



Original/*Obesidad*

Short-term changes in macronutrient intake in morbidly obese patients undergoing biliopancreatic diversion: a longitudinal study

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Abstract

Introduction: biliopancreatic diversion (BPD) has been shown to be one of the most effective techniques for losing weight, although nutritional education also might play an important role. Our aim was to determine the effect of the combination of a nutrition educational program (NEP) and BPD on changes in the intake of energy and macronutrients after the surgery.

Methodology: this longitudinal study included all patients eligible for BPD who filled in a dietary record. Two assessments were performed: six weeks before and twelve months after surgery. The nutrition educational program was given two weeks after surgery by a registered dietitian and a 3-day food record was collected for further analysis at both of the assessments.

Results: 68 patients were included. The percentage of excess weight loss was 60.76% (SD 14.50%). A year after the surgery there was a reduction of energy (-602.27 kcal [SD 930.19 kcal], $p < 0.001$), fat (-41.70 g [SD 77.87 g], $p < 0.001$), percentage of fat (-4.79% [SD 11.38%], $p = 0.001$), and an increase in the percentage of protein (+2.72% [SD 7.10%], $p = 0.002$). A lower consumption of fat, especially of polyunsaturated fatty acids, was observed in the patients that achieved the nutritional recommendations and in the super-obese patients.

Conclusion: The combination of NEP and BPD resulted in an improvement in the nutritional profile, with a reduction of fat and maintenance of the protein intake.

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Key words: *Dietary intervention. Nutrient intake. Bariatric surgery. Morbid obesity.*

CAMBIOS A CORTO PLAZO EN LA INGESTA DE MACRONUTRIENTES EN PACIENTES SOMETIDOS A DERIVACIÓN BILIOPANCREÁTICA: ESTUDIO LONGITUDINAL

Resumen

Introducción: la derivación biliopancreática (DBP) ha demostrado ser una de las técnicas más efectivas en la pérdida de peso, aunque la educación nutricional también puede jugar un papel importante. El objetivo del estudio fue determinar el efecto de la combinación de un programa de educación nutricional (PEN) y DBP en los cambios de ingesta energética y de macronutrientes después de la cirugía.

Métodos: estudio transversal que incluyó a todos los pacientes subsidiarios de DBP que cumplimentaron la encuesta dietética. Se realizaron dos valoraciones: seis semanas antes y doce meses después de la cirugía. El PEN fue impartido dos semanas después de la cirugía por una dietista-nutricionista. Fue recogida una encuesta dietética de tres días en ambas visitas para realizar el análisis nutricional de la ingesta.

Resultados: fueron incluidos 68 pacientes. El porcentaje de exceso de peso perdido fue de 60,76% (DE 14,50%). Un año después de la intervención se produjo una disminución de la ingesta calórica (-602,27 kcal [DE 930,19 kcal], $p < 0,001$), de grasa total (-41,70 g [DE 77,87 g], $p < 0,001$), de porcentaje de grasa (-4,79% [DE 11,38%], $p = 0,001$), y un incremento en el porcentaje de proteínas (+2,72% [DE 7,10%], $p = 0,002$). Se observó una menor ingesta de grasa, especialmente de ácidos grasos poliinsaturados, en aquellos pacientes que habían alcanzado las recomendaciones nutricionales planteadas en el PEN y en los super-obesos.

Conclusión: la combinación de PEN y DBP logró una mejora en el perfil nutricional de la dieta tras una reducción de la ingesta grasa y un mantenimiento de la ingesta proteica.

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Palabras clave: *Intervención dietética. Ingesta nutricional. Cirugía bariátrica. Obesidad mórbida.*

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Abbreviations

BMI: body mass index.
BPD: biliopancreatic diversion.
BS: bariatric surgery.
EWL: excess weight loss.
IBW: Ideal body weight.
MO: morbid obesity.
MUFA: monounsaturated fatty acids.
NEP: nutrition educational program.
OB: obese.
PUFA: polyunsaturated fatty acids.
RD: registered dietitian.
SD: standard deviation.
SENC: Spanish Society of Community Nutrition.
SFA: saturated fat acids.
SOB: super-obese.

