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Changes in lipid parameters in patients undergoing bariatric surgery. Lipid parameters and bariatric surgery

Cambios en los parámetros lipídicos en pacientes sometidos a cirugía bariátrica. Parámetros lipídicos y cirugía bariátrica

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Obesity, bariatric surgery, atherogenic index, cholesterol, triglycerides, non-HDL cholesterol.

Palabras clave:
Obesidad, cirugía bariátrica, índice aterogénico, colesterol, triglicéridos, colesterol no-HDL.

ABSTRACT

Introduction: Obesity is associated with multiple comorbidities such as dyslipidemia. **Objective:** To analyze changes in lipid parameters in patients undergoing bariatric surgery procedures. **Material and methods:** Longitudinal study in patients undergoing bariatric surgery in 2016. Post-procedure changes in lipid parameters were recorded. **Results:** 66 patients were included. Gastric sleeve was performed in 33.3%, Roux-en-Y bypass in 22.7% and single-anastomosis bypass in 43.9%. Initial patient weight was 122 ± 26.9 kg and initial patient BMI was 46.72 ± 8.7 kg/m^2. Atherogenic dyslipidemia (AD) was present in 83.3%. Statistically significant differences were found in all the variables studied at one year of follow-up; there were no differences between the different techniques employed in weight: p = 0.674, %EPP: p = 0.420, TG: p = 0.287, and c-HDL: p = 0.432; there were statistically significant differences in changes in TC (p = 0.0001) and LDL-C (p = 0.01). When evaluating the indices, a statistically significant difference was found in all of them at baseline and at 12 months of follow-up (p = 0.001) with no difference between the surgical procedures studied. With respect to AD, significant improvement was observed at one year follow-up (p = 0.05) with remission in 74%. **Conclusions:** Bariatric surgery is associated with improvement in different lipid parameters with remission of AD in most patients regardless of the type of procedure performed.

RESUMEN

Introducción: *La obesidad se asocia a múltiples comorbilidades como la dislipidemia.* ***Objetivo:*** *Analizar los cambios en los parámetros lipídicos en pacientes sometidos a procedimientos de cirugía bariátrica.* ***Material y métodos:*** *Estudio longitudinal en pacientes sometidos a cirugía bariátrica en 2016. Se registraron los cambios posteriores al procedimiento.* ***Resultados:*** *Se incluyeron 66 pacientes. Se realizó manga gástrica en 33.3%, bypass en Y de Roux en 22.7% y bypass de una anastomosis en 43.9%. Peso inicial de 122 ± 26.9 kg e IMC inicial de 46.72 ± 8.7 kg/m^2. Se presentó dislipidemia aterogénica (DA) en 83.3%. Se encontraron diferencias significativas en todas las variables estudiadas al año de seguimiento; sin diferencia entre las diferentes técnicas en peso: p = 0.674, %EPP: p = 0.420, TGC: p = 0.287 y c-HDL: p = 0.432; si en los cambios de CT (p = 0.0001) y c-LDL (p = 0.01). Al evaluar los índices, en todos se encontró diferencia significativa al inicio y a los 12 meses de seguimiento (p = 0.001) sin diferencia entre las técnicas estudiadas. Con respecto a la DA, se observó mejoría significativa al año de seguimiento (p = 0.05) con remisión en 74%.* ***Conclusiones:*** *La cirugía bariátrica se asocia a mejoría de los diferentes parámetros lipídicos con remisión de la DA en la mayoría de los pacientes independientemente del tipo de procedimiento realizado.*

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INTRODUCTION

Overweight and obesity are defined as an abnormal or excessive accumulation of fat that is detrimental to health. In adults, the World Health Organization (WHO) defines overweight when the BMI (body mass index) is 25-29.9 kg/m^2; and obesity when the BMI is equal to or greater than 30 kg/m^2. According to WHO data in 2014 more than 1.9 billion adults aged

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18 or older were overweight, of which more than 600 million were obese.[1] Regarding data from the National Health and Nutrition Survey (ENSANUT) 2016 in Mexico, three out of 10 children under 11 years of age were overweight or obese as well as four out of 10 adolescents and seven out of 10 adults; an increase in overweight and obesity figures was observed in adult women and in rural areas.[2]

