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Early Improvement in Glycemic Metabolism after Laparoscopic Sleeve Gastrectomy in Obese Patients – A Prospective Study

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Rezumat

Ameliorarea rapidă a metabolismului glucidic după gastrectomia longitudinală laparoscopică la pacienții cu obezitate - studiu prospectiv

Introducere: Conform Organizației Mondiale a Sănătății, existau în 2014 peste 600 de milioane de adulți cu obezitate (mai mult decât dublu față de anul 1980) care prezintă un risc crescut de dezvoltare a sindromului metabolic, deci inclusiv pentru diabetul zaharat de tip 2. Datorită controlului slab glicemic în urma tratamentului conservator al DZ tip 2, chirurgia metabolică a fost capabilă să câștige un rol important în managementul pacientului cu DZ tip 2 și obezitate, cu remisii sau îmbunătățiri semnificative raportate în literatura de specialitate.
Obiectiv: studierea efectelor gastrectomiei longitudinale laparoscopice (LSG) asupra metabolismului glucidic la pacienții cu obezitate, cu sau fără DZ tip 2.
Metodă: 60 de pacienți consecutivi, operați în spitalul Ponderas pentru obezitate prin gastrectomie longitudinală laparoscopică, au fost incluși într-un studiu prospectiv, în perioada Februarie - Martie 2013. IMC-ul (indicele de masă corporală), circumferință abdominală și parametrii glicemici au fost studiați pre-operator, la 10 zile și 6 luni postoperator.
Rezultate: controlul glicemic a fost semnificant îmbunătățit începând cu ziua 10 postoperatorie. Imbunătățiri semnificative statistic au fost notate la 6 luni postoperator în valorile IMC-ului ($p<0.0001$), circumferința abdominală ($p<0.0001$), glicemie ($p<0.0001$), insulinemie ($p<0.0001$), peptid C ($p<0.0001$) și HOMA.
Concluzii: o îmbunătățire rapidă a metabolismului glucidic, atât la pacienții cu obezitate și DZ tip 2 cât și la cei fără DZ tip 2, se regăsește înaintea scăderii ponderale semnificative (10 zile postoperator). La 6 luni postoperator, când se asociază și o scădere ponderală semnificativă, atât pacienții diabetici cât și cei nediabetici prezintă o îmbunătățire suplimentară a metabolismului glicemic, care poate susține ideea ca gastrectomia longitudinală laparoscopică este o metodă eficientă pentru tratamentul pacienților cu obezitate și sindrom metabolic. Aceste modificări benefice pot explica atât remisia DZ tip 2 dar și prevenția acestuia la pacienții cu obezitate supuși tratamentului chirurgical metabolic.

Cuvinte cheie: obezitate, metabolism glucidic, gastrectomie longitudinală laparoscopică, remisia și prevenția diabetului zaharat tip 2

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Abstract

Background: according to W.H.O. in 2014 more than 600 million adults were obese, (more than doubled since 1980), and face a major risk for the onset of metabolic syndrome, including T2DM. Due to the poor control of glycemic imbalance for the conservative treatment of T2DM, the metabolic surgery was able to gain an important role in modern management of T2DM, with significant reported improvements or remissions for these patients.
Objective: to study the effects of laparoscopic sleeve gastrec-

tomy (LSG) on glycemic metabolism in obese patients, with or without T2DM.
Methods: 60 consecutive patients were included in a prospective study and were submitted to laparoscopic sleeve gastrectomy in Ponderas Hospital between February – March 2013. BMI, waist circumference and glycemic parameters were studied at the moment of entering the study, 10 days after surgery and at 6 months follow up.
Results: the glycemic control was significantly improved starting with postoperative day 10. Statistically significant improvements were noticed after six months postoperatively in BMI values ($p<0,0001$), waist circumference ($p<0,0001$), glycemic levels ($p<0,0001$), insulin ($p<0,0001$), C-peptide ($p<0,0001$) and HOMA.
Conclusions: a rapid induced improvement of glucose metabolism in both diabetic and non-diabetic patients occurs before a significant weight loss (POD 10). At 6 months, when associated with an important weight loss, both diabetic and non-diabetic patients present a furthermore improvement in glycemic metabolism, that enables us to consider that sleeve gastrectomy is an efficient method for a sustained improvement in the metabolic status of patients with obesity. These beneficial changes that can explain the remission of T2DM can also explain the prevention of T2DM after metabolic surgery.

Key words: obesity, glycemic control, laparoscopic sleeve gastrectomy, T2DM remission and prevention

Introduction

Morbid obesity has become a real health problem worldwide with an increased incidence over the last few decades; the most important comorbidities related to this disease are caused by the metabolic changes which occur at various levels in these patients (1). One of the most complex changes is recognized under the generic name of metabolic syndrome and consists of alterations of glycemic metabolism and insulin resistance, dyslipidemia and visceral obesity which will lead in time to the development of aggressive diseases such as Type 2 Diabetes Mellitus (T2DM) and cardio-vascular affections.