Introduction

A sedentary lifestyle and an inadequate diet play an important role in the rising prevalence of obesity in Spain¹. Morbid obesity (MO), defined as body mass index (BMI) ≥ 40 kg/m², rose by 65.0% from 9.1% in 1993 to 15.0% in 2006 of the population of Spain².

The first step to losing weight is to make changes in diet and physical activity. Lifestyle changes are not always sufficiently long-lasting to result in an important amount of weight loss^{2,3}. When attempts to make these changes are ineffective, bariatric surgery (BS) appears to be the most long-lasting technique for obtaining major weight loss, which is both prolonged in duration and helps to control comorbidities associated with MO, including decreased mortality⁴. According to the Bariatric Surgery Clinical Practice Guidelines (2013), BS should be recommended when the body mass index (BMI) is ≤ 35 kg/m² and with associated comorbidities or BMI ≤ 40 kg/m² and for whom the surgery will not be an excessive risk⁵.

One of the BS procedures is biliopancreatic diversion (BPD), which consists of a modest gastric restriction in association with a biliopancreatic diversion. This surgery can involve a duodenal switch where a smaller gastric pouch is created with the preservation of the pylorus and a small portion of duodenum. The percentage of excess weight loss (%EWL) after these procedures can reach 75–80%⁶. Energy restriction is easily achieved at first in BPD due to a smaller stomach capacity and malabsorption. But BPD can have side effects such as an unbalanced diet and nutritional deficiencies, especially protein due to the fact that patients are not able to accomplish their daily intake of protein⁷. Protein intake recommendations in recent guidelines are 60 g/day and up to 1.5 g/kg of ideal body weight (IBW)⁵.

A multidisciplinary team with medical, surgical, psychiatric, and nutritional expertise is needed for the follow up of these patients. Registered dietitians (RDs)

should be involved in nutritional assessment and education after surgery. The objective of this education is to help the patients reach a suitable weight, improve their feeding (with a better energy and nutrient intake), increase their physical activity, and guide the patient towards achieving the objectives (such as a shopping lists, portion sizes, etc.). Some studies have highlighted the importance of a nutrition educational program (NEP) to improve the quality of the diet after BS and achieve an effective and maintained weight loss^{8,9}.

The aim of this study was to determine the effect of the combination of a NEP and BPD on changes in the intake of energy and macronutrients after the surgery.

Methods

A longitudinal study was conducted at the *Complejo Asistencial Universitario de León*, Spain, after approval by the Ethics and Clinical Research Committee of the hospital. All participants provided written informed consent. Patients were eligible to participate if they had previously received bariatric surgery and had completed two dietary records (before surgery and one year after the procedure). The sample size for the study was a convenience sample, determined by the number of candidates for bariatric surgery in the period of time selected (from October 2008 to January 2011).

The study visits included two assessments and one NEP. The first assessment was six weeks before surgery, when the subjects completed a 3-day food record, were weighed, and their height was measured. The second one was a year after the surgery when the subjects completed a 3-day food record and were weighed again. Two weeks after the surgery all the patients received NEP by the same RD. The nutritional program consisted of two phases, one individual and another one collective, and involved a relative of the patient. The first part of the program included individualized advice about the adequate selection of food, serving portions, physical activity, and other strategies (e.g., menus, shopping lists). Collective nutritional education was done in small groups (3 patients with 1 relative each) and focused on reinforcing the information provided in the first session, actively involving the relatives in the nutritional treatment, and addressing any queries.

Dietary assessment

The patients provided a prospective serial assessment of nutritional intake over 3 days, including one day at a weekend, and written food records at the baseline visit and a year after the surgery. The subjects were instructed by an RD to provide as much information on the food and drinks consumed as possible (e.g., volume, ingredients, type of oil, brand name, etc.). The records were reviewed by the RD and analyzed using

a computer-based data evaluation system with Diet-source 3.0[®] software (Novartis Consumer Health-Cath Soft, 1997–2003). The nutritional characteristics of the diet were compared with the recommendations of the Spanish Society of Community Nutrition (SENC). Patients were categorized based on the accomplishment of two daily protein intake goals: ≥ 60 g/day or ≥ 1.2 g/kg IBW/day^{5,7}. The body weight corresponding to BMI = 22.5 kg/m² was used to calculate IBW. Weight loss was calculated by the formula: percentage of excess weight loss = (weight loss/excess weight) \times 100, where excess weight = total preoperative weight – ideal weight.

