

Original

Resolution of diabetes mellitus and metabolic syndrome in normal weight 24-29 BMI patients with one anastomosis gastric bypass

M. García-Caballero¹, M. Valle¹, J. M. Martínez-Moreno¹, F. Miralles², J. A. Toval¹, J. M. Mata¹, D. Osorio¹ and A. Mínguez¹

¹Departamento de Cirugía. Facultad de Medicina. Universidad de Málaga. Málaga. Spain. ²Servicio Medicina Interna. HU Asociado Parque San Antonio. Málaga. Spain.

Abstract

Introduction: Diabetes mellitus type 2 (DMT2) is a major cause of death in the world. The medical therapy for this disease has had enormous progress, but it still leaves many patients exposed to the complications developed from the disease. It is well known the beneficial effects of bariatric surgery in obese diabetic patients, however it is important to investigate if the same principles of bariatric surgery that improve diabetes in obese patients, could be applied to non obese normal weight diabetics.

Material and methods: Thirteen diabetic patients operated by One Anastomosis Gastric Bypass (BAGUA), were evaluated in the preoperative period and 1,3 and 6 months after surgery. Body weight and composition, Fasting Plasma Glucose, HbA1c levels, blood pressure and serum lipids levels were analyzed, as well as the monitoring of the immediate postoperative treatment necessities for Diabetes and other metabolic syndrome comorbidities.

Results: After the surgery the 77% of the patients resolves its T2DM, 46% from surgery, and rest noted a significant improvement of the disease in spite of having a C peptide level near to zero some of the patients. The comorbidities, mainly hypertension and lipid abnormalities experience improvement early. All patients reduce their weight and the amount of fat mass until values consistent with their age and height.

Conclusions: The One Anastomosis Gastric Bypass leads to resolution or improvement of T2DM in non obese normal weight patients. The best results are obtained in patients with few years of diabetes, without or short term use of insulin treatment and high C-peptide levels.

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Key words: Normalweight diabetes surgery. Metabolic surgery. One anastomosis gastric bypass. Metabolic syndrom. C Peptide.

Correspondence: M. García-Caballero.
Departamento Cirugía. Facultad de Medicina.
29080 Málaga. Spain.
E-mail: gcaballe@uma.es

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RESOLUCIÓN DE LA DIABETES MELLITUS Y DEL SÍNDROME METABÓLICO

Resumen

Introducción: La diabetes mellitus de tipo 2 (DMT2) es una causa principal de muerte a escala mundial. El tratamiento médico de esta enfermedad ha progresado tremendamente pero sigue dejando a muchos pacientes expuestos a las complicaciones derivadas de la enfermedad. Son bien conocidos los efectos beneficiosos de la cirugía bariátrica en los pacientes diabéticos obesos, sin embargo es importante investigar si se podrían aplicar los mismos principios de la cirugía bariátrica que mejoran la diabetes en los pacientes obesos podrían aplicarse a los pacientes diabéticos no obesos, con un peso normal.

Material y métodos: Se evaluó a 13 pacientes operados mediante una derivación gástrica de un sola anastomosis (BAGUA) durante el período preoperatorio y a los 1, 3 y 6 meses después de la cirugía. Se analizó el peso corporal y su composición, la glucemia en ayunas, las concentraciones de HbA1c, la presión sanguínea y las concentraciones séricas de lípidos, así como las necesidades de tratamiento en el posoperatorio inmediato para la diabetes y otros comorbididades del síndrome metabólico.

Resultados: Después de la cirugía, el 77% de los pacientes resuelve su DMT2, el 46% desde la cirugía, y en el resto se vio una mejoría significativa de la enfermedad a pesar de que algunos pacientes tenían una concentración del péptido C cercana a cero. Las comorbididades, principalmente la hipertensión y las anomalías lipídicas, mostraron una mejoría de forma temprana. En todos los pacientes se redujo el peso y la cantidad de grasa hasta cifras correspondientes con su edad y talla.

Conclusiones: la derivación gástrica con una única anastomosis conlleva una resolución o una mejoría de la DMT2 en los pacientes no obesos con peso normal. Los mejores resultados se obtienen en los pacientes con una corta evolución de la diabetes, sin uso de insulina, o por poco tiempo, y con concentraciones elevadas del péptido C.

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Palabras clave: Cirugía diabetes normopeso. Cirugía metabólica. Bypass gástrico una anastomosis. Síndrome metabólico. Péptido C.

