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Protein malnutrition incidence comparison after gastric bypass *versus* biliopancreatic diversion

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Abstract

Background: **bariatric surgery is widely employed nowadays. Nutritional complications following malabsorptive bariatric surgery are common.**

Objectives: **to compare protein malnutrition incidence, the amount of protein intake and the influence of various risk factors in patients undergoing Roux-en-Y gastric bypass (RYGB) and biliopancreatic diversion (BPD).**

Methods: **retrospective study comparing the development of hypoalbuminemia in 92 patients undergoing BPD and 121 RYGB, before surgery and 3, 6, 12, 18 and 24 months after it. Protein intake was estimated by serum prealbumin. The influence of prior body mass index (BMI), age and sex was analyzed.**

Results: **hypoprealbuminemia was found in around 40% of patients 3 months after both procedures, decreasing to about 10% after 2 years of surgery. Hypoalbuminemia incidence was close to 20% in the first post-surgery year in BPD, persisting in 10-15% of cases thereafter. After RYGB, hypoalbuminemia incidence was lower (5-9% in all postoperative follow-up measurements). During the first year after surgery, hypoalbuminemia was more frequent after BPD than after RYGB (at the 3rd month (OR:3.9; p=0.006; 95%CI:1.5-10.4), 6th (OR:5.0; p=0.002; 95% CI:1.8-13.8), and at the 12th month (OR:4.4;p=0.007;95%;CI:1.5-12.8)), but not after the first year. A higher preoperative BMI favored it (OR: 1.03; p=0.046; 95% CI:1-1.06), as well as greater age during the first 6 months.**

Conclusion: **Patients with BPD had a higher risk for hypoproteinemia than those undergoing RYGB, especially during the first year post-surgery. Higher preoperati-**

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COMPARACIÓN DE LA INCIDENCIA DE MALNUTRICIÓN PROTEICA TRAS BYPASS GÁSTRICO *VERSUS* DERIVACIÓN BILIOPANCREÁTICA

Resumen

Introducción: **la cirugía bariátrica es muy empleada actualmente y en las malabsortivas, las complicaciones nutricionales son habituales.**

Objetivos: **comparar la incidencia de malnutrición proteica e ingesta estimada de proteínas en pacientes intervenidos de bypass gástrico en Y-de-Roux (BGYR) y derivación biliopancreática (DBP), y la influencia de algunos factores de riesgo.**

Métodos: **estudio restrospectivo comparando el desarrollo de hipoalbuminemia en 92 pacientes intervenidos mediante DBP y 121 de DBP (prequirúrgico, a los 3, 6, 12, 18 y 24 meses postquirúrgicos). La ingesta proteica se estimó mediante prealbúmina. Se evaluó la influencia del índice de masa corporal (IMC) previo, la edad y el sexo.**

Resultados: **se encontró hipoprealbuminemia en torno al 40% de los pacientes a los 3 meses tras ambas técnicas, disminuyendo hasta el 10% a los dos años. La incidencia de hipoalbuminemia fue cercana al 20% durante el primer año tras DBP, persistiendo posteriormente en un 10-15% de los casos. Tras el BGYR, dicha incidencia fue menor (5-9% en todos los momentos). Así, durante el primer año postquirúrgico la hipoalbuminemia fue más frecuente tras DBP [3 meses: (OR:3,9;p=0,006; 95%CI:1,5-10,4), 6 meses (OR:5,0; p=0,002; 95% CI:1,8-13,8), y al año (OR:4,4;p=0,007;95%;CI:1,5-12,8)], pero no así después. Un mayor IMC prequirúrgico favoreció la incidencia de hipoalbuminemia (OR:1,03; p=0,046; 95% CI:1-1,06), así como una mayor edad a los 6 meses postquiúrgicos.**

Conclusión: **los pacientes intervenidos mediante DBP tuvieron mayor riesgo de presentar hipoproteinemia que tras BGYR, especialmente durante el primer año postquirúrgico. Un mayor IMC postquirúrgico y la edad**

ve BMI, and age (in the short-term period) could have a significant inverse relation to hypoproteinemia.

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Key words: *Obesity. Bariatric surgery. Protein malnutrition. Prealbumin. Serum albumin.*

(a los 6 meses) podrían favorecer la aparición de hipoproteinemia.

