

## DIGESTIVE AND METABOLIC CHANGES IN POSTOPERATIVE BARIATRIC SURGERY

### *Alterações metabólicas e digestivas no pós-operatório de cirurgia bariátrica*

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**ABSTRACT – Background** - Changes in digestion and nutrients losses are relevant aspects in weight reduction and maintenance of the nutritional status of patients undergoing gastroplasty, but few studies are available in the literature. **Aim** - To study the systemic changes arising from the reduction in weight over time after surgery. **Method**: A prospective cohort study with 44 morbid obese patients operated on between July 2001 and April 2005. The operation performed was a gastric by pass Roux-en-Y with silicon ring. Medical tests were conducted at different times: preoperatively, six months after the operation and during the years 2006 and 2007. The examinations performed were: fasting glucose, serum albumin, total cholesterol, hemoglobin, fecal fat, reducing substance in stool, occult blood in the stool. Endoscopy was also performed to measure the ring in centimeters. Also studied were the gender, age, height, weight, BMI, diabetes, and time after operation. **Results**: The initial weight ranged from 91 to 216 kg (Md = 141 kg) and BMI at this stage was between 36,3 and 80,3 kg/m<sup>2</sup> (Md = 49,28 kg/m<sup>2</sup>). Anemia manifested in eight patients (18,2%) and 13 (29,5%) had albumin with reduced values. Follow-up ranged from 32 to 79 months (X = 52,5 months, SD = 8,8). The final weight ranged from 60,3 to 122,9 kg (mean = 83,95 kg, 1<sup>o</sup> and 3<sup>o</sup> quartile = 75,7 and 83,95) and BMI was between 24,62 and 45,54 kg/m<sup>2</sup> (mean = 31,69 kg/m<sup>2</sup>, 1<sup>o</sup> and 3<sup>o</sup> quartile = 28,93 and 35,89). The percentage of weight reduction at this stage was 36,31% (p>0,001), one patient had weight gain, in three (6,8%) patients the albumin level was reduced and nine had anemia. The faecal fat was positive in 16 patients (36,4%), reducing substance in stool was positive in one patient and the presence of faecal occult blood was positive in 13 patients (29,5%). The internal diameter of the silicon ring was between 0,45 and 1,4 cm (mean 0,75, SD = 0,22). **Conclusion** - After surgery there is a significant weight loss, but the BMI is still above 35 kg/m<sup>2</sup> in 26 patients (59%), followed for a long time. There is a substantial improvement in cholesterol and glucose blood levels. The diameter of ring in the small stomach showed no significant association with weight reduction, while patients with greater than 1 cm ring did not show anemia or low levels of albumin, clinically better than those with rings smaller than 1 cm.

**HEADINGS** – Obesity. Postoperative. Bariatric Surgery.

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**RESUMO – Racional** - As alterações na digestão e perdas de nutrientes são aspectos relevantes na redução do peso e na manutenção do estado nutricional do paciente submetido à gastroplastia, mas poucos estudos estão disponíveis na literatura. **Objetivo** - Estudar as alterações sistêmicas decorrentes da redução de peso ao longo do tempo, após o tratamento cirúrgico. **Método** - Estudo tipo coorte prospectivo com amostra de 44 indivíduos, obesos mórbidos, operados com derivação gástrica em Y-de-Roux e com anel de silicone. Análises clínicas foram realizadas em tempos distintos: período pré-operatório, seis meses após a operação e durante os anos de 2006 e 2007. Os exames efetuados foram: glicemia de jejum; albumina sérica; colesterol total; hemoglobina; gordura fecal; substância redutora nas fezes; sangue oculto nas fezes. Endoscopia digestiva alta também foi realizada para medir o anel em centímetros. Ainda foram estudados o gênero, idade, altura, peso, IMC, diabetes, e o tempo após a operação. **Resultados** - A mediana do peso foi de 141 kg (91 - 216) e o IMC, teve mediana de 49,28 kg/m<sup>2</sup> (36,3 - 80,31). A anemia se manifestou em oito (18,2%) pacientes e 13 (29,5%) apresentaram albumina com valores reduzidos. No final do estudo, a média dos meses de seguimento foi de 52,56 + 8,84 meses. O peso médio foi de 86,96 + 15,44 kg e a média do IMC foi de 32,41 + 4,82 kg/m<sup>2</sup>. A pesquisa de gordura fecal foi positiva em 16 pacientes (36,4%), substância redutora positiva nas fezes em um (2,3%) paciente e presença de sangue oculto nas fezes foi positiva em 13 (29,5%) pacientes. O diâmetro interno do anel de silicone apresentou uma média de 0,75 cm + 0,23 cm. **Conclusão** - Após a operação ocorreu perda significativa de peso, porém, o IMC ainda se mantinha acima de 35 kg/m<sup>2</sup> na maioria dos pacientes acompanhados por longo tempo. Houve melhora substancial dos níveis de colesterol e glicemia. O diâmetro do anel não demonstrou associação significativa com a redução do peso; contudo, os pacientes com anel superior a 1 cm, não apresentaram anemia ou hipoalbuminemia, estando clinicamente melhores do que aqueles com anel menor.