The observation that an increased volume of adipose tissue is strongly correlated with higher levels of pro-inflammatory cytokines and with a low grade systemic inflammatory syndrome which is furthermore associated with an increased risk of developing a metabolic syndrome led the scientists to focus on studying whether weight loss might influence all this biological chain reaction (2,3).

When it comes to the most frequently performed type of bariatric surgery, LSG is currently on second position after gastric bypass (GBP), but has the potential of becoming the number one procedure worldwide due to its more physiological mechanisms of action. In this study we tried to estimate the efficiency of this bariatric procedure not only on weight loss but especially on its early metabolic effects.

The present study was conducted on 60 consecutive patients with BMI$>$40 kg/m^2 or BMI$>$35 kg/m^2 and associated co-morbidities submitted to laparoscopic sleeve gastrectomy.

The aim of the study was to evaluate the effects of laparoscopic sleeve gastrectomy (LSG) on glycemic metabolism in obese patients, with or without T2DM.

Material and Methods

In this prospective study we included 60 consecutive patients with BMI$>$40 kg/m^2 or BMI$>$35 kg/m^2 and associated co-morbidities. They were submitted to laparoscopic sleeve gastrectomy in Ponderas Hospital between February – March 2013.

The exclusion criteria were: previous surgical or endoscopic bariatric procedures, gastro-intestinal resections, malignancies, psychiatric diseases, alcohol abuse.

51 patients were normoglycaemic and 9 patients were diagnosed preoperatively with T2DM.

Preoperative evaluation included medical history and clinical examination, biochemical tests, endocrine evaluation in order to exclude any hormonal dysfunction, cardiac and psychological consults, abdominal ultrasonography and upper endoscopy.

Demographics including age, BMI, waist circumference, preoperative glucose levels, fractioned cholesterol, C peptide and insulin were obtained. In order to assess insulin resistance, the homeostasis model assessment of insulin resistance (HOMA - IR) was used. Anthropometric measurements of weight were performed in the morning, after voiding, in light clothing and without shoes. Waist circumference was measured at the midpoint between the lower border of the rib cage and the iliac crest. Body mass index was calculated as kg/m^2. The body composition was estimated by dual-energy X-Ray absorptiometry (DXA) at the moment of including the patient in the study and at 6 months follow-up.

Our standard surgical technique was used in all cases: the stapling line began at 1 cm from the pylorus up to the angle of His, using a calibration tube of 35 Fr. The integrity of the staple line and the position of the gastric tube were checked intra-operatively by methylene blue instillation while the hemostatic control was performed after rising up the blood pressure at a value with 30% higher than the usual blood pressure of each patient. A suction drain and a nasogastric tube were placed in all cases and were removed 24 hours after ending the surgical procedure. All surgical procedures were performed by the same surgical team. Postoperatively, the same clinical and biological parameters were determined in the 10th postoperative day and at six months follow up. All patients received nutritional counseling by the same certified nutritionist.

After the Ethics Committee's approval from Ponderas Hospital, an informed written consent was obtained from all patients before entering the study.

Data were collected and introduced in an Apache OpenOffice Calc database, version 4.1.0 (Copyright © 2014 The Apache Software Foundation). Statistical analysis was performed using R program, version 3.1.2 (2014-10-31) -- "Pumpkin Helmet" (c) R Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria URL http://www.R-project.org/.).

Results

The study group included 22 males and 37 females with a mean age of 41,06 (±11,84) years. BMI value was 41,75 kg/m^2, while the median abdominal waist was 124 cm.

In our study group, 15% of patients (9/60) had T2DM, 30% of patients (15/60) had increased levels of total cholesterol and 41,6% of cases (25/60) had increased levels of triglycerides.

T2DM subgroup included three females and six males; the mean age of the subgroup was 49,5 years (range 44-59 years), the median BMI value was 40,4 kg/m^2 while the median abdominal waist was 133 cm.

Preoperatively, biochemical measurements performed on the entire study group revealed a median glycemic level of 90,5 mg/dl, a median insulin value of 10,7 μU/ml, and a mean C peptide value of 3,25 ng/ml (± 1,42). When studying the lipid profile, a mean level of Cholesterol of 191,18 mg/dl (±39,42) was encountered, while the fractioned levels were: mean LDL-Cholesterol level= 112,34 mg/dl (± 35,91), mean HDL- Cholesterol level = 45,31 mg/dl (± 7,2) in males and 51,01 mg/dl (± 11,05) in females while the median level of triglycerides was 132,5 mg/dl.

In the subgroup of patients diagnosed with T2DM the median glycemic level was 136 mg/dl, median insulin value was 12,8 μU/ml while the mean value of C peptide was 3,87 ng/ml.

The median surgery time was 75 minutes with no conversions to laparotomy. The postoperative course was uneventful in all cases, the patients being discharged after tolerating liquid diet (at 48-72 hours after surgery). No late complications or deaths were recorded.

All the parameters measured preoperatively were determined at 6 months follow-up and significantly statistic correlations were found for BMI ($p < 0,0001$), waist circumference ($p<0,0001$), fasting glucose ($p<0,0001$), insulinemia ($p<0,0001$), C peptide ($p<0,0001$),triglycerides ($p<0,0001$), and HDL cholesterol in males ($p=0,0019$) (*Table 1*).