Obesity is associated with the presence of insulin resistance in peripheral tissues together with the existence of a proinflammatory state caused mainly by the release of different cytokines and hormones by adipose tissue.[3] Obesity has been related to the presence of atherogenic dyslipidemia, characterized by low levels of high-density cholesterol (HDL-C), hypertriglyceridemia and increased levels of low-density cholesterol (LDL-C). On the other hand, bariatric surgery has proven to be an effective treatment alternative in patients with obesity and its comorbidities. The present study was carried out to evaluate the changes in the different lipid indices after bariatric surgery.

MATERIAL AND METHODS

An observational, longitudinal, and analytical study approved by the institution's research committee with registration number DIR/19/310B/3/006 was carried out, where patients undergoing bariatric surgery at the Comprehensive Care Center for Diabetes and Obesity (CAIDO) of the General Hospital of Mexico in the period from January to December 2016 were evaluated. Patients taking hypolipidemic drugs or with metabolic syndrome were excluded. The indication for the type of surgical procedure (gastric sleeve, Roux-en-Y gastric bypass [RYGB] or single-anastomosis gastric bypass [SAGB]) was based on clinical criteria and on the consensus of the different specialists at the clinic. All patients were evaluated preoperatively and at one, three, six and 12 months postoperatively. During each visit weight, BMI, % of excess weight lost (%EWL) and biochemical tests for total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and triglyceride (TG) levels were measured.

Body mass index (BMI) is calculated as weight in kilograms divided by squared height (kg/m^2).[1] The percent of Excess Weight Loss (%EWL) was calculated based on the excess weight compared to the weight corresponding to a BMI of 25 kg/m^2.[4] The atherogenic index (AI) was obtained with the TC/HDL-C ratio

Table 1: Baseline features of patients.

	Gastric sleeve (22)	SAGB (29)	RYGB (15)	p
Weight (kg)	125 ± 26.0	122 ± 33.0	118 ± 29	0.796
BMI (kg/m^2)	47 ± 9.0	47 ± 9.0	45 ± 8	0.799
TC (mg/dl)	180 ± 34.0	171 ± 33.0	178 ± 35	0.663
TG (mg/dl)	167 ± 97.0	154 ± 62.0	203 ± 107	0.199
HDL-C (mg/dl)	38.6 ± 10.0	39.8 ± 9.0	38.2 ± 10	0.837
LDL-C (mg/dl)	106.6 ± 28.0	106.5 ± 23.0	105.3 ± 35	0.988
CT/HDL-C	4.9 ± 1.2	4.5 ± 1.1	4.9 ± 1.3	0.378
TG/HDL-C	4.7 ± 3.5	4.03 ± 1.8	5.5 ± 2.7	0.210
LDL-C/HDL-C	2.9 ± 0.9	2.8 ± 0.8	2.9 ± 1.1	0.860
Non-HDL-C	140.9 ± 33.0	131 ± 36.0	139.3 ± 35.0	0.555

SAGB = single-anastomosis gastric bypass, RYGB = Roux-en-Y gastric bypass, BMI = body mass index, TC = total cholesterol, TG = triglycerides, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein-cholesterol. Own elaboration.