Introduction

Diabetes mellitus type 2 (T2DM) is a metabolic disease of enormous global significance because of their different complications, such as loss of vision, cardiovascular disease, renal failure...¹ The therapeutic approach of this disease has advanced significantly, however, 97.7 % of the diabetic patients do not have controlled their disease.²

The complete resolution of the T2DM after procedures of bariatric surgery is reflected in the meta-analysis of Buchwald,³ on patients with a BMI > 35, where it observes the resolution of diabetes in 84% of the patients who underwent surgery after gastric bypass and 98% after biliopancreatic diversion. The resolution of the T2DM after these techniques occurs early, before it has resulted in the loss of weight, suggesting the involvement of other factors with more importance in the glucose homeostasis. Similarly, the antidiabetic effect after surgery, over time, as demonstrated by a series of patients with a follow-up of more than 14 years.⁴ In patients with a BMI between 30 and 35 the existing data show similar behaviour in relation to resolution and improvement of T2DM.⁵⁻⁷

But, what happens in normal weight 25-29 DM patients? So far we have discussed obesity surgery in patients who also suffer from diabetes, but the real diabetes surgery it must be carried out to solve Diabetes Mellitus as main reason and not for producing weight loss (what is known as obesity surgery).

In the light of the few data that we are at present, it seems that the mechanism for the development of T2DM in thin patients might be different from that of patients with IMC > 30, in which the excess weight could be the most decisive factor in the development and progression T2DM and therefore, the results regarding diabetes and side effects after surgery could be worse in these patients.⁸

On the other hand, most studies agree that the best results after surgery are obtained in patients with shorter evolution of the disease.⁹

But what is behind the surgery? Regardless of the molecular explanation that remains almost unknown, several articles advocating an essential role in incretins and intestinal gluconeogenesis.¹⁰ It is important to understand that anatomical modifications are essential for the anti-hyperglycaemic activity of the surgery. Based on animal models, two mechanisms have been suggested, the upper intestinal theory and the hindgut theory. In both occurs an increase in the synthesis of the incretin GLP1 that stimulated insulin secretion, and experimental studies has shown to have a neogenic role in the synthesis of the beta cells in the pancreas.^{11,12}

But the surgery not only solves or improves the T2DM, but also have a beneficial effect on the metabolic syndrome comorbidities present in diabetic patients, such as dyslipidemia, high blood pressure among others.¹³

There is no doubt that the findings described in these clinical experiences represent an important change in the current paradigm in the management of patients with T2DM. In fact, the BMI is not itself an ideal tool for accurately assessing the risk/benefit in patients with diabetes.

This change is represented by the surgery in several aspects:¹⁴

- Better understanding of the disease due to the study of patients that were resolved or improved their DM after surgery.
- Development of new drugs based on substances related to the synthesis of insulin that change after the surgery.
- The effect of surgery on the control and/or remission of the disease.

Until now the surgery for the treatment of T2DM is linking to the weight of the patient, thought that could only be effective in patients who submit both things, obesity and diabetes. However, the comments on the resolution of the T2DM was the case before the loss of weight, have led to the question of what, if this is so, normoweight patients could solve their diabetes also with surgery.

This surgery similar to the bariatric to treat diabetic patients was seen in the Diabetes Surgery Summit Consensus Conference (DSSCC).¹⁵ The recommendations of this expert meeting recognized the legitimacy of gastric bypass for treating patients with poorly controlled diabetes and body mass index more than 30. And pointed out the necessity of clinical trials to clarify the exact role of surgery in normal weight to over weight (25-29 kg/m²) diabetes patients.

The present study outline the short/medium terms results of the first group of normal weight diabetes patients operated by one anastomosis gastric bypass with the intention of solving their diabetes mellitus.

Hypothesis and objectives

The one anastomosis gastric bypass (BAGUA) resolves or improves Diabetes Mellitus and its associated metabolic syndrome comorbidities without direct relationship with the weight loss:

1. Evaluate the needs of antidiabetic treatment after laparoscopic BAGUA.
2. Study the changes in blood glucose levels and glycosylated hemoglobin after laparoscopic BAGUA.
3. Assess the changes in weight and body composition after BAGUA.
4. Study the changes in diet and exercise.
5. Evaluate the evolution of the metabolic syndrome comorbidities after BAGUA.