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Palabras clave: *Obesidad. Cirugía bariátrica. Malnutrición proteica. Prealbúmina. Albúmina sérica.*

Abbreviations

RYGB: Roux-en-Y gastric bypass.
BPD: biliopancreatic diversion.
BMI: body mass index.
OR: odd ratio.
EWL: excess weight lost.
EBMIL: excess BMI lost.
%EWL: percentag of excess weight lost.
%EBMIL: percentage of excess BMI lost.

Introduction

Very commonly, lifestyle modifications and medical treatment fail to achieve significant weight loss in the follow up of obese patients. This leads to bariatric surgery being widely employed nowadays, remaining the most effective treatment option for a sustained weight loss over time, especially in patients with morbid obesity. The surgical techniques most commonly used in morbid obese patients are gastric bypass with Roux-en-Y anastomosis (RYGB), which has a higher restrictive component and is partially malabsorptive, and biliopancreatic diversion (BPD), primarily malabsorptive in all of its forms. One procedure or another is performed depending on the severity of the patient's obesity or the surgeon´s experience with each procedure[1,2].

Obese patients have a high risk of hypoproteinemia before surgery, as they may have comorbidities that favor it[3-5]. The surgery itself causes an increase in organic stress, protein needs, along with an anorexic state in the immediate postoperative period, and can trigger possible infectious or mechanical complications that can appear after the intervention. In the mixed bariatric techniques, gastrectomy (more importantly in RYGB) and intestinal malabsorption (higher in BPD) mechanisms are combined.

Gastrectomy causes early satiety which limits intakes[6], especially of proteins (with greater satiating power), mostly in the short and medium term. The effect of intestinal malabsorption on protein balance can be long lasting, caused by a very short alimentary limb added to a fast intestinal transit[2,7]. In BPD it appears that endogenous nitrogen loss by the lack of enteric enzymes or by the presence of bacterial overgrowth may be greater than the apparent protein loss by malabsorption alone[8]. In any case, moderate to severe protein malnutrition is rare after any of these techniques, usually disappearing when protein intake increases due to a better protein tolerance over time. In addition, no relevant differences in protein malnutrition have been observed in the few studies that compare both surgical procedures[8-15].

In the study of Rinaldi *et al*., a correlation between prealbumin and protein intake in these patients was observed. Although more studies are needed in this regard, such contributions could be a good marker of protein intake[3]. Few studies have assessed the determination of prealbumin after bariatric mixed techniques, mainly finding deficiencies during the first year after both RYGB[12,13,16] and BPD[13].

Most of the studies published to date provide protein malnutrition data after performing a particular surgical procedure, but few compare its incidence after the two most common procedures (classical RYGB and BPD)[10,11]. The purpose of this study is to estimate and compare protein malnutrition incidence after each technique (Larrad BPD was used)[15], and to analyse how some preoperative factors influence its appearance. This study is the first to estimate and compare protein malnutrition incidence after RYGB and Larrad BPD, and how several preoperative factors influence its appearance.

Materials and methods

Comparative study of two retrospective clinical nonconcurrent cohorts in which the occurrence of protein deficiencies in 92 patients operated by classic RYGB (from 2002 onwards), and 121 operated by BPD with the Larrad modified technique (up to 2004), was assessed. This variation in surgical procedure performed was due to the change in the team of surgeons practising in the hospital.

The Larrad variant consists of a surgical subcardial gastrectomy (about 4/5), and an intestinal bypass that lengthens the alimentary canal (by > 300 cm), preserving most of the jejunum and ileum, and shortens the biliopancreatic limb (by 50 cm), while the common channel maintains the same length as the classical Scopinaro technique (14). In RYGB, however, a gastrectomy is performed with a gastric pouch of 15ml capacity separated from the rest of the stomach, and the jejunum anastomosed using a Roux-en-Y assembly. The biliopancreatic limb measures 50-150 cm, the alimentary limb 50-250 cm, while the common channel measures between 150 and 250 cm, depending on the degree of pre-obesity.

Patients were excluded if they had coexisting pathology that could alter the nutritional parameters (moderate to severe renal or hepatic failure, intestinal maldigestion or malabsorption unrelated to surgery, or serious postoperative complications) and those who did not attend periodical medical reviews.