BMI comparison between the pre-operative and 6 months post-operative values (*Fig. 1*), showed a significant improvement.

Waist circumference also encountered a significant decrease at 6 months postoperatively when compared to the initial values (*Fig. 2*):

Significant modifications for both insulin and C peptide were observed at 10 days postoperatively, respectively at 6 month postoperatively, compared to preoperative values. Preoperatively, the median insulin value was 10,7 μU/ml, while the mean C peptide value of 3,25 ng/ml (± 1,42), at 10 days postoperatively the median value for insulin was 7,52 μU/ml ($p=0,0001$) while the mean value of C peptide was 2,75 ng/ml (±1,21) ($p=0,0014$) while at 6 months postoperatively the median value for insulin was 4.85 μU/ml (4.04) ($p< 0,0001$) and the mean value of C peptide was 1.63 ng/ml (±0.63) ($p<0,0001$) (*Figs. 3, 4*).

In order to establish more specific correlation, Pearson's indexes of linear correlation between BMI respectively waist circumference and levels of insulin, C peptide, HDL, LDL and triglycerides were calculated; the most significant correlations were identified between BMI, respectively waist circumference and insulin levels (0,2484 respectively 0,3109) (*Table 2*).

When estimating Spearman correlation coefficients, the most significant values were obtained between measured serum levels of insulin and C peptide at 6 months postoperatively (*Table 3*).

HOMA 2. A significant improvement was obtained at 10 POD in metabolic changes regarding insulin sensitivity. The median value of the insulin sensitivity significantly increased from 72,2% (at preoperative measurements) to 105,1% at ten days postoperatively ($p<0,01$).

Among patients who initially had an inadequate insulin sensitivity (defined as lesser than 100% values), the post-operative values also encountered a statistically significant improvement (from 46,6% to 87,3%, $p<0,01$) (*Table 4*).

Table 1.

Variable	Preoperatively	6 months follow up	p-value [CI95%]
BMI (kg/m^2) – median (IQR)	41.75 (11.10)	30.10 (7.50)	< 0.0001´H [-]
WC (cm)– median (IQR)	124.00 (27.00)	99.00 (22.00)	< 0.0001´H [-]
Glycaemia (mg/dl) – median (IQR)	90.50 (23.00)	83.00 (10.00)	< 0.0001´H [-]
Insulin (μU/ml) – median (IQR)	10.70 (14.92)	4.85 (4.04)	< 0.0001´H [-]
C peptide (ng/ml) – mean (±SD)	3.25 (±1.42)	1.63 (±0.63)	< 0.0001^2 [1.31 to 1.92]
Cholesterol (mg/dl) – mean (±SD)	191.18 (±39.42)	189.26 (±32.48)	0.5187^2 [-5.71 to 11.19]
LDL(mg/dl) – mean (±SD)	112.34 (±34.91)	117.76 (±28.73)	0.1598^2 [-13.03 to 3.20]
HDL (mg/dl) mean (±SD) - males	45.31 (±7.20)	50.11 (±8.16)	0.0019^2 [-7.61 to -1.98]
HDL(mg/dl) mean (±SD) - females	51.01 (±11.05)	52.25 (±10.03)	0.3410^2 [-3.84 to 1.36]
TGL(mg/dl) – median (IQR)	132.50 (90.00)	100.00 (27.50)	< 0.0001´H [-]

´H Wilcoxon matched-pairs signed-ranks test
^{2} Matched Pairs Student's t test
BMI: body mass index, WC: waist circumference, LDL: low density lipoprotein, HDL: high density lipoprotein, IQR: interquartile range, SD: standard deviation