Table I
Characteristics of the patients undergoing BAGUA

	Sex	Age	BMI (kg/m ²)	Evolution DM	Use of insulin	Comorbidity	N° tablets/day	Surgical background
1	M	65	25.09	2	0	HTG	3	-
2	M	58	27	17	0	HTA	4	-
3	F	80	28.06	20	11	HCOL, HTA, Depression	9	Cholecystectomy Appendectomy
4	M	66	28.12	19	10	HTA, Cardiopathy, Retinopathy	7	Cataract
5	M	60	29	20	7	HTA, Cardiopathy	5	Appendectomy Meniscus
6	M	61	26.7	12	9	HTA	4	-
7	M	76	25.09	37	20	HTA, Cardiopathy, Retinopathy	3	-
8	M	65	28.73	11	5	HCOL, HTA	0	Appendectomy Phimosi
9	M	47	28.4	8	0	HTA	3	-
10	F	63	24.24	19	7	HTA	4	-
11	M	66	29	15	5	HTA, HCOL, HTG, Cardiopathy	6	Cholecystectomy Appendectomy
12	M	66	29.06	30	2	HTA, Cardiopathy, Angioneurotic edema	3	-
13	F	57	22.19	10	6	HCOL, HTA	2	-

Age: Years

Evolution of Diabetes: Years

Use of insulin: Years of use

M: Male; F: Female; HTA: Arterial hypertension; HTG: Hypertriglyceridemia; HCOL: Hipercholesteremia.

Patients and methods

Patients

The study group consisted in 13 T2DM patients (table I), normoweight (BMI < 30 kg/m²) who had undergone One Anastomosis Gastric Bypass (BAGUA) from April 2010 to February 2011 and had at least 6 months of follow-up.

Variables of the study

All patients completed a structured interview to obtain the following data: sex, age, weight, height, medical history, drug use, frequency of consumption of alcohol and tobacco and prevalent diseases. In the same way it was recorded their dietary habits and physical activity.

Body composition was determined by bioimpedance (TANITA) is effected by placing the feet of the patient over the electrodes. It transmits the patient an electric current type alternate, of 800 LA and at a frequency of 50 MHz. It is accepted that the body conducts electricity through the lean tissue and fat is not conductive. Mathematically it can be calculated the proportion and the amount of lean body mass and fat mass from weight and height and body impedance. The variation of the hydration status modifies the results by affect the conductivity, being an error factor.

Blood samples were extracted from peripheral vessels by vein puncture with fasting for 12 hours.

From this sample is determined the concentrations of glucose by ultraviolet spectrophotometry visible and the glycosylated hemoglobin by high performance liquid chromatography (HPLC). The normal values of our laboratory are: Fasting Plasmatic Glucose from 65 to 105 mg/dl and glycosylated hemoglobin of 4.3 to 6.1% (23-43 mmol/mol). Equally determined the levels of C-peptide through immunological methods. Normal values are 0.8 to 4 ng/ml. Furthermore we take 10 ml more samples for obtaining serum samples that are stored -80° C for future research purposes. These extraction are repeated 1 and 3 months for comparing the changes obtaining by diabetes surgery.

We analyzed variables of type lipid, cholesterol, HDL-cholesterol and triglycerides by ultraviolet spectrophotometry Visible, LDL-cholesterol was obtained by the Friedewald formula. Normal levels in our laboratories are: Cholesterol from 130 to 220 mg/dl, HDL-cholesterol greater than 35 mg/dl, LDL-Cholesterol below 150 mg/dl and triglycerides between 45 and 185 mg/dl in men and between 40 and 160 mg/dl for women.

Similarly, follow-up of the antidiabetic treatment and metabolic syndrome comorbidities, as well as the weight, body composition, and the eating habits and physical activity through successive interviews throughout the postoperative period.

Preoperative evaluation

All patients were subjected to a preoperative study following the indications of the Clinical Practice Guideline (CPG) of the European Association for endoscopic surgery (EAES).¹⁶ This study consists of an analytical of blood in which we studied the following parameters:

- Complete blood count with differential leukocyte count-
- Blood type.
- Glucose, urea, Na, Cl, K, Ca.
- Clotting time and prothrombin activity.
- Total cholesterol, HDL, triglycerides.
- Alkaline phosphatase, AST, ALT, GGT and bilirubin.
- Plasma cortisol.
- Thyroid hormones: TSH, T3 and T4.
- Total protein and Proteinogramme.
- Serum iron.
- Vitamin B12.
- Antibodies anti-Helicobacter Pylori.

In addition there is a radiologic study, with abdominal ultrasound, Rx A-P and lateral chest and oesophago-gastro-intestinal transit; cardiological exploration with Electrocardiogram (ECG) and stress tests (if applicable); functional respiratory tests and study endoscope (only in selected cases).