The preoperative characteristics are shown in table I. In addition to preoperative data, 3, 6, 12, 18 and 24 months post-surgery anthropometric data were collected. Plasma albumin was measured during the consultations, as an indicator of protein malnutrition. The latter was classified according to albumin levels (g/dl) in: mild (2,8-3,5); moderate (2,1-2,79); and severe (<2,1) malnutrition. Protein intake was also studied by measuring serum prealbumin at each postoperative visit (deficiency if levels <16,7 mg/dl).

The amount of protein intake after each type of surgery is also estimated by measuring serum prealbumin levels, seeking to provide information that may help to clarify the frequency of this nutritional complication, thus helping to prevent it if necessary.

We evaluated the possible influence of prior body mass index (BMI), age and sex in the evolution of these protein parameters. All patients included in this study were instructed to follow a progressive phased diet in addition to a hyperproteic nutritional supplements intake that provided 15 to 30 g/protein/ day and 400 kcal/day for approximately the first three months. Furthermore, a multivitamin complement and calcium and vitamin D (1000 mg and 800 IU/day respectively) was given postoperatively.

Statistical analysis

Qualitative parameters were summarized by their frequency distribution and quantitative parameters by their mean and standard deviation (m ± SD). The last observation carried forward (LOCF) method was used to impute missing post-baseline data.

According to the basal characteristics in case of qualitative measurements, comparison was evaluated by the X^2 test, or by Fisher's exact test if more than 25% of the expected values were less than five. For comparisons between the two groups, the t-student test for quantitative variables was used. We conducted analysis of variance for repeated measures (ANOVA) to compare the evolution of anthropometric variables between the two study groups in relation to time (interaction effect between group and time). The cumulative incidences and their 95% confidence intervals were calculated at each post-surgery evaluation. A multiple logistic regression model evaluated the influence of prior BMI, age and sex in the incidence of hypoalbuminemia at each post-surgery period adjusted for baseline albumin levels. All the results of the regression models were presented using the odds ratio (OR) and its 95% confidence intervals. The null hypothesis was rejected by a type I error <0,05 (α <0,05). Statistical analyses were performed using SPSS 15.0 (SPSS Inc., Chicago, Illinois, USA).

Table I
Preoperative patient characteristics

	GB	*BPD*	*p*
Nº of patients	92 (43.2%)	121 (56.8%)	
Sex (Women)	68 (73.9%)	90 (74.4%)	0.531
Weight (kg)*	139.1 (20.6)	144.6 (26.7)	0.102
BMI (kg/m^2)*	51.4 (6.5)	54.5 (8.9)	0.005
Albumin (g/dl)*	3.8 (0.3)	4.0 (0.5)	<0.005
Age*	39.1 (8.1)	38.9 (9.7)	0.867

* Mean and standard deviation

Results

The number of subjects on whom data have been obtained on the variables of interest at each follow-up (baseline, 3 months, 12 months, 18 months and 2 years) was 86, 81, 81, 70 and 58 in the RYGB procedure group, while in the Larrad group it was 102, 105, 111, 100 and 106. The percentage of patients loss at each follow up was compared between the two groups without finding statistically significant differences, except at the 2-year follow-up (p <0,001).

Weight loss

Weight loss results are presented in table II. Weight loss is similar at 24-month follow-up of both procedures (p = 0,105). There was a significant reduction of BMI in patients undergoing BPD (p = 0,037).

No differences were found in the percentage of excess weight lost (% EWL) between both groups (p=0,649), so that after RYGB there was a 61,4 ± 20,9% loss after two years, whereas after BPD there was a 62,6 ± 17% (p = 0,649). Also, there were no differences in the percentage of excess BMI lost (%EBMIL) (p = 0,285), so that after RYGB it decreased in 70,8 ± 17,9% and 67,6 ± 18,5% after BPD.

Prealbumin

Serum prealbumin was measured in 84 patients that underwent RYGB and 106 that underwent BPD. There was no difference between the two procedures in the levels of this parameter at any time after surgery. The prealbumin deficiency incidence was 40% in both groups at 3 months post-surgery, having a similar evolution in the following months, and falling progressively, reaching around a 10% decrease two years after both surgical procedures (Fig. 1).