Figure 1. BMI: pre-operative vs. 6 months postoperative

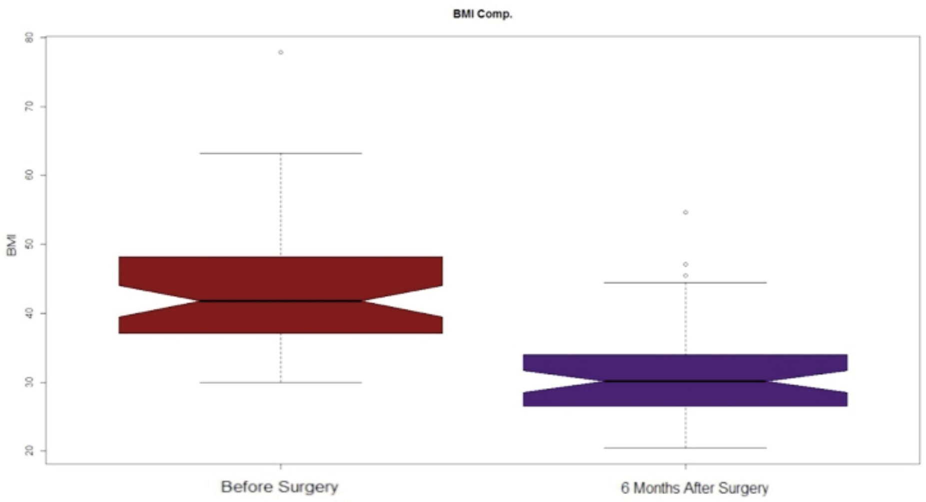


Figure 2. Waist circumference: preoperative vs. 6 months postoperative

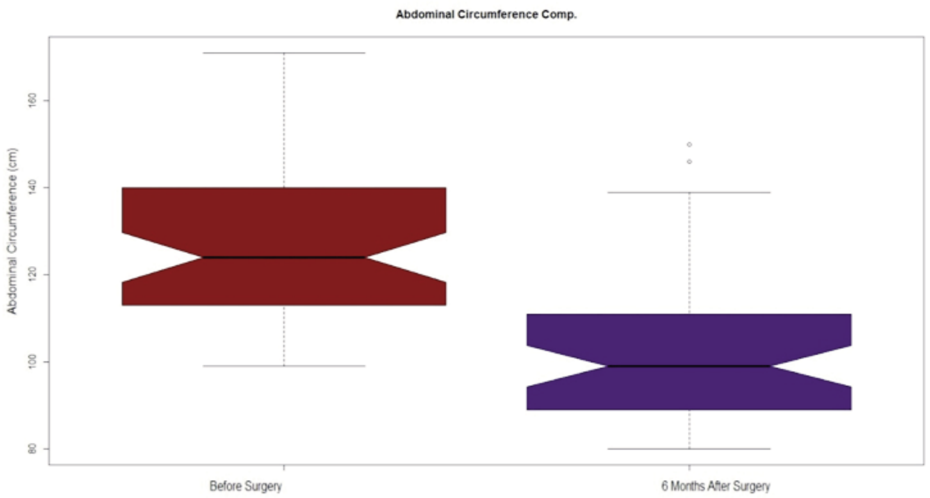
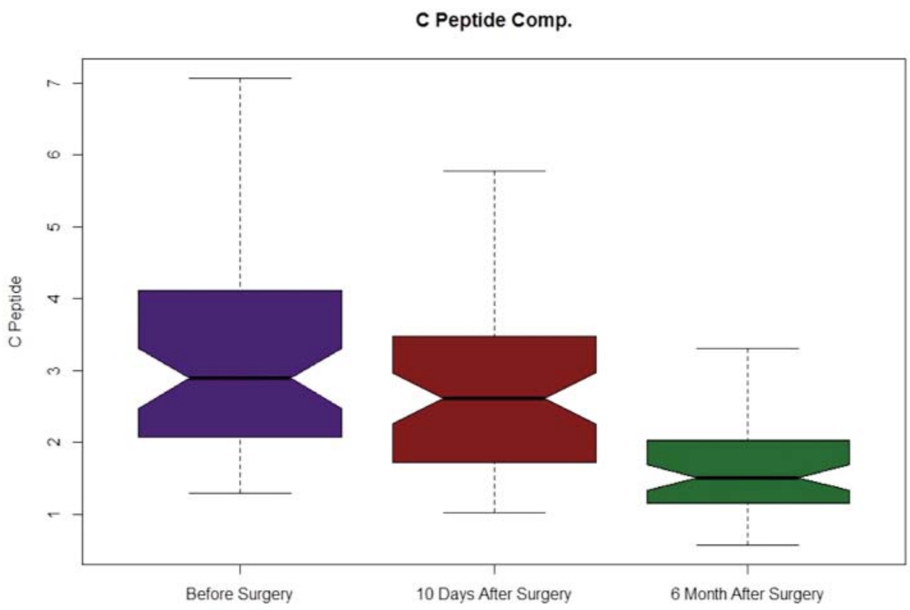


Figure 3. C-Peptide comparison between preoperative and 10 days respectively preoperative and 6 month postoperative values



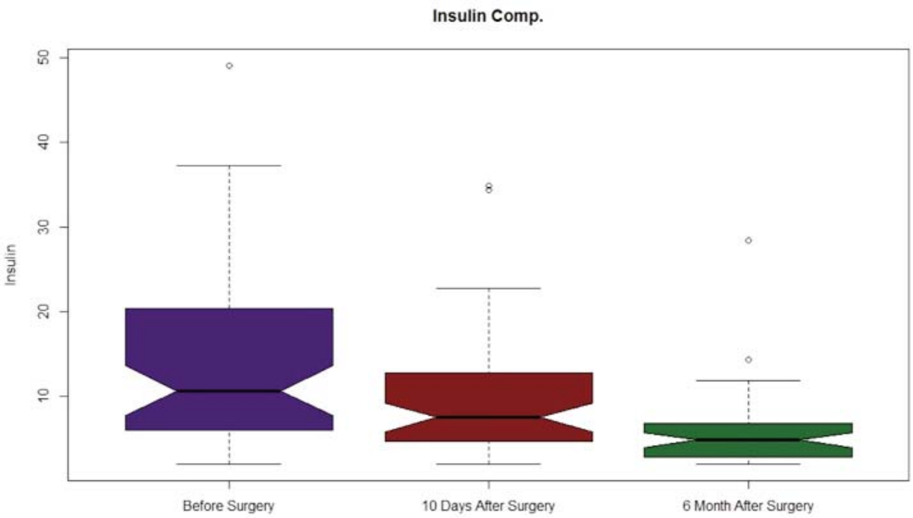


Figure 4. *Insulin comparison between preoperative and 10 days respectively preoperative and 6 month postoperative values*