Surgical procedure

All patients take only liquid diet during five days previous to surgery and received antibiotic and anti-thrombotic prophylaxis before surgery. The laparoscopic gastric bypass of single anastomosis (BAGUA)¹⁷ consists of the construction of a gastric pouch from the gastroesophageal junction to the end of the minor gastric curvature at the lower level of the cisura angularis. The stapler line of the gastric pouch is fixed in approximately 12 cm to an intestinal loop (first layer of the anti-reflux mechanism) and anastomosed to it in a laterolateral position excluding from the feeding course a length proportional to the BMI and distal to the Treitz ligament. Finally the anti-reflux mechanism is completed fixing the afferent loop to the gastric remnant and the efferent loop to the antrum.

Both, the size of the gastric pouch and the length of bowel excluded depend on the BMI of the patient. In this group of patients the gastric pouch was always double as the size for obese patients and we excluded only 100 cm jejunum distal to the Treitz ligament. We left systematically a drainage during hospital stay.

Immediate postoperative care

First 24 hours patients received analgesics, antibiotics, low molecular weight heparin, prokinetic,

omeprazol and fluído-therapy. Patients are stimulated to start walking 8 hours after surgery. After the first 24 hours we retired all treatment except fluído-therapy and omeprazol. Aproximately 48 hours after surgery we perform a gastrografin radiological test to check the gastro-intestinal anastomosis. If it is correct we start liquid diet and discharge patient home with only oral omeprazol and sucralfate. First week patient continues with liquid diet, second and third weeks every food pure and then start normal diet again.

Adjustment of the preoperative medical treatment

The diabetic treatment is adjusted according to the preoperative situation. Patients with only oral antidiabetic treatment and those with short period insulin treatment and normal C Peptide levels, we try always leaving with no treatment. In case of blood glucose levels greater than 200 mg/dl, we administrate oral antidiabetic drugs. Patients with longer preoperative insulin treatment and/or higher dose of insulin, we indicate only delay insulin as treatment according with the dose the patient need during the five days liquid diet previous to surgery. We maintain a daily contact with each patient to adjust the dose. Then we proceed reducing the dose progressively using the rule of permitting glucose levels never higher than 200 mg/dl until the total retirement of the treatment. This period vary among patients between zero and 3 months depending on years of disease, years of insulin treatment, preoperative dose of insulin necessary and C Peptide levels. Patients with C Peptide levels between 0,00 and 0,1, in the experience accumulated until now, need always reduced dose of insulin (1 to 5 iu) or only antidiabetic drugs after BAGUA surgery.

We indicated always the total abandon of antihypertension, antiuricemic and antilypemic drugs. Exceptionally patients need taken treatment again and, if so, just some doses. We leave the control other diseases to the correspondent specialists.

Follow up

The data were collected prospectively according with a previously fixed protocol. This protocol included a baseline evaluation preoperatively that studied parameters related to the evaluation of the disease, comorbidities, weight and body composition. Similarly we took a sample of blood for the analysis of biochemical variables.

After surgery by BAGUA (the procedure explained before) and the protocol outlined (diets, drugs) follow up was performed in biochemical variables, BMI and body composition during, 1, 3 and 6 months. Routinely we continue seeing the patients at 12, 18 and 24 months and then yearly.

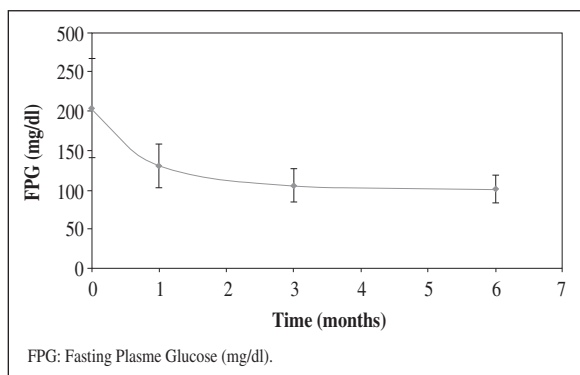


Fig. 1.—Evolution of fasting blood glucose in patients undergoing surgery.

Statistical analysis

To determine the sample size we have taken the main variable glycosylated hemoglobin (HbA1c) in mmol/mol. It has been accepted a alpha risk of 0.05 and a beta risk of 0.20 . It is assumed that the standard deviation is 5 mmol/mol. It has been estimated a loss rate of follow-up to 0.