Table II
Anthropometric changes after both bariatric procedures.

		GB			BPD			p
		n	Mean	SD	n	Mean	SD	
Initial data	Weight	92	139.1	20.59	121	144.63	26.68	
	BMI	92	51.4	6.51	121	54.51	8.90	
3 Months	Weight	92	118.2	19.64	121	120.77	22.55	
	BMI	92	43.8	7.10	121	45.49	7.31	
	%EWL	92	27.0	14.18	120	28.61	10.39	
	%EBMIL	82	33.3	12.73	120	31.37	11.05	
6 Months	Weight	92	103.9	20.05	121	105.16	21.17	
	BMI	92	38.5	7.16	121	39.65	7.32	
	%EWL	92	45.7	18.73	120	48.48	13.34	
	%EBMIL	82	55.3	14.24	120	52.40	14.73	
12 Months	Weight	92	93.9	19.38	121	95.84	19.00	
	BMI	92	34.8	7.09	121	36.09	6.29	
	%EWL	92	58.3	21.65	120	58.61	14.81	
	%EBMIL	82	69.2	15.40	120	63.38	16.35	
18 Months	Weight	92	92.3	20.26	121	92.68	18.14	
	BMI	92	34.2	7.34	121	34.95	6.21	
	%EWL	92	60.5	22.63	120	61.85	16.07	
	%EBMIL	82	71.2	17.72	120	66.87	17.68	
24 Months	Weight	92	91.9	20.32	121	91.49	17.08	0.105*
	BMI	92	34.0	7.12	121	34.49	5.71	0.037*
	%EWL	92	61.4	20.87	120	62.58	17.00	0.649*
	%EBMIL	82	70.8	17.88	120	67.60	18.52	0.285*

* p value of anthropometric data evolution during the 24 months of follow up.

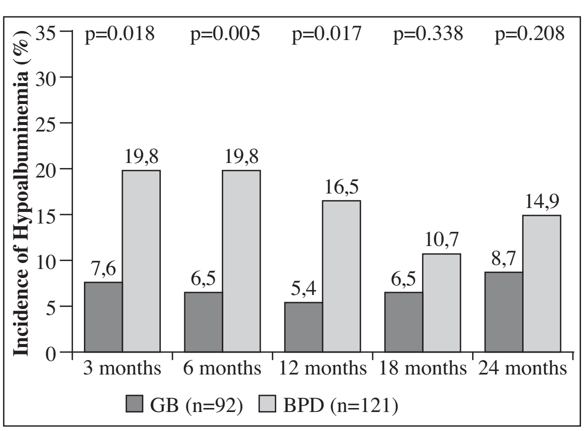

Fig. 1.—Incidence of hypoalbuminemia in the 24-month follow up period after surgery.

Albumin

Although the average serum albumin levels were within the normal range before performing both procedures, as described in table I, they were significantly greater in patients assigned to undergo BPD. However, the incidence of hypoalbuminemia was significantly higher during the first BPD postoperative year, being close to 20%, whereas after RYGB the incidence was <8%. The incidence of hypoalbuminemia decreased during the second year after BPD (Fig. 2), with no differences between groups in this period after adjusting for BMI, age and sex (Table III).

There were no cases of severe hypoalbuminemia after performing either of the surgical techniques. There were only two isolated cases of moderate hypoalbuminemia

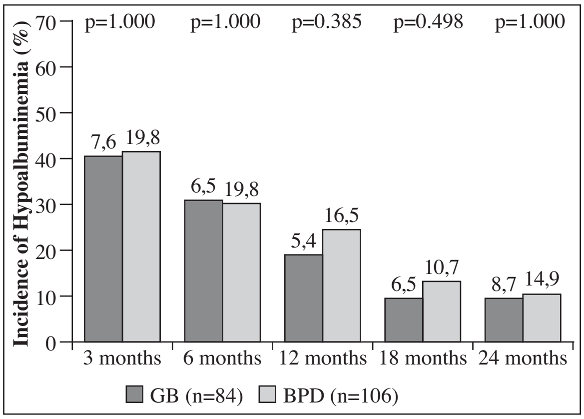

Fig. 2.—Incidence of hypoprealbuminemia in the 24-month follow up period after surgery.

after RYGB at 6 months post-surgery, becoming normal after adequate protein intake and no longer appearing at 12 months post-surgery. However, after the completion of BPD, 5 patients had moderate hypoalbuminemia during the first year after surgery. Only one patient remained hypoalbuminemic during the second year.