**DESCRITORES** - Obesidade. Pós-operatório. Cirurgia bariátrica.

The cause of obesity is multifactorial where genetics and sedentary lifestyle associated with diets hypercaloric contribute substantially to its development with a significant increase in morbidity and mortality <sup>11</sup>. The most common comorbidities: heart disease, diabetes, hypertension, joint diseases and sleep apnea<sup>7</sup>.

Gastroplasty is the only treatment option that has resulted in effective and sustained long term<sup>7</sup>. In 1967, Mason performed the gastric bypass for treatment of obesity<sup>5</sup>. The Y gastric bypass Roux-en-with silicone ring technique is widely and successfully used, but controversy exists as to which mechanisms are involved in long-term weight loss. Changes in digestion and nutrient losses are relevant aspects in reducing weight and maintaining the nutritional status of patients undergoing gastroplasty, but few studies are available in the literature.

This work aimed to study systemic alterations resulting from the reduction in weight over time after surgery.

**METHOD**

Prospective cohort study, conducted at the University Hospital of Londrina State University between July 2001 and December 2007. The study population comprised 44 individuals, morbidly obese patients operated between July 2001 and April 2005, having joined the multidisciplinary ambulatory care until December 2007. All patients signed informed consent to participate. This study was approved by the Bioethics Committee of the Londrina State University, according to resolution 196/96 of the National Health

Medical tests were conducted at different times: preoperatively, six months after the operation and during the years 2006 and 2007. Followed the conventional collection and standardized reference values. The tests were performed: fasting glucose, serum albumin, total cholesterol, hemoglobin, fecal fat, reducing substance in stool occult blood in the stool. Endoscopy was also performed to measure the ring in centimeters.

The operation performed was gastric bypass in Roux-en-Y with silicon ring in the distal third of the gastric pouch by laparotomy.

The variables were: gender, age, height, weight, BMI, diabetes, clinical testing and endoscopy cited, and the time after the operation.

Data were collected and analyzed from a prospective protocol with descriptive and analytical component.

Statistical significance was set at 5% (p <0.05). Statistical analysis was performed using the

Of the 44 patients studied, 10 (22.7%) were male and 34 (77.3%) females. The age ranged between 18 and 61 years, with an average of 41.13 + 9.22 years. The height was between 1.45 m and 1.88 m with a mean of 1.64 + 0.90 m.

In the preoperative phase was observed that 13 (29.6%) patients were diabetic and required treatment with hypoglycemic agents; the end of the study, this figure dropped to 6 (13%). Blood glucose was within the normal range from 6. months after the operation and remained so until the end of the study.

Total cholesterol, preoperatively, was high (> 239 mg/dL) in four (9.1%) patients at 6. months after surgery in only one (2.3%) and at the end of the study none had high levels of total cholesterol.

In the pre-operative median weight was 141 kg (91 - 216). BMI at this stage showed an average of 49.28 kg/m<sup>2</sup> (36.3 to 80.31). Anemia is expressed in eight (18.2%) patients and 13 (29.5%) had albumin with reduced values.

After six months of postoperative follow-up, average weight was 103.2 + 23.34 kg and median BMI was 36.56 kg/m<sup>2</sup> (27.30 to 58.37). The percentage of weight loss was 26.70% (p <0.001). Eleven (25%) patients had anemia and hypoalbuminemia was recognized in seven (15.9%). Table 1 shows the result of the BMIs of patients at 6. months after the operation, categorized according to the classification of Reinhold, cited by Maruja ND<sup>6</sup>.

**TABLE 1 – BMI of patients at 6. months (classification of Reinhold<sup>6</sup>)**

BMI kg/m <sup>2</sup>	n	(%)
Less than 30	3	(6,8)
Between 30 and 35	14	(31,8)
Greater than 35	27	(61,4)
<b>Total</b>	<b>44</b>	<b>(100)</b>

At the end of the study, the mean months of follow-up was 52.56 + 8.84 months. It was noted then that the average weight was 86.96 + 15.44 kg and mean BMI was 32.41 + 4.82 kg/m<sup>2</sup>. The percentage weight reduction at this stage was 36.31% (p <0.001). One patient (2.3%) showed weight gain. In three (6.8%) and albumin was reduced nine (20.5%) had anemia. Table 2 presents the final results of the BMI of the patients<sup>8</sup>.