Table 2. *Pearson's indexes of linear correlation between BMI respectively waist circumference and levels of insulin, C peptide, HDL, LDL and triglycerides*

Predictor	Ins Diff	C Peptide Diff	HDL Diff	LDL Diff	TGL Diff
BMI Diff	0.2484 p = 0.06242	0.0799 p = 0.5543	-0.0392 p = 0.7739	0.0249 p = 0.8579	0.0114 p = 0.9338
Waist Diff	0.3109 p = 0.03146	0.1276 p = 0.3873	0.0121 p = 0.9346	0.2452 p = 0.09663	-0.0515 p = 0.7278

Table 3. *Spearman correlation coefficients*

Correlation	Correlation Coefficient	pValue	
Insulin vs. C Peptide	Preoperatively	0.7033	< 0.0001
Insulin vs. C Peptide	at 10 days postoperatively	0.6466	< 0.0001
Insulin vs. C Peptide	at 6 months postoperatively	0.7411	< 0.0001
Insulin vs. C Peptide	at 10 days postoperatively (diff)	0.7699	< 0.0001
Insulin vs. C Peptide	at 6 months postoperatively (diff)	0.8335	< 0.0001

Table 4. *HOMA modifications ten days after sleeve gastrectomy*

Variable	Preoperative values	10 days postoperatively values	P value
HOMA – median (IQR) t	72.20 (92.20)	105.90 (109.10)	0.0002
HOMA – median (IQR) b 39	46.60 (38.10)	87.30 (63.00)	< 0.001

Modifications encountered at 10 days postoperatively regarding insulin sensitivity are shown in *Fig. 5*.

Insulin sensitivity values at six months postoperatively are shown in *Table 5*. A significant increase of insulin sensitivity (from 72,2% to 171,05%, p<0,01) was found. Among patients with initially altered insulin sensitivity even a more important improvement was obtained (from 46,6% to 154,4, p<0,01).

As expected, according to the modifications of insulin sensitivity, an important change of insulin resistance was observed even from 10 days postoperatively (*Fig. 6*), also statistically significant among patients with initial inadequate insulin sensitivity (*Fig. 7*).

The statistically significant insulin resistance was even more improved at six months postoperatively (*Tables 6, 7*).

Discussions

T2DM is one of the most important health problems worldwide both in developed and in developing countries being strongly associated with obesity and decreased physical

Figure 5. *Modifications of insulin sensitivity among patients with optimal and sub-optimal insulin sensitivity at 10 days respectively 6 month postoperatively*