The qualitative variables will be described through frequencies and percentages. The quantitative variables with mean and standard deviation or median, quartiles first and third according to the distribution of the variable.

To compare qualitative variables has been used the Chi-square test or Fisher's exact test in terms of implementation, and quantitative variables were analyzed by Student's T-test in the case of the variables with normal distribution and the test of Fridman otherwise. In all analyzes shall be deemed to be statistically significant p values less than 0.05.

Analyzes carried out with the statistical package SPSS (version 15.0 for Windows, SPSS, Chicago, IL) and Excel 2007.

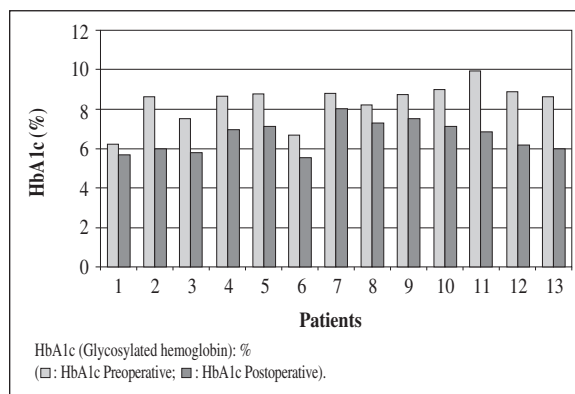


Fig. 2.—HbA1c values in patients undergoing.

Results

Remission of Type 2 Diabetes Mellitus after BAGUA

Biochemical markers of diabetes severity (FPG) and long-term control (HbA1c) were markedly improved or returned to normal levels in all patients (figs.1 and 2). For the total population, means of FPG decreased post surgery from 203 mg/dl to 100 mg/dl and mean HbA1c decreased from 8,3% to 6,6% ($p < 0.05$).

For insulin dependent patients (table II), the mean insulin dosage requirement in 10 insulindependent patients before surgery was 37 units per patient per day and 2 of the 10 patients also required oral agents. Three patients required daily insulin at a dose preoperatively of 85 units/day and reduced to 24 units/day ($p < 0.05$) after surgery.

Patients ($n = 3$) on only oral agents treatment, required a mean of 3 tablets/day/patients. After surgery, all of them left free of treatment.

Changes in its disease following BAGUA in patients with Diabetes Mellitus are represented in

Table II
Insulin requirements in patients with T2TDM subjected to BAGUA

Patients	Insulin dose (U)/day					
	Breakfast		Lunch		Dinner	
	Delayed insulin	Rapid insulin	Delayed insulin	Rapid insulin	Delayed insulin	Rapid insulin
3	32	5-10	32	5-10	32	5-10
4	24		24		14	
5	90				110	
6	24		24		24	
7	24	2-10	24	5-10	24	5-10
8	14		14		14	
10	19	14	19	14	19	14
11	16		16		16	
12	20	5-10	20	5-10	20	5-10
13	14-18		14-18		14-18 + 20	

U: Units of insulin.

Table III
Need of antidiabetic treatment after BAGUA

Patients	Age	BMI	Evolution of DM	Use of insulin	C-peptide	Resolution time			Improvement
						Immediate	1 m	3 m	
1	65	25	2	0	4.21	✓			
2	58	27	17	0	1.49	✓			
3	80	28	20	11	1.88	✓			
5	60	29	20	7	2.27	✓			
9	47	28	8	0	2.45	✓			
11	66	29	15	5	2.73	✓			
12	66	29	30	2	1.57		✓		
4	66	28	19	10	1.49			✓	
10	63	24	19	7	0.45			✓	
13	57	22	10	6	2.89			✓	
7	76	25	37	20	0				✓
8	65	29	11	5	0.06				✓
6	61	27	12	9	0.04				✓

Age: Years.
Evolution of Diabetes: Years
Use of insulin: Years of use.
C Peptide: ng/ml.
m: Months.

table III. Seventy seven percent of the patients resolves your DM, being the 46,15% immediately after the surgery. Only 3 patients failed to resolve their DM2. They presented the lower C-peptide levels of the sample.

Weight loss and body composition

Mean preoperative BMI was $27 \pm 7.5 \text{ kg/m}^2$ (22-29). All of the patients lost weight after surgery, achieving an average reduction of 97% of their excess weight during the first 6 months after surgery. The mean BMI at 6 months decreased to $21.19 \pm 1.63 \text{ kg/m}^2$ ($p < 0.05$) (fig. 3).