Nutritional and dietetic recommendations

The nutritional and dietetic recommendations used in the NEP were those of the Spanish Society for the Study of Obesity (SEEDO) used on the Spanish population, which consist of recommendations on adequate protein and fat intake, and on the characteristics and stages of the diet, following the goals of the Mediterranean diet¹⁰.

Statistical analyses

A Shapiro-Wilk test was performed to check whether or not the quantitative data were normally distributed. The descriptive data presented are the mean and standard deviation (SD). The significance tests were two-sided, with the significance set at $p < 0.05$. Patients were divided by gender and classified by BMI as obese (OB) (BMI < 50 kg/m²), super-obese (SOB) (BMI ≥ 50 kg/m²), and by the percentage of excess weight loss (%EWL) after twelve months higher or lower than the mean. In order to identify the effect of the NEP, patients were divided into two groups depending on whether they attained the nutritional objective or not, which was defined as a protein intake higher than 60 g/day and 30–35% fat. Pearson's chi-square and the paired t-test for matched data were used to compare baseline characteristics and those a year after surgery, and the t-test for independent-sample was used to compare data regarding the nutritional objectives, gender, BMI, and %EWL.

Results

The study cohort was composed of 49 women and 19 men. Initially, 106 patients were invited to participate in the study and, although none refused to participate, only 68 filled in both dietary records. The participants were 44.89 (SD 9.58) years old. Body weight and BMI were markedly reduced 12 months after surgery compared to baseline (table I). A year after the surgery the %EWL was 60.76% (SD 14.50%). There were differences

in weight by gender before surgery ($p < 0.001$) and twelve months after surgery ($p = 0.002$), as seen in table I.

Dietary intake

Total daily caloric and macronutrients intake were markedly reduced 12 months after surgery compared to baseline (table I). The percentage of daily caloric intake coming from fat was lower, especially because of the decreased intake of polyunsaturated fat acids (PUFA) and saturated fatty acids (SFA), and the percentage of protein intake was higher a year after surgery (table I). No differences were found when comparing patients whose %EWL was either higher or lower than the mean (60.55%).

When compared with the recommendations of the Spanish Society of Community Nutrition (SENC), we observed that the percentage of patients attaining the recommendations did not differ between pre- and post-surgery, as shown in table II. The number of patients that achieved PUFA's recommendations was statistically significantly lower.

Effects of nutritional program

27.9% of patients that attended NEP achieved the nutritional objectives. Although it was not a statistically significant difference, energy intake was lower in patients who achieved the objectives ($p = 0.077$). There were differences in grams of fat ($p = 0.001$), percentage of fat intake ($p = 0.033$), grams of SFA ($p = 0.002$), percentage of SFA ($p = 0.006$), grams of PUFA ($p = 0.005$), percentage of PUFA ($p = 0.021$), grams of fiber per 1000 kcal ($p = 0.039$), and grams of ethanol ($p = 0.006$).

There were no differences in %EWL, BMI, and weight between patients who achieved the nutritional objectives, as shown in table I.

Dietary intake by gender

There were differences by gender before bariatric surgery in energy, grams of protein, fat, and MUFA, and after surgery in energy, grams of CHO, protein, fat, SFA, MUFA, and cholesterol (Table I). No differences were found in percentage of macronutrients and grams of protein (g/kg IBW) before and after surgery. There were no differences in %EWL, BMI, and weight between genders, as shown in table I.