Table III shows the effects of sex, age and preoperative BMI on the incidence of hypoalbuminemia in the different periods evaluated. Increasing age has a statistically significant correlation with the probability of hypoalbuminemia at 3 and 6 months post-surgery. Gender showed no difference in any of the evaluated periods. We found a significant association between preoperative BMI and the likelihood of malnutrition two years after surgery, so that for every kg/m^2 there was a 6% increased risk of developing hypoalbuminemia.

Discussion

Bariatric surgery, with a restrictive and a malabsorptive component (both BPD as RYGB) has demonstrated significant weight loss in obese patients that persists over time[17]. Generally, malabsorptive techniques achieve greater weight loss[15,18,19,20]. In fact, in the only prospective study comparing gastric bypass and BPD, conducted in patients with BMI between 35 and 50 kg/m^2, EWL was significantly greater after BPD, both after one year (EWL 73,7% after RYGB, and 83,1% after BPD) and after two years (72,6% after RYGB, and 83,1% after BPD[11]. Larrad modified BPD has shown similar results, with 69% EWL, which stabilizes at 18-24 months after surgery. The EWL reaches 80% in the morbidly obese and 62% in the super obese up to 5 years[15,19], similar to that obtained in our study (also super obese patients with average preoperative BMI> 50 kg/m^2).

In our study, however, no significant differences were found between both groups regarding EWL and EBMIL, probably because the patients that underwent BPD started from a higher weight and BMI (5,5 kg, not significant, and 4,1 kg/m^2 with p<0,005, respectively), and when applying the formula in percentage, patients with more room for improvement obtain lower percentages. As for BMI, the total decline over two years is greater after the Larrad technique, partly because preoperative BMI was significantly higher in these patients.

One of the possible nutritional complications of these surgical techniques is the appearance of protein malnutrition. A mild hypoalbuminemia can often occur after RYGB in the short term and even before surgery[21,22], but it is rare for moderate to severe hypoalbuminemia to appear after this procedure, even in the short or medium term[9,14,23]. In the various series of BPD clinically significant postoperative hypoalbuminemias are not usually observed[8,13,20]. Other studies following the Larrad technique in the short to medium term, showed that one-quarter of patients had isolated episodes of hypoalbuminemia in the first year, whereas there was only one case of severe hypoalbuminemia that required parenteral nutri-

Table III
Multivariate logistic regression models for hypoalbuminemia malnutrition, adjusted for baseline albumin levels

	Prior BMI		*Female sex*		*Age*		*Larrad*	
	OR	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*
3 months	1.04 (0.99-10.96)	0.091	1.14 (0.40-3.3)	0.806	1.06 (1.01-1.11)	0.029	3.94 (1.50-10.41)	0.006
6 months	1.02 (0.98-1.07)	0.337	0.52 (0.20-1.34)	0.173	1.05 (1.00-1.11)	0.045	4.98 (1.80-13.81)	0.002
12 months	1.01 (0.96-1.06)	0.706	0.99 (0.35-2.79)	0.985	0.99 (0.95-1.04)	0.886	4.40 (1.50-12.84)	0.007
18 months	0.99 (0.93-1.05)	0.759	1.30 (0.40-4.26)	0.659	0.98 (0.93-1.03)	0.417	2.16 (0.74-6.28)	0.158
24 months	1.06 (1.01-1.11)	0.018	0.99 (0.37-2.66)	0.994	1.00 (0.96-1.05)	0.839	1.33 (0.51-3.50)	0.558

OR: odds ratio.

tion in a patient previously diagnosed with anorexia nervosa[19]. Also, no significant differences were found in the few studies comparing BPD with RYGB[10,11,12]. Our study showed similar results to those reported in the literature, with no cases of severe hypoalbuminemia, and some isolated moderate ones which did not require specific treatment. Our findings of mild protein malnutrition are also within the ranges described in the literature[8-15,19,23].