All patients loss weight after BAGUA, from mean preoperative values of $75.89 \pm 11.6 \text{ kg}$ to $61.74 \pm 9.93 \text{ kg}$ after surgery ($p < 0.05$) (fig. 4).

With regard to body composition, fat mass average in preoperative patients was $20.23 \pm 5.61 \text{ kg}$, at 6

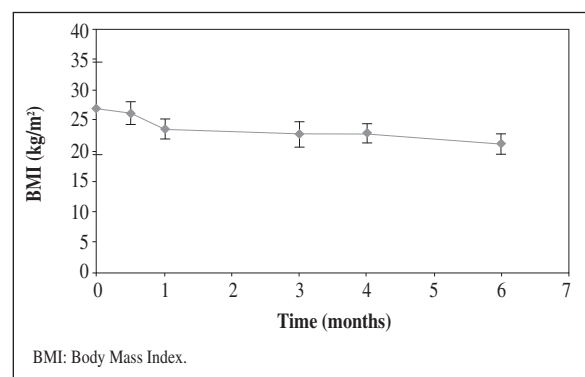


Fig. 3.—Evolution of BMI in patients undergoing.

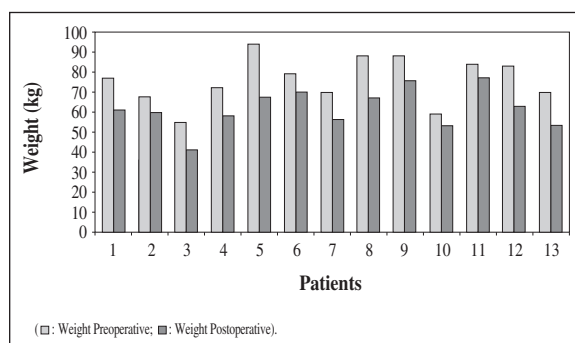


Fig. 4.—Weight changes after laparoscopic BAGUA.

months we observed significant changes ($p < 0.05$) in this, decreasing $8.5 \pm 1.55 \text{ kg}$. In the case of lean mass and muscle mass, there is a small decrease in the first month and then remain stable throughout the 6 months follow up ($p > 0.05$) (fig. 5).

Changes in diet and exercise

Patients were asked about their dietary habits before surgery and six months after this. Seventy-seven percent of patients undergoing surgery performed diet, avoiding an excessive consumption of carbohydrates and fats. After surgery, 90% of these patients have a free diet. Thirty one percent (4/13) of patients operated on, said they had changed their eating habits, not only in quantity (feeling satisfied more easily) but in terms of appetite.

Similarly, patients were asked about physical exercise, intensity and duration of this. The 61.53% (8/13) of patients performed physical exercise, mainly

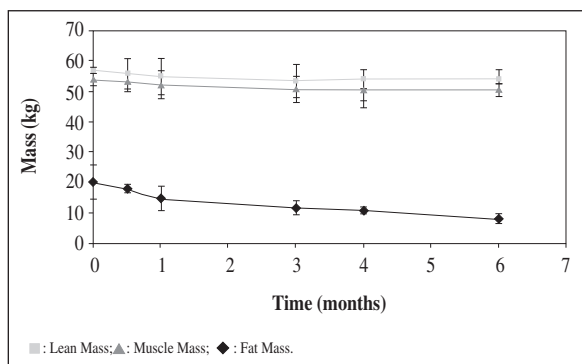


Fig. 5.—Changes in fat mass, lean mass and muscle mass in patients undergoing.

walking for 1 hour at a moderate intensity. After surgery, all they keep doing exercise as part of the diabetic treatment. None of the patients who do not exercise before surgery, is done later. In summary, there are not changes in exercise habits.

Evolution of comorbidities

In the 13 diabetic patients during the preoperative evaluation, the presence of comorbidities (100% of patients with one or more comorbidities) was confirmed (table IV).

Dyslipidemia appeared in 38.46% (5/13) patients, 40% of who used lipid-lowering drugs. Serum levels of total cholesterol, LDL and triglycerides, decreased significantly since the first month ($p < 0.05$).

The 92.3% were hypertensive, with 66.6% treated by antihypertensive drugs. At 6 months, all patients normalized their blood pressure values ($p < 0.05$).