By checking the behavior of albumin during the study showed that in the first six months increased

**TABLE 2 – BMI of patients in the final stage (classification of Reinhold<sup>8</sup>)**

BMI kg/m <sup>2</sup>	n	(%)
Less than 30	18	(40,9)
Between 30 and 35	14	(31,8)
Greater than 35	12	(27,3)
<b>Total</b>	<b>44</b>	<b>(100)</b>

significantly, going from a median of 3.47 (2.80 to 4.29) to 3.69 (3.20 to 4.14 ) (p = 0.026). This increase was kept growing until the end of the study, but no statistically significant difference between the values found in the first six months and end of study.

Anemia was detected in eight patients (18.2%) still in the pre-operative in the first half after surgery there was a significant increase in the number of anemic patients rising to 11 (25% p <0.001). At the end of the study the prevalence decreased to nine patients (20.5%) (p = 0.018) similar to the initial phase (p = 0.186).

Even in the final phase of the study, tests were performed for fecal fat that was positive in 16 patients (36.4%), reducing substance in stool in a positive (2.3%) and presence of occult blood positive stool in 13 (29.5%). endoscopic Measure the inside diameter of the silicon ring showed an average of 0.75 cm + 0.23 cm.

In this study there was no correlation between the internal diameter of the ring and weight reduction at six months and at the end of the study (R = 0.001 and R = -0.005, respectively). Table 3 shows the distribution of measurement of the diameter of the ring according to the classification of Reinhold<sup>6</sup>.

**TABLE 3 – Size of the diameter of the ring at the end of the study (classification of Reinhold<sup>8</sup>)**

bmi kg/m <sup>2</sup>	n	(%)	Ring > 1cm	(%)	Ring < 1cm	(%)
< 30	18	(40,9)	4	(57,2)	14	(37,8)
30 e 35	14	(31,8)	1	(14,3)	13	(35,1)
> 35	12	(27,3)	2	(28,5)	10	(27,1)
<b>Total</b>	<b>44</b>	<b>(100)</b>	<b>7</b>	<b>(100)</b>	<b>37</b>	<b>(100)</b>

When using the average ring size as a cutoff, one can observe a significant association between larger rings (above average) and presence of faecal occult blood (p = 0.050). In setting the value of 1 cm as the cutoff point for the diameter of the ring, it is observed that patients with measurements above this value showed a significant association with the presence of fecal fat (p = 0.003). Table 4 presents the frequency of fecal fat, fecal occult blood and the presence of reducing substance in stool, distributed by the ring size. Table 5 presents the final results of the BMI of the patients and the variables that had changed, categorized according to the classification

of Reinhold<sup>4,6</sup>. Three patients (6.8%) showed no change.

**TABLE 4 – Variables distributed ring size**

Ring	< 1cm	(%)	> 1cm	(%)
Fecal fat +	10	(27)	6	(85,7)
Occult Blood +	9	(24,3)	4	(57)
Hypoalbuminemia	3	(8,1)	0	(0)
Anemia	9	(24,3)	0	(0)
<b>n</b>	<b>37</b>	<b>(100)</b>	<b>7</b>	<b>(100)</b>

**TABLE 5 – Variables changed according to the classification of Reinhold<sup>8</sup>**

BMI	< 30	(%)	30 a 35	(%)	> 35	(%)	Total	(%)
AANEM	4	(22,2)	4	(28,5)	1	(8,3)	9	(20,5)
Hipoalbuminemia	2	(11,1)	1	(7,2)	0	(0)	3	(6,8)
Fecal fat +	6	(33,3)	6	(42,8)	4	(33,3)	16	(36,4)
Occult blood +	6	(33,3)	3	(21,5)	4	(33,3)	13	(29,6)
<b>n</b>	<b>18</b>	<b>(100)</b>	<b>14</b>	<b>(100)</b>	<b>12</b>	<b>(100)</b>	<b>44</b>	<b>(100)</b>

## DISCUSSION

Bariatric surgery is the treatment of choice for morbid obesity and its objectives are to reduce the signs of hunger, increase satiety signals producing controllable state of malnutrition<sup>6</sup>. In this study, patients were followed for an average period of 52 months and noted that the weight reduction was 26.7% in the first six months and 36.5% at the end of the study. BMI who initially presented median of 49.28 kg/m<sup>2</sup> decreased to 36.5 kg/m<sup>2</sup> at six months postoperatively and 32.4 kg/m<sup>2</sup> at the end of the study. Although there was significant reduction of weight at the end of the study, 26 (59.1%) patients had a BMI greater than 30 kg/m<sup>2</sup> and 12 (27.3%) of these had a BMI above 35 kg/m<sup>2</sup>. Other authors observed weight gain in five to seven after operation. According to Christou following 10 years, noted that 57% of patients had a BMI between 40 and 49 kg/m<sup>2</sup>. However, a significant improvement of comorbidities<sup>3</sup>. This fact was also observed in this study because there was an improvement of 50% of type II diabetes with normal blood glucose levels from<sup>6</sup>. months after the operation and improvement in total cholesterol levels, where all patients had normal levels at the end of the study.