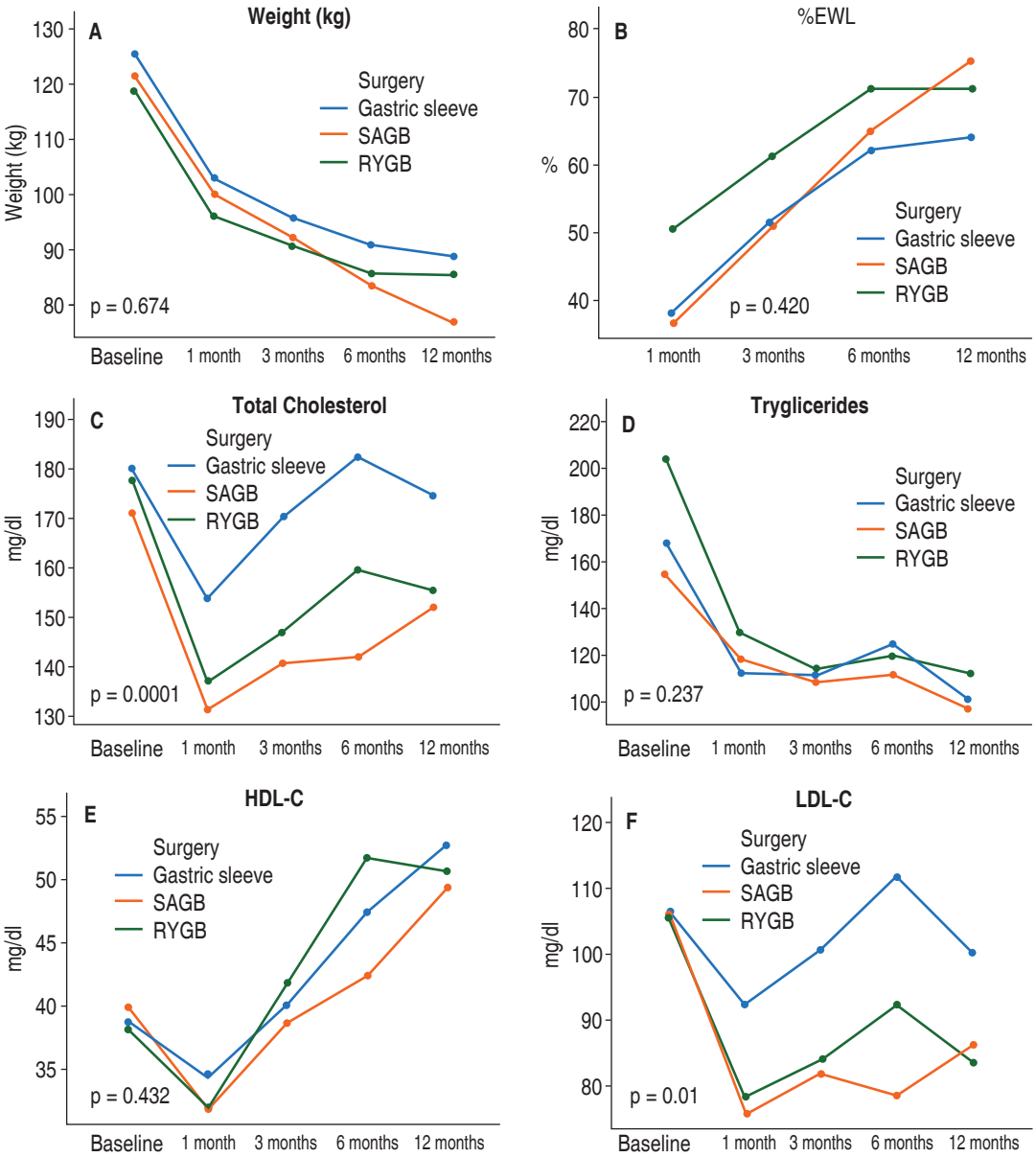

Figure 1:

Changes in the different variables after bariatric surgery. *All variables show statistically significant improvement 12 months after the intervention regardless of the type of surgical procedure used ($p < 0.05$). The p-value shown in the image represents the difference between the different techniques for each variable:* ***A)*** *Weight, $p = 0.674$;* ***B)*** *%EWL, $p = 0.420$;* ***C)*** *Total cholesterol, $p = 0.0001$;* ***D)*** *Triglyceride level, $p = 0.237$;* ***E)*** *HDL-C, $p = 0.432$;* ***F)*** *LDL-C, $p = 0.01$. %EWL: % excess of weight lost. The results shown are the mean of each variable. Own elaboration.*

considering a value > 4.5 as a predictor of coronary risk.[5] The TG/HDL-C index was obtained dividing the total fasting triglyceride level by HDL-C, where the cut-off values that have been associated with elevated insulin levels (as an indicator of insulin resistance) correspond to 2.5 in women and 3. 5 in men,[6] so that a value greater than 3 in adults has been considered as a marker of insulin resistance.[7,8] Non-HDL cholesterol (non-HDL-C) is a measure of LDL, intermediate density LDL-C (IDL) and very low density (VLDL-C) cholesterol[5] and is calculated by subtracting HDL-C from the TC value; non-HDL cholesterol has been found to be the main determinant of early atherosclerosis.[9] Atherogenic dyslipidemia (AD) was defined as a triglyceride value > 150 mg/dl, and HDL-C less than 40 mg/dl in men and 50 mg/dl in women.[4]