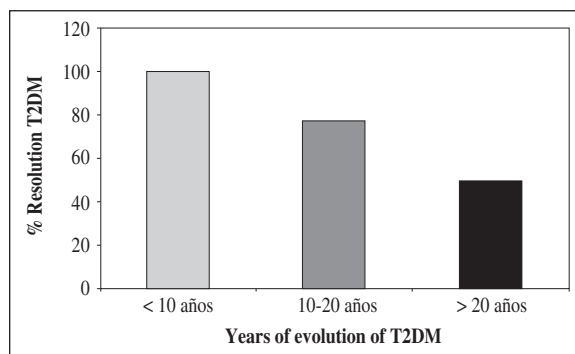


Fig. 6.—Percentage of resolution of the T2DM patients after BAGUA according to the years of evolution of the disease.

The 38.46% (5/13) had some form of heart disease, at 6 months decreased their treatment needs for their illness. The 15.38% (2/13) had depressive disorders.

The resolution of comorbidities occurs in all patients regardless of the resolution of the DM.

Relationship between changes following surgery and the development of T2DM

We have analyzed the possible relationship between preoperative factors, such as years of DM, C-peptide levels and use of insulin, and the evolution of T2DM after surgery.

Remission of type 2 diabetes according to the time of disease progression is shown in figure 6. The 13 patients were divided into 3 groups, group I, DM2 evolution of < 10 years ($n = 2$); group II, DM2 evolution of 10-20 years ($n = 9$) and group III, DM2 evolution of > 20 years ($n = 2$). There were significant diffe-

Table IV
Evolution of comorbidities after BAGUA

Patient	Age (years)	Years of DM	Peptide C	Outcome after DM surgery	Comorbidities	Resolution of comorbidities
1	65	2	4.21	Resolved	HTG	Resolved
2	58	17	1.49	Resolved	HTA	Resolved
3	80	20	1.88	Resolved	HCOL, HTA, Depression	Depression
4	66	19	1.49	Resolved	HTA, Cardiopathy	Cardiopathy
5	60	20	2.27	Resolved	HTA, Cardiopathy	Cardiopathy
6	61	12	0.04	Improved	HTA	Resolved
7	76	37	0	Improved	HTA, Cardiopathy	Cardiopathy
8	65	11	0.06	Improved	HCOL, HTA	Resolved
9	47	8	2.45	Resolved	HTA	Resolved
10	63	19	0.45	Resolved	HTA	Resolved
11	66	15	2.73	Resolved	HTA, HCOL, HTG, Cardiopathy	Cardiopathy
12	66	30	1.57	Resolved	HTA, Cardiopathy	Cardiopathy
13	57	10	2.89	Resolved	HCOL, HTA, Depression	Depression

C Peptide: ng/ml.

HTA: Arterial hypertension; HTG: Hypertriglyceridemia; HCOL: Hipercholesteremia.

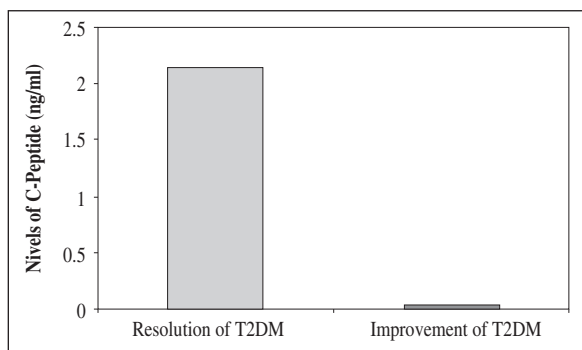


Fig. 7.—Resolution of the T2DM after BAGUA as a function of the levels of PC.

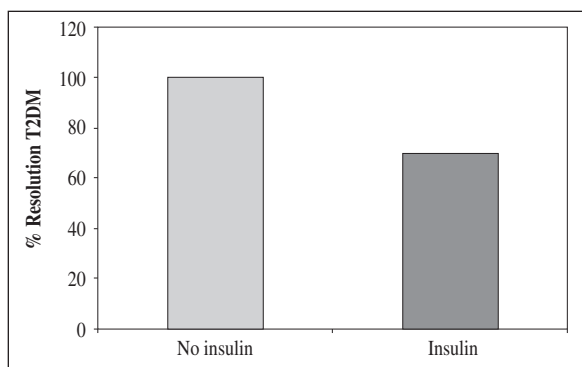


Fig. 8.—Percentage of resolution of the T2DM after BAGUA depending on the use of insulin.

rences among the three groups, as years of diabetes increase the percentage of patients who resolved their disease is decreased.