Post surgical low protein intake is the most common cause of protein malnutrition in these patients. Rinaldi *et al*. observed that in patients undergoing RYGB, for every 0,5 g of protein intake/kg ideal body weight/day, there was a statistically significant increase of 2,34 mg/dl of plasma prealbumin (this being therefore a good indicator of protein intake) and an increase of 0,11 g/dl of serum albumin[3]. In our sample of patients, there was a hypoprealbuminemia rate of about 40% 3 months after the surgery in both groups, reflecting a low protein intake in these patients, which decreased progressively to about 10% after 18 months as food tolerance, and therefore protein intake, improved. Often, the protein intake of these patients is not enough during the first year[9,12,13,24], even after providing recommendations for an intake of at least 60 g/day and high protein supplements for the first 3 months, as done in this study[25].

Since hypoprealbuminemia incidence and evolution were similar between the two procedures, we cannot justify this cause as an explanation of the differences seen in protein malnutrition during the first year. In addition, preoperative mean plasma albumin was higher in the BPD intervention group, leading us to believe that the reason for the differences found lies between surgery and the early postoperative period. In this sense, early complications are not registered in this study, although a higher incidence, as well as a higher average hospitalization in patients undergoing BPD compared to RYGB has been described previously[26,27]. This usually causes an increase in protein catabolism, which may be an explanation for the results obtained.

In our study, older patients were more likely to develop protein malnutrition within the first 6 months, although there were no differences in patient age between groups. Still, this point should be considered when assessing whether age is really a risk factor for the development of this nutritional complication, as shown in a previous study[28].

Conclusions

Protein malnutrition has a significant effect on these patients, especially in the short term after the completion of BPD (in our case by the Larrad modified technique), so it should be prevented based on strict nutritional recommendations. Prealbumin and albumin levels can be very informative in this regard, so it would be advisable to measure them, especially during the first year after surgery.

References

1. Mechanick JI, Kushner RF, Sugerman HJ, *et al*. American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. Obesity 2009;17:S1-70.
2. Miller MR, Choban PS. Surgical management of obesity: current state of procedure evolution and strategies to optimize outcomes. Nutr Clin Pract 2011;26:526-533.
3. Rinaldi SE, Pettine SM, Adams E, Harris M. Impact of varying levels of protein intake on protein status indicators after gastric bypass in patients with multiple complications requiring nutritional support. Obes Surg 2006;16:24-30.
4. Moize V, Deulofeu R, Torres F, de Osaba JM, Vidal J. Nutritional Intake and Prevalence of Nutritional Deficiencies Prior to Surgery in a Spanish Morbidly Obese Population. Obes Surg 2011;21:1382-8.
5. Ernst B, Thurnheer M, Schmid SM, Schultes B. Evidence for the necessity to systematically assess micronutrient status prior to bariatric surgery. Obes Surg 2009;19:66-73.
6. Amaya García MJ, Vilchez López FJ, Campos Martín C, Sánchez Vera P, Pereira Cunill JL. Micronutrientes en cirugía bariátrica. *Nutr Hosp* 2012:27:349-361.
7. Scopinaro N. Biliopancreatic diversion: mechanisms of action and long-term results. Obes Surg 2006;16:683-9.
8. Scopinaro N, Marinari G, Camerini G, Papadia F. Biliopancreatic diversion for obesity: state of the art. Surg Obes Relat Dis 2005;1:317-28.
9. Moize V, Geliebter A, Gluck ME, Yahav E, Lorence M, Colarusso T, Drake V, Flancbaum L. Obese patients have inadequate protein intake related to protein intolerance up to 1 year following Roux-en-Y gastric bypass. Obes Surg 2003;13:23-8.
10. Skroubis G, Sakellaropoulos G, Pouggouras K, Mead N, Nikiforidis G, Kalfarentzos F. Comparison of nutritional deficiencies after Roux-en-Y gastric bypass and after biliopancreatic diversion with Roux-en-Y gastric bypass. Obes Surg 2002;12:551-8.
11. Skroubis G, Anesidis S, Kehagias I, Mead N, Vagenas K, Kalfarentzos F. Roux-en-Y gastric bypass versus a variant of biliopancreatic diversion in a non-superobese population: prospective comparison of the efficacy and the incidence of metabolic deficiencies. Obes Surg 2006;16:488-95.
12. Ritz P, Becouarn G, Douay O, Salle A, Topart P, Rohmer V. Gastric Bypass is not Associated with Protein Malnutrition in Morbidly Obese Patients. Obes Surg 2009;19:840-4.
13. Salle A, Demarsy D, Poirier AL, Lelievre B, Topart P, Guilloteau G, Becouarn G, Rohmer V. Zinc deficiency: a frequent and underestimated complication after bariatric surgery. Obes Surg 2010;20:1660-70.
14. Dalcanale L, Oliveira CP, Faintuch J, Nogueira MA, Rondó P, Lima VM, Mendonça S, Pajecki D, Mancini M, Carrilho FJ. Long-term nutritional outcome after gastric bypass. Obes Surg 2010;20:181-7.
15. Larrad-Jimenez A, Diaz-Guerra CS, de Cuadros BP, Lesmes IB, Esteban BM. Short-, mid- and long-term results of Larrad biliopancreatic diversion. Obes Surg 2007;17:202-10.
16. Coupaye M, Puchaux K, Bogard C, Msika S, Jouet P, Clerici C, Larger E, Ledoux S. Nutritional consequences of adjustable gastric banding and gastric bypass: a 1-year prospective study. Obes Surg 2009;19:56-65.
17. Giraldo Villa A, Serna López AM, Mustiola Calleja KG, López Gómez LM, Donado Gómez J, Toro Escobar JM. Factores relacionados con la pérdida de peso en una cohorte de pacientes obesos sometidos a bypass gástrico. *Nutr Hosp* 2013;28:623-630.