A sample size calculation was performed with the Gpower 3.1 software indicating a total of 40 patients to achieve a statistical power of

0.8, an α-error of 0.05 and a β-error of 0.2. For data analysis, measures of central tendency were used as descriptive statistics. A general linear repeated measures model was used to evaluate changes in laboratory parameters and weight loss, and ANOVA to evaluate differences between the various techniques. A value of $p < 0.05$ was considered statistically significant. The analyses were performed using the IBM SPSS v. 20 package.

RESULTS

A total of 66 patients were studied. The group consisted of 56 women (84.4%) and 10 men (15.6%). The surgical procedures performed were: 22 gastric sleeves (33.3%), 15 Roux-en-Y bypasses (22.7%) and 29 single-anastomosis bypasses (43.9%). The baseline characteristics of the patients are shown in *Table 1*.

ANOVA repeated measures were performed to evaluate changes in the different variables over time *(Figure 1)*. Statistically significant differences were found in all the variables studied at 1-year follow-up. No differences were observed in weight ($p = 0.674$), %EWL ($p = 0.420$), TG levels ($p = 0.287$) and HDL-C ($p = 0.432$) between the different surgical techniques. A statistically significant difference was found in the changes in TC ($p = 0.0001$) and LDL-C ($p = 0.01$).

When evaluating the different indices, a statistically significant difference was found in all of them at baseline and at 12 months of follow-up ($p = 0.001$) *(Figure 2)*. No difference was detected between the techniques studied *(Table 2)*. Regarding atherogenic dyslipidemia (AD), it was present in 83.3% of patients at baseline: 19 (86.3%) with gastric sleeve, 23 (79.3%) with SAGB, and 13 (86.6%) with RYBG. Statistically significant improvement was observed at one year follow-up ($p = 0.05$) with remission in 74% of patients, with no difference observed between the different surgical techniques.

DISCUSSION

Obesity has become a pandemic and is considered a priority issue for public health, research, and economics worldwide. The prevalence of AD is associated with overweight, obesity, diabetes mellitus, and myocardial infarction.[10] In the present study it was found that 83.3% of patients showed criteria for AD prior to surgery, with remission of AD in 74% of cases following the bariatric surgery procedure. This correlates with previously reported data, where 20-63% of pre-surgical patients had criteria for AD with a post-surgical remission of 62-74%.[4,11] No significant differences in remission were found between patients undergoing gastric sleeve, Roux-en-Y bypass or single-anastomosis bypass procedures as reported in the literature.[12,13] Likewise, a decrease in TG levels to normal ranges was observed in 89.4% of patients, in TC in 89.3%, and in HDL-C in 74.2% at 12 months of follow-up, which is in agreement with previous studies reporting a 30-63% decrease in TG and a 12-39% increase after bariatric surgery.[14,15]

TC values decreased to normal values in up to 89.3% of the cases, which correlates with an increase in HDL-C and a decrease in LDL-C, with the degree of increase in HDL-C being of greater importance in assessing the reduction in cardiovascular risk.[15]

With respect to HDL-C, it is important to highlight that an abrupt decrease in its values was observed in the first month after the surgical procedure, probably due to the postsurgical diet, followed by an overt and statistically significant increase after three months post-surgery, correlating with previous descriptions in the literature and independent of the type of surgery used,[12,16] suggesting that the increase in HDL-C values does have a direct correlation with weight loss after the procedure.