The relationship between C-peptide levels and the resolution of T2DM is shown in figure 7. Patients who resolved diabetes had mean values of C-peptide of 2.14 ± 1.2 ng/ml (4.21 to 0.45 ng / ml), compared to those that only improve with mean values of 0.033 ± 0.03 ng/ml (0.06 to 0 ng/ml).

According to their need for insulin, the patients not taking insulin solved in 100% of cases the diabetes compared to 70% resolution in insulin-dependent patients (fig. 8).

Discussion

In this study, we evaluated short- and medium-term effects of BAGUA on T2DM and its associated comorbidities such as dyslipidemia, hypertension, heart disease and/or depression.

The Gastric Bypass not only induces a weight loss of significant and lasting manner, but it also produces the improvement or resolution of the DM2 and associated co-morbidities. Several series shows that the Gastric Bypass normalizes hyperglycemia, improved levels of HbA1c and possibly reduces the mortality of the DM 7,17. Most patients recover blood glucose and HBA1c

levels normal after the surgery, and long before they have a significant loss of weight.⁴ This suggests that the control of the DM2 is probably mediated by changes in the secretion of hormones from the gastrointestinal tract and/or other mechanism independent of weight loss.

In our study we agree with the revised series, all patients decreased their values of glucose and HbA1c. Obtaining resolution in 77% of cases (46,15 % immediately after the surgery) and a significant improvement in the rest. We have linked the changes after surgery with the evolution of the DM2. Taking into account what is described in literature on the influence of time of illness and the resolution of this, patients were divided into three groups based on years of Diabetes; we note that the greater the time evolution of the disease, the lower is the percentage of resolution, results also observed in other revised series.^{7,14}

Similarly relate the values of C-peptide (PC) and use of insulin with the resolution of the DM2, our data are consistent with those described in other articles,^{7,14,18} observing a percentage of higher resolution in patients with levels of PC preserved and without use of insulin. This also reinforces the theories described in the literature on the entero-insular axis and the fundamental role of incretins following the metabolic surgery.

As in literature, in our serie, it is obvious a weight loss after gastric bypass. In our patients the mean weight loss was 14.15 ± 6.48 kg.

Similarly, we observed significant changes from preoperative to the amount of fat mass ($p < 0.05$), reaching values recommended but no significant changes were found in the amount of lean mass and muscle mass after surgery. This pattern indicates a proper weight loss, from reserves of fat mass.

We have found not significant changes between the resolution of the DM2 and the percentage of weight lost, as we have said above. A 97.7% of diabetics reaches its ideal weight regardless of the resolution of the DM2. This absence of differences suggests that the weight in these patients does not play an essential role in the resolution of the disease and is consistent with the recent bet from numerous groups by factors related to the evolution of Diabetes.

In concordance with the high prevalence of comorbidities associated with DM2 as described in the literature, in this series there was a 38.46% of patients with dyslipidemia, 92.3% with HTA, 38.46% with heart disease and 15.38% with depression. It was found that 61.5% suffered from more than one of these pathologies. As is the case of bariatric surgery in obese (39), in our patients, after the surgery, it was found a significant improvement in the lipid profile, characterized by a decrease in the levels of total cholesterol, LDL cholesterol and triglycerides and increasing HDL cholesterol levels.

Sjostrom,^{13,19} in patients undergoing bariatric surgery, after two years of follow-up, reported a decrease in the incidence of hypertension (HT). In our serie, after

surgery all the patients suffering from hypertension abandon all the pharmacological treatment.

In the patients with heart disease we note a decline in the use of drugs for their disease, although there is not a complete resolution of this.

In patients with long term deep depression did not find significant differences with regard to the preoperative, possibly due to we follow them in the short-medium term and it is required more time to observe changes or are not affected by the surgery.

We are seeing the start of a new era in the treatment of diabetes although there is still a long way to go. The medical and scientific community should be open to these changes in the treatment of this chronic disease. It must be generated research initiatives with rigorous protocols, enabling comparison of improved surgical techniques with the best pharmacological treatment. These studies will provide information on the criteria in the selection of patients, techniques more secure and identify the best time for surgery.

Conclusions

After One Anastomosis Gastric Bypass surgery, the levels of glucose and HbA1c, experience early improvement. In this small and heterogeneous serie, 77% of diabetic patients resolves the illness, 46% of them immediately after the surgery. A better response would be conditioned by the years of the evolution of the T2DM, levels of C-peptide and use of insulin. In the same way the comorbidities, especially hyperlipidemia and hypertension, are experienced an immediate improvement after BAGUA.

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