18. Brolin RE, LaMArca LB, Kenler HA, Cody RP. Malabsorptive gastric bypass in patients with superobesity. J Gastrointest Surg 2002;6:195-203.
19. Sanchez-Cabezudo C, Larrad-Jimenez A, Ramos García I, Moreno-Esteban B. Five-year results of Larrad Biliopancreatic bypass in the treatment of morbid obesity. Cir Esp 2001;70:133-141.
20. Kalfarentzos F, Papadoulas S, Skroubis G, Kehagias I, Loukidi A, Mead N. Prospective evaluation of biliopancreatic diversion with Roux-en-Y gastric bypass in the super obese. J Gastrointest Surg. 2004;8:479-488.
21. Faintuch J, Matsuda M, Cruz ME, Silva MM, Teivelis MP, Garrido AB Jr, Gama-Rodrigues JJ. Severe protein-calorie malnutrition after bariatric procedures. Obes Surg 2004;14:175-81.
22. Higa K, Ho T, Tercero F, Boone KB. Laparoscopic Roux-en-Y gastric bypass: 10-year follow-up. Surg Obes Relat Dis 2010;7:516-25.
23. Laurenius A, Taha O, Maleckas A, Lonroth H, Olbers T. Laparoscopic biliopancreatic diversion/duodenal switch or laparoscopic Roux-en-Y gastric bypass for super-obesity-weight loss versus side effects. Surg Obes Relat Dis 2010;6:408-14.
24. Andreu A, Moize V, Rodriguez L, Flores L, Vidal J. Protein intake, body composition, and protein status following bariatric surgery. Obes Surg 2010;20:1509-15.
25. Moize V, Andreu A, Rodriguez L, Flores L, Ibarzabal A, Lacy A, Jimenez A, Vidal J. Protein intake and lean tissue mass retention following bariatric surgery. Clin Nutr 2013;32:550-550.
26. Topart P, Becouarn G, Ritz P. Comparative early outcomes of three laparoscopic bariatric procedures: sleeve gastrectomy, Roux-en-Y gastric bypass, and biliopancreatic diversion with duodenal switch. Surg Obes Relat Dis 2012;8:250-4.
27. de la Matta-Martín M, Acosta-Martínez J, Morales-Conde S, Herrera-González. A Perioperative morbi-mortality associated with bariatric surgery: from systematic biliopancreatic diversion to a tailored laparoscopic gastric bypass or sleeve gastrectomy approach. ObesSurg. 2012;22:1001-7.
28. Cossu ML, Fais E, Meloni GB, Profili S, Masala A., Alagna S. Impact of age on long-term complications after biliopancreatic diversion. Obes Surg 2004;14:1182-6.