Non-HDL cholesterol has been suggested as a therapeutic target in patients with hypertriglyceridemia and high cardiovascular risk, and it has also been said that it may be a marker of apo-B concentration in clinical practice.[5] In this study, a decrease in non-HDL cholesterol levels was observed together with an increase in HDL-C levels with a less marked decrease in TC levels as previously reported.[15]

Atherogenic index (AI) has been related to insulin resistance and as the best predictor of cardiovascular risk.[5] The greatest decrease in the level of the AI was detected at three months post-surgery and was maintained through follow-up as reported by Climent et

al,[4] who mentioned that the decrease in AI levels correlates with a remission of AD and an improvement in the HOMA-IR index.

When comparing our results with those of other centers for obesity and its comorbidities in Mexico, we observed that Molina-Ayala et al[17] reported a significant decrease in weight, glucose, insulin, HOMA-IR, TC, TG, HDL-C, LDL-C, and uric acid levels one year after the bariatric surgery procedure. Reyes-Perez et al[18] showed similar results in postoperative Roux-en-Y gastric bypass patients in a private setting. The age of the patients was 40.1 ± 11.5 years; women represented 42% of the group and the

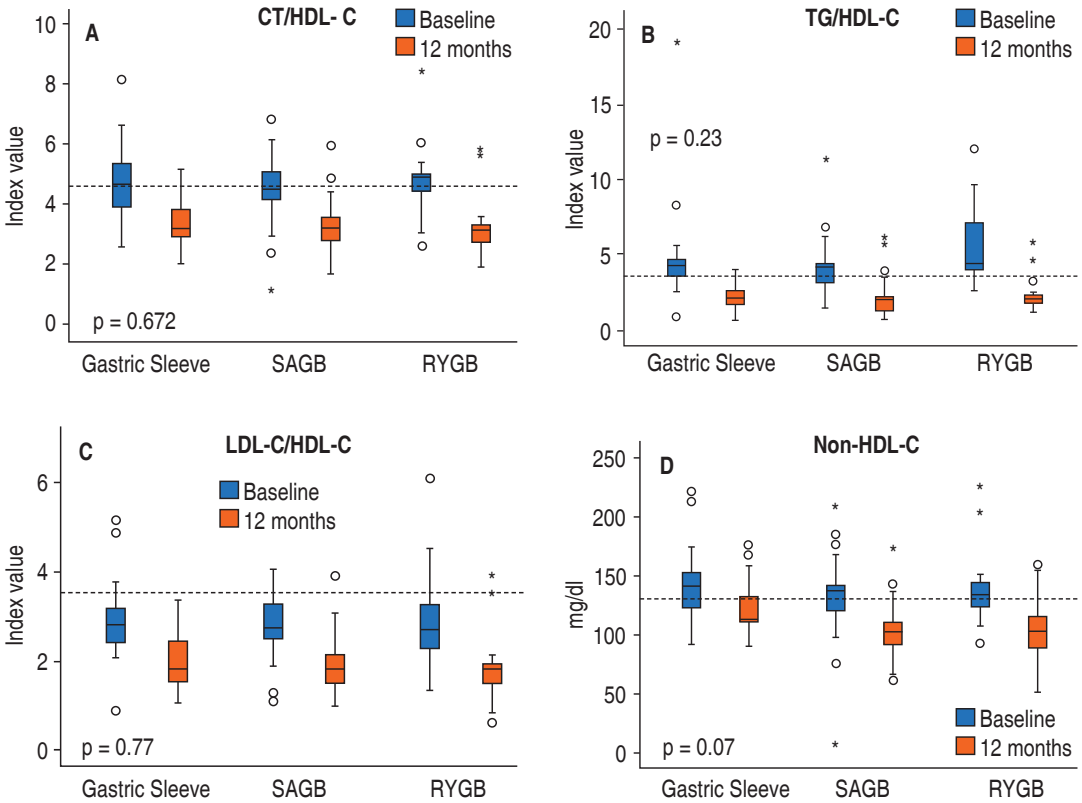

Figure 2:

Changes in the different lipid indices 12 months after the bariatric surgery procedure. *All indexes presented statistically significant improvement and return to normal values 12 months after the procedure. No difference was found between the different surgical techniques. Dotted lines represent the ideal normal value. Own elaboration.*

Table 2: Changes in the different lipid parameters.