Dietary intake by BMI higher or lower than 50 kg/m²

Before surgery, the proportion of SOB (≥ 50 kg/m²) was 26.5% ($n = 18$). There were differences be-

Table I
Evolution of weight, BMI, and dietary intake before and after BPD

	Effects of nutritional program [†]						Gender				BMI higher or lower than 50 kg/m ²					
	Global (all patients)		After surgery		Before surgery		After surgery		Before surgery		After surgery		Before surgery		After surgery	
	Before (n = 68)	After (n = 68)	Yes (n = 49)	No (n = 19)	Man (N = 19)	Woman (N = 49)	Man (N = 19)	Woman (N = 49)	Man (N = 19)	Woman (N = 49)	OB (n = 50)	SO (n = 18)	OB (n = 50)	SO (n = 18)	OB (n = 50)	SO (n = 18)
Weight (kg)	124.14 (17.68)	84.90 (13.71)	82.13 (13.47)	85.93 (13.80)	137.18 (14.30)*	119.08 (16.31)*	93.36 (13.19)*	81.72 (12.62)*	117.87 (15.03)*	141.55 (12.01)*	82.63 (12.23)*	91.42 (15.95)*				
BMI (kg/m ²)	47.25 (5.76)	32.29 (4.72)	32.25 (6.15)	32.31 (4.14)	46.64 (4.84)	47.48 (6.10)	31.53 (4.37)	32.58 (4.86)	44.50 (3.34)*	54.89 (3.82)*	31.22 (3.58)*	35.41 (6.18)*				
Energy (kcal)	2,289.04 (928.88)*	1,686.77 (459.72)*	1,563.91 (262.85)	1,734.41 (510.69)	2,653.27 (1,031.23)*	2,147.80 (855.98)*	2,020.72 (504.70)*	1,557.28 (371.78)*	2,145.64 (853.80)*	2,687.36 (1,034.84)*	1,737.35 (499.33)	1,546.28 (293.04)				
CHO (g)	226.05 (105.43)*	177.83 (49.15)*	175.55 (38.71)	178.71 (52.98)	250.15 (140.07)	216.70 (88.54)	199.06 (46.03)*	169.60 (48.27)*	214.97 (103.97)	256.83 (106.24)	179.30 (49.72)	173.73 (48.69)				
CHO (%)	41.12 (8.20)	42.99 (7.54)	44.58 (3.64)	42.37 (8.55)	39.11 (9.01)	41.90 (7.82)	40.74 (6.65)	43.86 (7.75)	41.12 (7.76)	41.11 (9.55)	42.38 (7.93)	44.67 (6.22)				
Protein (g)	99.51 (34.85)*	83.81 (21.86)*	85.98 (11.72)	82.96 (24.76)	115.74 (35.70)*	93.21 (32.75)*	98.74 (19.50)*	78.02 (20.05)*	95.10 (31.06)	111.74 (42.32)	84.80 (22.41)	81.06 (20.63)				
Protein (%)	18.94 (4.94)*	21.66 (5.25)*	22.16 (2.19)	21.47 (6.04)	19.47 (5.40)	18.73 (4.79)	22.89 (7.99)	21.18 (3.69)	19.02 (4.31)	18.72 (6.51)	21.62 (5.98)	21.78 (2.32)				
Protein (g/kg IBW/d)	1.68 (0.56)*	1.43 (0.37)*	1.51 (0.25)	1.39 (0.40)	1.75 (0.51)	1.66 (0.58)	1.50 (0.31)	1.40 (0.39)	1.60 (0.45)*	1.93 (0.74)*	1.43 (0.37)	1.41 (0.38)				
Total fat (g)	111.86 (75.58)*	70.15 (28.93)*	57.53 (8.36)*	75.05 (32.48)*	149.98 (109.95)*	97.08 (51.39)*	87.95 (38.43)*	63.25 (20.99)*	96.75 (45.96)*	153.82 (117.84)*	74.24 (32.14)*	58.81 (11.73)*				
Total fat (%)	40.18 (8.38)*	35.38 (8.61)*	33.05 (1.75)*	36.29 (9.96)*	42.37 (8.16)	39.33 (8.39)	36.89 (9.47)	34.80 (8.28)	40.20 (7.68)	40.11 (10.34)	36.08 (9.05)	33.44 (7.11)				
Cholesterol (mg)	482.66 (259.45)*	345.77 (186.04)*	341.25 (112.89)	347.52 (208.61)	564.62 (261.74)	450.88 (254.12)	469.71 (254.62)*	297.71 (124.74)*	447.72 (233.41)	579.71 (307.75)	361.78 (201.28)	301.29 (129.53)				
Fiber (g)	16.17 (6.87)	15.11 (5.71)	16.22 (4.76)	14.69 (6.03)	18.46 (7.69)	15.29 (6.39)	15.44 (4.74)	14.99 (6.08)	15.60 (6.12)	17.78 (8.61)	15.05 (5.51)	15.29 (6.40)				
Fiber (g/1000 kcal)	7.50 (2.85)*	9.08 (2.94)*	10.25 (2.23)*	8.62 (3.08)*	7.48 (2.96)	7.51 (2.84)	7.92 (2.48)	9.53 (3.01)	7.78 (2.95)	6.71 (2.44)	8.85 (2.89)	9.73 (3.08)				
Ethanol (g)	3.77 (9.78)	1.86 (5.47)	0.00 (0.00)*	2.58 (6.31)*	7.83 (16.64)	2.20 (4.53)	4.81 (9.08)	0.71 (2.45)	3.81 (10.83)	3.68 (6.20)	2.32 (6.27)	0.58 (1.47)				
SFA (g)	29.99 (17.47)*	17.47 (10.36)*	13.31 (1.94)*	19.08 (11.78)*	34.48 (17.01)	28.25 (17.51)	23.47 (14.35)*	15.14 (7.27)*	27.78 (15.50)	36.16 (21.34)	18.66 (11.67)*	14.17 (3.86)*				