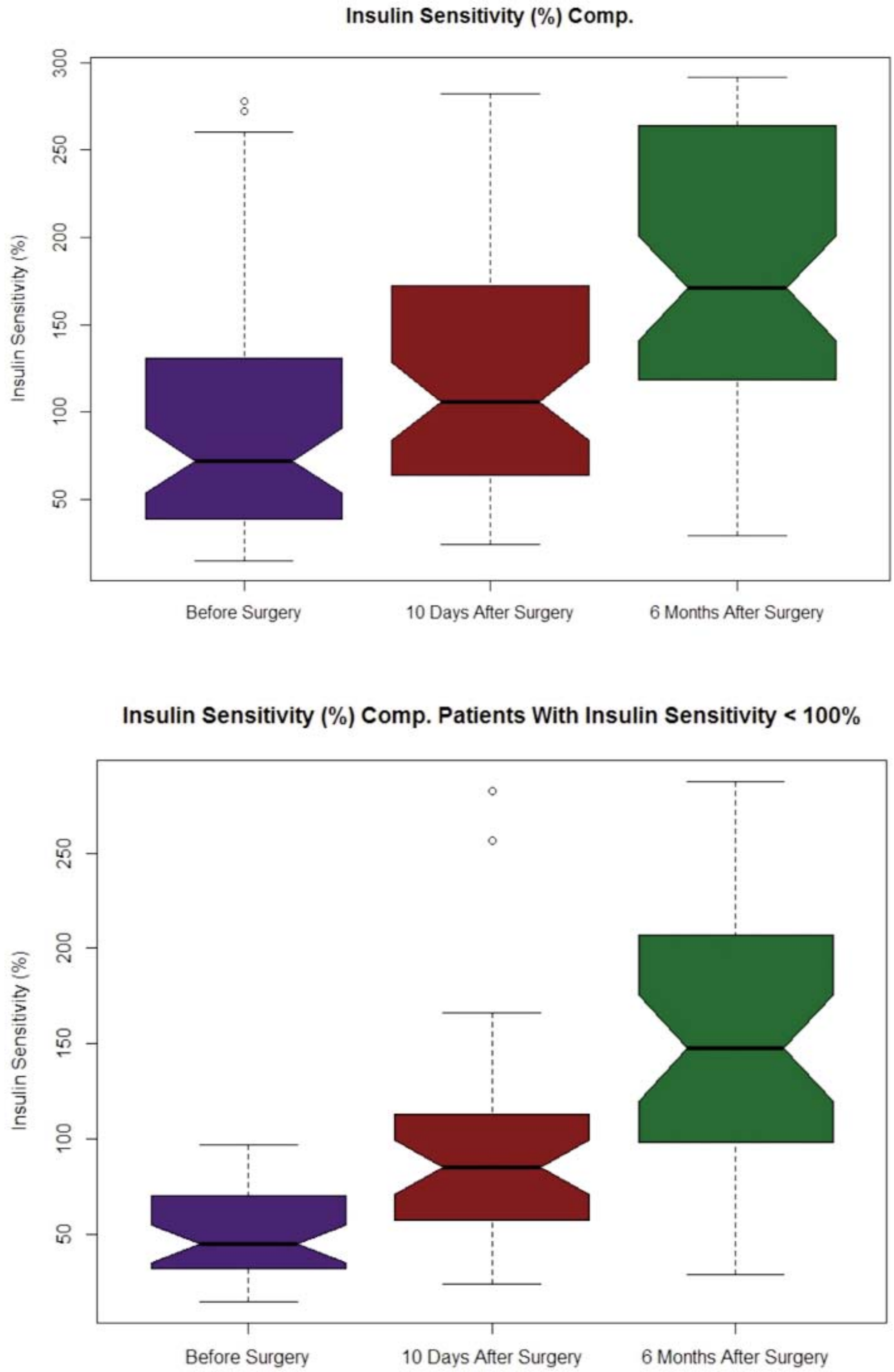


Table 5. *Preoperative insulin sensitivity compared to six months values*

Variable	Preoperative values of insulin sensitivity	Values of insulin sensitivity measured at six months postoperatively	P value
HOMA – median (IQR) t	72.20 (92.20)	171.05 (146.10)	< 0.0001
HOMA – median (IQR) b 39	46.60 (38.10)	154.40 (108.80)	< 0.0001

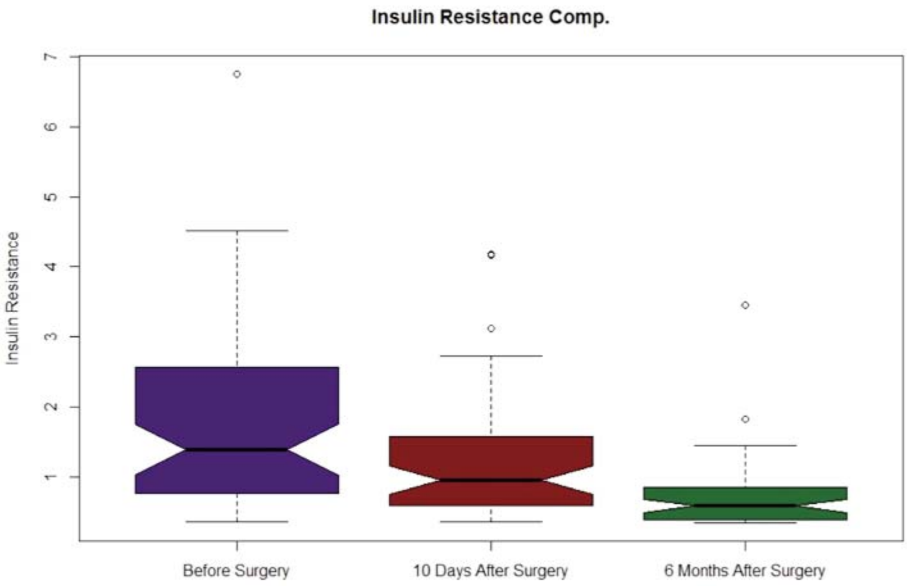


Figure 6. *Modifications of insulin resistance among patients insulin resistance at 10 days postoperatively respectively at 6 month postoperatively*

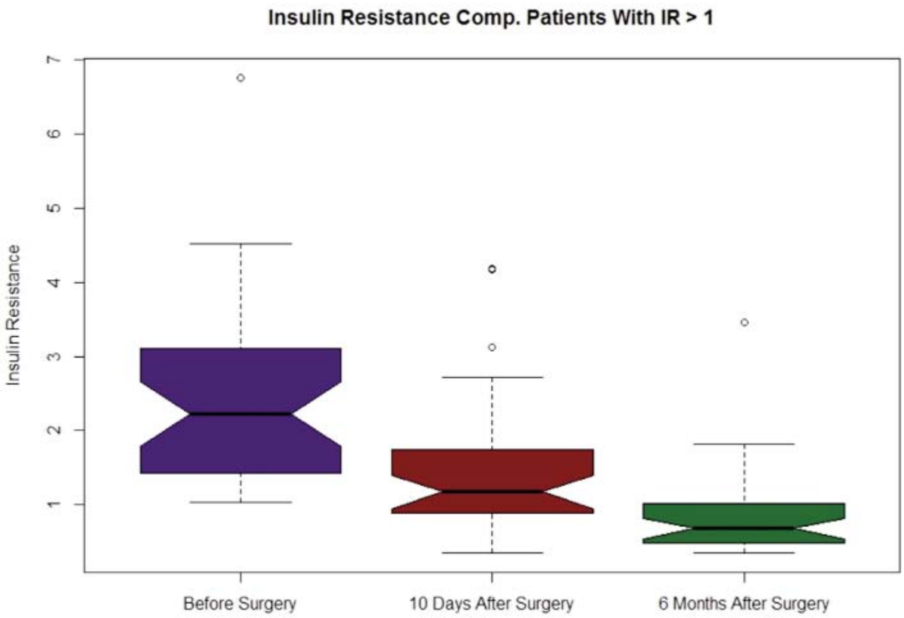


Figure 7. *Modifications of insulin resistance at 10 days respectively six month postoperatively among patients with initial suboptimal sensitivity*