	Gastric sleeve		SAGB		RYGB		
	Baseline	12 months	Baseline	12 months	Baseline	12 months	p-value*
CT/HDL-C	4.9 ± 1.2	3.5 ± 0.8	4.5 ± 1.1	3.3 ± 0.9	4.9 ± 1.3	3.3 ± 1.1	0.672
TG/HDL-C	4.7 ± 3.5	2.1 ± 0.8	4.03 ± 1.8	2.3 ± 1.2	5.5 ± 2.7	2.3 ± 1.2	0.23
LDL-C/HDL-C	2.9 ± 0.9	2 ± 0.6	2.8 ± 0.8	1.9 ± 0.6	2.9 ± 1.1	1.8 ± 0.9	0.77
Non-HDL-C	140.9 ± 33.0	122 ± 23.0	131 ± 36.0	102 ± 25.0	139.3 ± 35.0	104 ± 28.0	0.07
Dyslipidemia (%)	19 (86.4)	4 (18.2)	23 (79.3)	8 (27.6)	13 (86.7)	3 (20.0)	0.05

*Difference among techniques.
Own elaboration.

initial BMI was 42 ± 6.5 kg/m^2. Likewise, at the Mexican Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán", postoperative Roux-en-Y gastric bypass patients were analyzed, reporting a mean age of 38 ± 10; the BMI at the beginning of the study was 48 ± 6 kg/m^2 with a %EWL of 70% one year after the procedure. The values for HDL-C, LDL-C and TG decreased significantly one year after the surgical procedure.[19]

The reduction in the different lipid parameters after bariatric surgery has been associated with a decrease in cardiovascular events and deaths from the same cause,[20] so the results in the remission and improvement of the different lipid alterations in patients undergoing bariatric surgery are of utmost importance. Among the limitations of the present study, we found that lifestyle data such as dietary habits and physical activity were not assessed and given the small sample size, it is difficult to extrapolate the results due to an inadequate statistical power.

CONCLUSIONS

Bariatric surgery is associated with frank improvement of the different lipid parameters, with remission of AD in most patients from the third month and continuing 12 months after surgery ($p = 0.0001$). Weight loss seems to have the greatest impact on the decrease of the different indexes and this improvement is independent of the type of procedure performed. A non-statistically significant decrease in weight ($p = 0.674$), %EWL ($p = 0.420$), TG levels ($p = 0.287$) and HDL-C levels ($p = 0.432$) among the different techniques were seen. Therefore, we can conclude that bariatric surgery is a therapeutic option in obese patients with AD from the first months of the procedure. As this is a preliminary study, we should continue to observe the lipid behavior over a longer period and with a larger number of patients.