Table I (cont.)
Evolution of weight, BMI, and dietary intake before and after BPD

Global (all patients)	Effects of nutritional program [†]						Gender				BMI higher or lower than 50 kg/m ²					
	After surgery			Before surgery			After surgery		Before surgery		After surgery		Before surgery		After surgery	
	Before (n = 68)	After (n = 68)	Yes (n = 49)	No (n = 19)	Man (N = 19)	Woman (N = 49)	Man (N = 19)	Woman (N = 49)	OB (n = 50)	SO (n = 18)	OB (n = 50)	SO (n = 18)	OB (n = 50)	SO (n = 18)	OB (n = 50)	SO (n = 18)
SFA (%)	11.19 (3.38)*	8.91 (3.02)*	7.76 (1.22)*	9.35 (3.39)*	11.17 (2.86)	11.20 (3.59)	9.90 (3.54)	8.53 (2.74)	11.08 (3.21)	11.49 (3.90)	9.09 (3.20)	11.49 (3.90)	11.49 (3.90)	9.09 (3.20)	11.49 (3.90)	8.40 (2.46)
MUFA (g)	44.03 (21.59)*	32.02 (13.19)*	28.73 (4.04)	33.30 (15.19)	53.16 (24.22)*	40.49 (19.62)*	41.15 (16.75)*	28.48 (9.59)*	41.46 (20.01)	51.17 (24.70)	33.40 (14.65)*	51.17 (24.70)	51.17 (24.70)	33.40 (14.65)*	51.17 (24.70)	28.18 (6.78)*
MUFA (%)	17.19 (3.71)	16.57 (4.27)	16.69 (1.76)	16.52 (4.93)	17.93 (4.17)	16.91 (3.52)	18.16 (3.86)	15.95 (4.30)	17.19 (3.87)	17.20 (3.35)	16.58 (4.57)	17.20 (3.35)	17.20 (3.35)	16.58 (4.57)	17.20 (3.35)	16.53 (3.44)
PUFA (g)	12.99 (9.64)*	7.34 (3.95)*	5.78 (1.79)*	7.94 (4.39)*	15.01 (7.30)	12.20 (10.37)	9.46 (4.80)	6.51 (3.27)	10.81 (6.20)*	19.04 (14.23)*	7.82 (4.41)*	19.04 (14.23)*	19.04 (14.23)*	7.82 (4.41)*	19.04 (14.23)*	5.98 (1.68)*
PUFA (%)	4.86 (2.34)*	3.87 (1.77)*	3.32 (0.69)*	4.09 (2.00)*	5.09 (2.14)	4.77 (2.43)	4.07 (1.16)	3.80 (1.96)	4.41 (2.10)*	5.83 (2.75)*	3.97 (1.93)	5.83 (2.75)*	5.83 (2.75)*	3.97 (1.93)	5.83 (2.75)*	3.58 (1.18)

