetes or high blood pressure. The three most common types of bariatric surgery are gastric bypass surgery, gastric sleeve surgery, and adjustable gastric banding. Each procedure has its own unique description and mechanism of action [15,16], and each patient demands a unique approach. Alongside surgical methods for obesity, it is widely recognized that treating and resolving underlying nutritional, psychological, and behavioural issues is vital for long-term success [17,18]. This comprehensive approach often includes a combination of dietary counselling, exercise programs, and therapy sessions to address the root causes of obesity. Additionally, ongoing support and monitoring are crucial to ensuring patients maintain their weight loss and adopt healthier lifestyles. By addressing both the physical and psychological aspects of obesity, healthcare professionals can provide patients with the best chance for sustained weight management and improved overall health [19-21].

This study aimed to investigate the efficacy of bariatric therapies on weight reduction, body composition, biochemical markers, and lifestyle modifications at one- and six-month postoperative follow-ups.

The average age of patients in this study was 37 years, the majority were women (43/50 subjects), and LG was the most commonly performed surgical procedure (35/50 subjects). Women and young age predominance was also observed in other populations [22]. In some registries, mean age and BMI were lower in women than in men [23]. Also, the age of persons who benefit from this sort of intervention is decreasing, which is concerning given the prevalence of childhood and teenage obesity and the danger of non-adherence to dietary and supplement recommendations.

During six months post-intervention follow-up, patients with RYGB lost significantly more weight (mean value of 35.96 kg) than those who underwent LG (30.19 kg). We also observed a higher decrease in the visceral fat percentage and an increase in the muscle mass percentage. Our study results were similar to those of Arterburn et al., meaning weight loss was superior among patients with gastric bypass compared to those who underwent gastric

sleeve [24]. Regarding body composition, fat mass (%) and BMI substantially decreased in the first 12 months in other prospective studies [25]. In several studies on patients treated by bariatric surgery, the mean decrease of fat mass was about -22.51 kg, [95% CI - 23.93, - 21.09] at six months, but with no indication of plateau at 12 months [26-28]. Some of our patients continued to lose weight at 12 months, including fat mass (data not shown), but few respected the medical visits.

Another feature is the increase in muscle tissue in our cohort. Vaurs et al. identified two phenotypes using dual-energy X-ray absorptiometry (DEXA) after metabolic surgery. One phenotype had severe muscle mass loss (more than 15%), and another one had an acceptable loss (below 15%) [29]. Few patients maintained their weight after the surgery [30-32]. Thus, we can interfere that our nutritional intervention prevents sarcopenia that was described before in studies with a similar design.

In our study, a registered dietician performed a nutritional evaluation during each postoperative checkup. Each patient received a personalized dietary and supplement recommendation for accelerated recovery, successful weight reduction, and the prevention of nutritional deficiencies. Nutritional deficits were detected in both LG and RYGB patients at baseline, particularly for 25-OHD. Micronutrient deficiencies were highly prevalent in obese subjects preparing for surgery: 25.4% had a severe 25-OH vitamin deficiency, 3.4% for folate, and 18.1% for vitamin B12 [33]. Screening for them is recommended [34,35]. To avoid deficiency [36], vitamin supplementation was started for some subjects at two weeks. Under nutritional intervention, the patients have increased the vitamin D, folate, and sideremia level. Otherwise, after surgery, one can expect an increase in the prevalence of anemia caused by iron or vitamin B12 deficits, folate deficiency in 9 to 39% percent of patients, or vitamin D deficiency in 10% [34]. Deficits in calcium, selenium, copper, and vitamin A were described [36], but we did not evaluate them in our study.

Regarding the glycemic profile, prediabetics' fasting blood glucose and HbA1c value improved one month after surgery. Also, none of the patients included in this study regained weight during follow-up. Together with biological profile improvement, this proves our intervention's effectiveness.

The post-bariatric regimen created by a registered dietitian included general recommendations and a personalized diet. The general recommendations focused on eating behavior: eating slowly, chewing food thoroughly, stopping to eat as soon as satiety is reached, avoiding drinking and eating at the same time (wait approximately 30 minutes after eating to resume fluid intake; also, liquids must be administered at room temperature), avoiding concentrated sweets, carbonated beverages, and high-saturated fats or having a meal in front of screens. Some of these general recommendations are evaluated using questionnaires identifying predictive weight loss factors [37,38].

In terms of daily calorie intake, each personalized dietary provided 400 kcal/day in the first week following surgery, gradually increasing to 600-800 kcal/day by weeks 3 and 4. Several months following surgery, patients were recommended to consume 1200 to 1500 kcal/day, and six months after surgery, most participants were able to consume approximately 1500 to 1700 kcal/day. Macronutrients intake was assessed and individualized based on sex, age, and weight: protein intake was 1.2 – 1.5 g/day/ideal body weight, carbohydrates intake was 50-130g/day, and lipids were 20-35% of the daily calorie intake. Other authors recommend 60 g protein per day and up to 1.5 g/kg ideal body weight per day [39]. An adequate protein intake from natural foods is difficult, but liquid protein supplements (30 g/d) can be used to achieve the requirements [40].

At one-month follow-up, we observed that most participants could consume approximately 100g of food per meal, regardless of the type of metabolic surgery chosen. Several months following surgery, patients were advised to consume 150-200g of food per meal and slowly increase fluid intake (>1.5 L/day). Each meal was well-balanced regarding nutrients, including protein, carbohydrates, fats, and fiber. Conditions like dizziness, fatigue, lack of attention, and hair loss have been observed in individuals who could not consume the appropriate amount of food and did not take vitamin and mineral supplements. Hair loss and poor wound healing have been described in other studies [40,41]. Some participants reported experiencing gastrointestinal symptoms such as nausea, vomiting, diarrhea, constipation, and abdominal pain. These symptoms appeared more frequently after meals that were either heavy in sugar or high in fat.

Our study observed patients' favorable clinical and biological evolution after metabolic surgery at six months follow-up. It is one of the few enrolled patients from North East Romania. Low patient adherence to the post-intervention assessment and monitoring program was one of the study's limitations; therefore, we were still determining the long-term effectiveness of bariatric surgery for glucose metabolism problems. The numerical difference between metabolic surgery groups was another one. Other variables like insulin resistance indicators and inflammatory markers could not be determined [42,43]. Calorie restriction, weight, and adipose tissue loss are associated with reduced inflammation grade and improved insulin sensitivity in other studies [43,44].

Conclusions

In conclusion, regardless of the type of metabolic surgery chosen, weight reduction was substantial - 10.8 kg for longitudinal gastrectomy and 12.6 kg for Roux-en-Y gastric bypass, with improved body composition. Despite low adherence to the post-intervention monitoring

program, patients improved their biological vitamin status under medical nutritional supervision. Consequently, comprehensive dietary counselling and follow-up are needed to meet long-term objectives and decrease the risk of nutritional deficits.

Compliance with ethical standards

Any aspect of the work covered in this manuscript has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript. Informed consent was obtained from all subjects involved in the study.

Conflict of interest disclosure

There are no known conflicts of interest in the publication of this article. The manuscript was read and approved by all authors.

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