Table 6. *Preoperative insulin resistance compared to 10 days values*

Variable	Preoperative values of insulin resistance	Values of insulin resistance measured at 10 days postoperatively	P value
IR – median (IQR) t	1.3850 (1.7825)	0.945 (0.982)	< 0.0001´H
IR – median (IQR) IR > 1 39	2.220 (1.678)	1.1750 (0.8575)	< 0.0001´H

´H Wilcoxon signed rank test with continuity correction

activity (4). One of the most important diabetes related complications responsible for an increased mortality rate is macro-vascular disease; in the study conducted by Almad et al involving 13000 patients with T2DM a direct correlation between the presence of diabetes mellitus and myocardial infarction, with a threefold increased risk among patients

Table 7. Preoperative insulin resistance compared to six months values

Variable	Preoperative values of insulin resistance	Values of insulin resistance measured at 6 months postoperatively	P value
IR – median (IQR) t	1.3850 (1.7825)	0.5850 (0.4625)	< 0.0001´H
IR – median (IQR) IR > 1 39	2.220 (1.678)	0.6800 (0.5305)	< 0.0001´H

´H Wilcoxon signed rank test with continuity correction

with diabetes mellitus when compared to those with normal glycemic level (5).

In order to establish the correlation between obesity, T2DM and body mass index, Chan et al and Colditz et al conducted two different studies in which they demonstrated a strong relationship between age, body mass index and relative risk of developing T2DM (6,7).

Once these correlations have been widely accepted, attention was focused on whether weight loss might also provide a remission rate of T2DM.

In order to obtain a longer weight loss and secondary a more durable effect on metabolic syndrome remission, including T2DM, attention was focused on the possible role and benefits of bariatric surgery.

Sjostom et al conducted a prospective, matched surgical interventional study on 4047 Swedish Obese Subjects. The study demonstrated that 72% of patients diagnosed with T2DM and submitted to bariatric surgery were in remission at 2 years follow up. The same authors also reported that bariatric surgery reduced the incidence of newly diagnosed patients with T2DM in non-diabetic patients by at least 75% at 2 and 10 years follow up (8, 9, 10), which promoted the idea of metabolic prevention benefits of bariatric surgery.

Our study demonstrates the early significant response of glycemic metabolism after LSG, both in T2DM and normoglycaemic patients, which can be considered an argument for metabolic prevention benefits of LSG.

As we already know, there are T2DM patients with obesity that are leaving the hospital after a bariatric procedure without any need for diabetic medication, long before the weight loss can influence the outcome. What is worth mentioned is that we found statistically significant results in patients with inadequate preoperative insulin sensitivity, explaining the early metabolic response of T2DM patients after LSG.

This is important, especially since sleeve gastrectomy has experienced a major boom over the last decade and became the second option in bariatric patients worldwide after gastric bypass, accounting for 27,8% of all bariatric procedures in 2011 (1). This increase is probably related to the fact that sleeve gastrectomy is a less technically demanding procedure which seems to be associated with almost similar outcomes in terms of weight loss and cure of associated morbidities when compared to gastric bypass (11,12). Other studies found the same results, like the prospective randomized study conducted by Woelner-Hanssen in 2011 involving patients submitted to gastric sleeve or gastric bypass, were there was no statistical significance between preoperative and post-operative levels of insulin, glucose, lipids, leptin and adiponectin between the two groups (13).

In their study Kashyap et al introduced 60 patients with uncontrolled T2DM and moderate obesity (BMI $36\pm2kg/m^2$) and they randomized these cases to intensive medical therapy alone, intensive medical therapy in association to Roux en Y gastric bypass or intensive medical therapy in association to sleeve gastrectomy. After 24 months follow up glycemic control improved in all three subgroups, with a mean level of HbA1c of $6{,}7\pm1{,}2\%$ for gastric by-pass, $7{,}1\pm0{,}8$ for sleeve gastrectomy and $8{,}4\pm2{,}3\%$ for the subgroup treated only with intensive medical treatment, with a reported p value$<0{,}05$ for each surgical sub-group when compared to medical treatment alone.