BMI: body mass index; CHO: carbohydrates; IBW: ideal body weight; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; SFA: saturated fatty acids. †Patients who attained nutritional objectives; * p < 0.050.

tween OB and SOB patients before bariatric surgery in energy, grams of protein per kg of IBW, grams of fat, PUFA, and %PUFA; after surgery, differences were found in grams of fat, SFA, MUFA, and PUFA (Table I). There were no differences in %EWL.

Discussion

As expected, the results of this study show that there was a reduction of global oral intake, especially from fat, which can be explained by the effects of the surgery itself (lower stomach capacity, malabsorption and decrease in ghrelin)¹¹ and the NEP, which might be reflected in the modification of dietary habits and the culinary techniques used.

Bavaresco et al. have demonstrated a decrease in energy intake and macronutrients a year after surgery (Roux-en-Y) compared to the energy intake before surgery, being 1,034 kcal and 2,347 kcal respectively¹². The protein intake decreased as well, being 117.8 g before surgery and 46.6 g a year after, which is remarkably lower than the recommendations of 60 g/day⁵. Correia Horvath et al. evaluated the intake in obese patients before surgery obtaining a protein intake similar to our study, being theirs 114.0 g of protein before the intervention¹³. McGrice et al. also showed that in gastric banding patients, energy, protein, and fat intake were reduced a year after surgery¹⁴. Our results differ from those of other studies, mainly because the surgical procedure and the nutritional and dietetic recommendations were different; overall, the studies show that energy and macronutrient intakes were reduced, but in our study an adequate protein intake was maintained. To date, we have not found studies in the literature that relate the effect of NEP to BPD and that compare the nutritional characteristics of oral intake before and after surgery, which is one of the strengths of this study.

Although the NEP was the same for the 68 patients included in the study, just 19 (27.9%) achieved the nutritional objectives, as shown by the results. This program could be the key to decreasing fat intake, but not the determinant of increased %EWL. Johnson Stoklossa et al. have highlighted the importance of a correct adherence to nutritional recommendations in order to succeed with a higher %EWL after BPD¹⁵. Ruiz Tovar et al. achieved a 64% of an average adherence to Mediterranean Diet after Laparoscopic Sleeve Gastrectomy¹⁶, but, to our knowledge, there are no references to the percentage of patients BPD operated who achieved the nutritional objectives in the literature.

An adequate amount of ingested fat should be one of the goals of nutritional education, as it is crucial both to preventing steatorrhea and attaining a higher weight loss. When evaluating the food records we found that what participants ate was not always clearly outlined (details of recipes, culinary technique, snacking, etc.), which might compromise the accuracy of the evaluation.

Table II
Comparative intake pre- and post-surgery according to total caloric intake (TCI) recommendations (Spanish Society of Community Nutrition)

	REC	Pre-surgery			Post-surgery			P
		According to REC	Under REC	Over REC	According to REC	Under REC	Over REC	
CHO (%)	50-55% TCI	14.7%	82.4%	2.9%	7.4%	89.7%	2.9%	0.664
Protein (%)	15-20% TCI	58.8%	13.2%	27.9%	36.8%	1.5%	61.8%	0.100
FAT (%)	30-35% TCI	20.6%	8.8%	70.6%	29.4%	20.6%	50.0%	0.627
SFA (%)	7-8% TCI	2.9%	13.2%	83.8%	19.1%	26.5%	54.4%	0.265
MUFA (%)	15-20% TCI	51.5%	26.5%	22.1%	51.5%	29.4%	19.1%	0.736
PUFA (%)	5-6% TCI	8.8%	64.7%	26.5%	8.8%	86.8%	4.4%	0.002
Cholesterol (mg)	< 300 mg	23.5%	–	76.5%	41.2%	–	58.8%	0.412
Fiber (g)	≥ 14 g/1,000 kcal	1.5%	98.5%	–	5.9%	94.1%	–	0.810

TCI: total caloric intake; REC: recommendations; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; SFA: saturated fatty acids.

tion of the dietary record. It also should be pointed out that food records in obese populations have their own limitations, as it has been shown that this population underestimates their overall intake and does not disclose all the food eaten throughout the day¹⁷.