REFERENCES

1. Organización Mundial de la Salud (Internet). México; 2018 (Citado 3 de feb 2018). Obesidad y sobrepeso. Disponible en: http://www.who.int/mediacentre/factsheets/fs311/es/
2. Instituto Nacional de Salud Pública (Internet). México; 2018 (Citado 3 de feb 2018). Encuesta Nacional de Salud y Nutrición de Medio Camino 2016 Informe Final de Resultados. Disponible en: http://oment.uanl.mx/wp-content/uploads/2016/12/ensanut_mc_2016-310oct.pdf.
3. Martinez J, Torres P, Juárez M. Los ácidos grasos y la lipotoxicidad: implicaciones metabólicas. Rev Fac Med. 2013; 56: 5-18.
4. Climent E, Benaiges D, Pedro-Botet J, Flores-Le Roux J, Ramón J, Villatoro M, et al. Atherogenic dyslipidemia remission 1 year after bariatric surgery. Obes Surg. 2017; 27: 1548.
5. Millán J, Pintó X, Muñoz A, Zúñiga M, Rubiés-Prat J, Pallardo LF, et al. Lipoprotein ratios: physiological significance and clinical usefulness in cardiovascular prevention. Vasc Health Risk Manag. 2009; 5: 757-765.
6. Hernández-Vite Y, Elizalde-Barrera C I, Flores-Alcántar M G, Vargas Ayala G, Loreto-Bernal M. Asociación entre el índice triglicéridos/colesterol HDL y la glucosa alterada en ayuno en pacientes normotensos con obesidad y sobrepeso. Med Int Méx. 2015; 31: 507-515.
7. Soutelo J, Graffigna M, Honf M, Migliano M, Aranguren M, Proietti A, et al. Índice triglicéridos/HDL-colesterol: en una población de adolescentes sin factores de riesgo cardiovascular. Alan. 2012; 62: 167-71.
8. González-Chávez A, Simental-Mendía L E, Elizondo-Argueta S. Relación triglicéridos/colesterol-HDL elevada y resistencia a la insulina. Cir Cir. 2011; 79: 126-131.
9. Acevedo M, Kramer V, Tagle R, Coebalan R, Arnaíz P, Berrios X, et al. Relación colesterol total a HDL y colesterol no HDL: los mejores indicadores lipídicos de aumento de grosor de la íntima media carotidea. Rev Med Chile. 2012; 140: 969-976.
10. Pedro-Botet J, Flores-Le Roux JA, Mostaza JM, Pintó X, de la Cruz JJ, Banegas JR, et al. Dislipemia aterogénica: prevalencia y control en las unidades de lípidos. Rev Clin Esp. 2014; 214: 491-498.
11. Courcoulas AP, Christian NJ, Belle SH, Berk PD, Flum DR, Garcia L, et al. For the longitudinal assessment of bariatric surgery (LABS) consortium. Weight change and health outcomes at 3 years after bariatric surgery among individuals with severe obesity. JAMA. 2013; 310: 2416-2425.
12. Benaiges D, Flores-Le-Roux JA, Pedro-Botet J, Ramon JM, Parri A, Villatoro M, et al. Impact of restrictive (sleeve gastrectomy) vs hybrid bariatric surgery (Roux-en-Y gastric bypass) on lipid profile. Obes Surg. 2012; 22: 1268-1275.
13. Vidal P, Ramón J, Goday A, Benaiges D, Trillo L, Parri A, et al. Laparoscopic gastric bypass versus laparoscopic sleeve gastrectomy as a definitive surgical procedure for morbid obesity. mid-term results. Obes Surg. 2013; 23: 292-299.
14. Asztalos BF, Swarbrick MM, Schaefer EJ, Dallal GE, Horvath KV, Ai M, et al. Effects of weight loss, induced by gastric bypass surgery, on HDL remodeling in obese women. J Lipid Res. 2010; 51: 2405-2412.
15. Zubiaga L, Ruiz-Tovar J, Giner L, Gonzalez J, Aguilar M, García A, et al. Valoración del riesgo cardiovascular

después de gastrectomía vertical: comparativa del IMC, la adiposidad, el índice de Framingham y el índice aterogénico como marcadores del éxito de la cirugía. Nutr Hosp 2016; 33: 832-837.
16. Leyba JL, Llopis SN, Aulestia SN. Laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy for the treatment of morbid obesity. a prospective study with 5 years of follow-up. Obes Surg. 2014; 24: 2094-2098.
17. Molina-Ayala M, Rodríguez-González A, Albarrán-Sánchez A, Ferreira-Hermosillo A, Ramírez-Rentería C, Luque-de León E, et al. Características clínicas y bioquímicas de pacientes con obesidad extrema al ingreso y un año después de someterse a cirugía bariátrica. Rev Med Inst Mex Seguro Soc. 2016; 54: 5118-5125.
18. Reyes-Pérez A, Sánchez-Aguilar H, Velázquez-Fernández D, Rodríguez-Ortíz D, Mosti M, Herrera MF. Analysis of causes and risk factors for hospital readmission after Roux-en-Y Gastric Bypass. Obes Surg. 2016; 26: 257.
19. Romero-Ibarguengoitia ME, Lerman-Garber I, Herrera-Hernández MF, Pablo-Pantoja J, Sierra-Salazar M, Lopez-Rosales F, et al. Bypass gástrico laparoscópico en Y de Roux y obesidad mórbida. Experiencia en el Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán". Rev Invest Clin. 2009; 61: 186-193.
20. Sjostrom L, Peltonen M, Jacobson P, Sjostrom CD, Karason K, Wedel H, et al. Bariatric surgery and long-term cardiovascular events. JAMA. 2012; 307: 56-65.

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