When estimating the modifications of body composition, the same study concluded that a greater total body weight loss, BMI reduction and a significant change in total body fat per-cent was seen in patients submitted to surgical procedures when compared to standard medical therapy. Another important outcome of this study was the demonstration of improving β cell function in order to achieve an appropriate glycemic control in patients submitted to bariatric surgery (14). This conclusion presented a high significance level due to the fact that other studies conducted only on medical therapy failed to demonstrate a similar effect in medically treated patients. For example, the United Kingdom Prospective Diabetes Study demonstrated that β cell function continues to deteriorate even after administration of oral hypoglycemic agents (15). In the study conducted by Kahn et al conducted on patients with T2DM treated by rosiglitazone – metformin or glyburide the mean time of deterioration of glycemic control was 33-60 months (16), while in a similar study conducted by Cook et al on patients with T2DM submitted to sulfonylureas and metformin the median HbA1c levels deteriorated at 6 months follow up, at a similar rate to those treated by metformin alone (17).

In order to determine the modifications of gluco-lipidic hormones and peptide levels in morbid obese patients, Bruno et al conducted a prospective study involving 20 patients submitted to sleeve gastrectomy, reporting at one year follow up the percentage of BMI loss of 72% while the rate of cure or improvement of the other co-morbidities were: 100% for dyslipidemia, 87,5% for diabetes, 84.6% for HTA and 57.1% for sleep apnea syndrome. At the same time, glycemic levels decreased significantly ($P<.001$), while IGF-1 and HDL-cholesterol levels increased significantly. Leptine levels, insulin levels and triglycerides levels also significantly decreased at one year follow up (p=0,003, p=0,004 and respectively p=0,016).

A similar conclusion may be drawn from our study, where statistically significant correlations were seen at 6 months follow up for glucose levels (p=0,004), insulin levels (p=0,004), triglycerides (p=0,02) and HDL cholesterol (p=0,033) (12).

In their study, Buzga et al included 78 women with an average BMI of 42 kg/m^2 submitted to sleeve gastrectomy, in which postoperative modifications of lipid and glucose metabolism were determined at 6 months follow up. Similarly to our study, statistical significant modifications were seen for BMI values (p<0,001), waist circumference (p<0,001), serum concentrations of triglycerides (p<0,001), C peptide (p<0,002) and high density lipoprotein (HDL) values (p=0,0025); however in the study conducted in our hospital, increased values of HDL cholesterol were seen both in males and women, but there were statistically significant only in males (18).

In our study no statistical significant modifications of LDL levels were seen 6 months postoperatively; similar results were also reported by Buzga et al and Strain et al (18,19).

In the study conducted by Iannelli et al regarding the influence of sleeve gastrectomy versus gastric bypass on the evolution of low-grade systemic inflammation, insulin resistance, anthropometrics, resting energy expenditure and metabolic syndrome, they compared 30 patients submitted to sleeve gastrectomy who were matched for age, sex, body mass index (BMI), and glycosylated hemoglobin (HbA1c) with 30 cases submitted to Roux en Y gastric bypass. Insulin resistance improved comparably in both groups as shown by the HOMA index and C-peptide while the preoperative difference in blood levels of insulin found before surgery reached borderline statistical significance one year after surgery (p = 0.05) (3).

In a similar study conducted by Lee et al involving 20 severe diabetic patients with BMI values ranging between 25-35 kg/m^2 preoperative values of HOMA index was 9.5, decreased immediately to 6.3 at 1 week postoperatively than it progressively decreased to 1.5 during follow-up (20).

In order to determine which are the best predictors of remission of type 2 diabetes mellitus in obese patients after gastrointestinal surgery, Lee et al introduced in their study 62 patients with T2DM with a mean body mass index (BMI) of 40.0 kg/m^2. They performed surgical procedures gastric sleeve in 12 cases, gastric bypass in 17 cases and mini-gastric bypass in 33 cases. Preoperative HOMA index was 18,2 ± 23 in the subgroup submitted to mini-gastric bypass, 17,5 ± 27,3 in the subgroup submitted to Roux en Y gastric by-pass and 20,2+/- 26,2 in the subgroup submitted to gastric sleeve (overall significance level 0,815). One year after surgery HOMA index was 1,1±0,9 for patients submitted to mini-gastric bypass, 4,2±2,6 for patients submitted to Roux en Y gastric by-pass and 1,8±0,3 for cases submitted to sleeve gastrectomy (overall significance level <0,00001). At one year follow up T2DM was best controlled in patients submitted to mini-gastric bypass followed by sleeve gastrectomy and gastric bypass. In conclusion, this study demonstrated that the operative associated with HOMA-IR were significant predictors of successful gastrointestinal surgery for the remission of T2DM in obese patients. Other significant prognostic factors were the serum levels of insulin, C-peptide and HbA1c (21).

Conclusions

As we already know, sleeve gastrectomy is a safe and efficient bariatric procedure associated with good outcomes and improvement of comorbidities' control from the first postoperative days, being associated to fast changes in glycollipid metabolism.

Improved rates of systemic glycemic control even in normoglycaemic patients enable us to consider that sleeve gastrectomy is not only an efficient therapeutic option for patients diagnosed with T2DM but also an efficient method in order to prevent T2DM onset in obese normoglycaemic subjects.

We reckon that along gastric bypass, LSG might be proposed as a prevention method for T2DM in obese patients and due to its more physiological mechanism should be considered even for T2DM patients with lower BMI's.

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