Steatorrhea is a common outcome of BPD when there is a higher intake of fat. As it triggers an uncomfortable situation, most patients might decrease the overall intake of fat to avoid it¹⁸. Nevertheless, there must be a correct intake of fat to guarantee the correct absorption of fat-soluble vitamins and essential fatty acids, which is one of the reasons why nutritional education by an RD is essential for attaining the nutritional and weight loss objectives of the bariatric surgery program. Fat intake was significantly reduced in our patients, mostly at the expense of PUFA and SFA. The Spanish Government's Department of Agriculture, Food, and the Environment has stated that in 2013 the consumption of vegetable oils in Spain was 12.9 liters per capita, of which 70.0% was olive oil while 26.9% was sunflower oil, among others. Sunflower oil is consumed more in the area of the study than in the rest of the country¹⁹. This vegetable oil is usually used to fry food, especially ready-to-eat food, while olive oil is reserved for the rest of the culinary preparations (salads, baking, boiling, searing, grilling). In 2011, the Central Markets Suppliers of Spain (MERCASA) showed that the consumption of processed meat is common in our country and that it represented 12.2 kg per capita²⁰. Sunflower oil is rich in PUFA and ready-to-eat food and fatty meats are rich in SFA, which might explain the decrease observed in overall fat, PUFA, and SFA, as the use of fried food, meat, and processed meat decreased.

The percentage of patients that achieved the SENC recommendations did not change pre- and post-surgery, which might be explained by the difficulty in making

lifestyle changes^{21,22}, but the work of the RD appears to be reflected in the reduction of fat after surgery while the levels of protein were maintained throughout the diet. These differences were also observed when the results were analyzed by gender, with fat intake being higher in men, as it was originally before surgery.

One enlightening aspect of this was that although the surgical technique and NEP were the same between both groups, the SOB achieved the objective of reducing fat intake better than the OB, although that was not reflected in %EWL. Even though we did not find any evidence in the literature, we can assume that the involvement of SOB participants in the NEP is better than OB participants.

In their meta-analysis and systematic review, Buchwald et al. showed that in the literature the percentage of %EWL and BPD was –70.12% (–73.91 to –66.34%)²³. Our results are out of this range, but it should be noticed that the %EWL in our study is in the first year and the meta-analysis is in the second one. The initial body weight and BMI might play an important role in the %EWL obtained after the surgery, although we did not find any differences between OB and SOB.

We acknowledge this study has some limitations. First of all, it was not possible to recruit all the potential patients, because some had not completed the dietary record. The second limitation is that we used a 3-day dietary record rather than a 7-day food record to estimate more accurately the amount of nutrient intake. A 7-day food record could have provided a more representative estimate of oral intake, although it is also necessary to train the patient and emphasize the importance of capturing every food item and recipe in as much detail as possible. The third limitation is that we did not include a control group to identify the differences in the particular effect of NEP. This was

because it is not possible to deny nutritional treatment to patients after bariatric surgery. Finally, this was a quantitative study of the nutritional characteristics of the diet, and was not about the qualitative characteristics of the diet. It is recommended that to strengthen the results further studies include these aspects in a food-frequency questionnaire.

In conclusion, the combination of BPD and NEP results in an improvement in the nutritional characteristics of the diet, with a reduction of fat and the maintenance of protein intake, which could reflect a modification of dietary habits, especially in SOB participants.

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Conflict of interest disclosure statement

The authors have no competing financial interests in relation to the work described herein.

Statement of human and animal rights

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee, and with the 1964 Helsinki Declaration and its later amendments or with comparable ethical standards.

Informed consent was obtained individually from all participants included in the study.

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