Anemia can affect two thirds of patients after surgery, this is due to iron deficiency and vitamin B12, folic acid and micronutrients, combined with a chronic inflammatory process<sup>8,10,11</sup>. The evolution of anemia in this study happened to differently. It was observed in the preoperative period eight (18%) patients had anemia, increased to 11 (25%) after operation and at the end of the study, dropping to 9 (20%) - similar to preoperatively. Of the anemic patients in the final stage,

one (11.1%) was associated with hypoalbuminemia and one (11.1%) in the presence of fecal occult blood. Therefore, malnutrition or loss of blood does not explain satisfactorily the anemic syndrome.

Agrawal to study the effect of weight reduction on albumin, found that 6.2% of the patients had microalbuminuria, and it was more important in patients with diabetes or metabolic syndrome<sup>2</sup>. In another study, the same author observed that albuminuria was directly proportional to weight loss<sup>1</sup>. This fact, corroborated by other studies that have shown an association between high weight loss and glomerular hyperfiltration, microalbuminuria or proteinuria with hypoalbuminemia and 4. In this study the patients had significant improvement in serum albumin, for the preoperative evaluation 13 (29.5%) had hypoalbuminemia, at 6<sup>th</sup> months after surgery that number decreased to seven (15%) and remained reduced until the end of the study when there was only three (6.8%) patients.

In the final phase of the study, the presence of faecal fat in 16 (36.4%) patients, reducing substance in stool in one (2.3%) patient. This result demonstrates deficiency in digestion and absorption of fat with little loss in digestion and absorption of carbohydrates after the operation. However, specific studies are needed in the quality of digestion and nutrient absorption in patients after surgery for definitive conclusions.

By analyzing the diameter of the ring, it was observed that a total of 37 patients with rings smaller than 1 cm, 34 (91.8%) had a BMI above 30 kg/m<sup>2</sup>, and a total of seven patients ring greater than 1 cm, all had a BMI above 30 kg/m<sup>2</sup>. Several authors have demonstrated the importance of the size of the silicone ring on the patient sustained weight loss. This study did not demonstrate this association.

Of the 34 patients with rings smaller than 1 cm, nine (26.4%) developed anemia and nine (26.4%) with fecal occult blood. This fact can be explained by the difficulty of passage of food through the ring and consequent injury gastric mucosa. However, only one patient had two amendments.

Of the seven patients with ring greater than 1 cm, six (85.7%) had positive fecal fat, four (57%) occult blood present in feces, but no anemia or hypoalbuminemia. Thus, patients with a larger ring that cm is easier in gastric emptying, resulting in increased loss of fat in feces. The presence of occult blood in stools may occur due to poor digestion of foods of animal origin. However, there is no impact on the patient's nutritional status and incidence of anemia.

After the operation was significant loss of weight, but BMI is still maintained above 35 kg/m<sup>2</sup> in most patients followed for a long time. There was substantial improvement in cholesterol and glucose levels. The diameter of the ring showed no significant association with weight reduction, however, patients with more than 1 cm ring, did not show anemia or hypoalbuminemia, with clinically better than those with smaller ring.

## REFERENCES

1. Agrawal V, Krause KR, Chengelis DL, Zalesin KC, Rocher LL, McCullough PA.. Relation between degree of weight loss after bariatric surgery and reduction in albumina and c-reactive protein. *Surg Obes Relat Dis*. 2009;5(1):20-6.
2. Agrawal V, Khan I, Rai B, Krause KR, Chengelis DL, Zalesin KC, Rocher LL, McCullough PA. The effect of weight loss after bariatric surgery on albumina. *Clin Nephrol* 2008;70(3):194-202.
3. Christou N V, Look D, Maclean L D. Weight gain after gastric by pass. *Ann Surg*. 2006;244(5):734-40.
4. Kruel NF, Huber PD, Roza A, Waltrick CA, Bernardo SA, Silva ACO Mamprim FC. Roux-en-Y gastric bypass for the treatment of morbid obesity: effects on body mass index and blood pressure in the first 90 postoperative days. *ABCD Arq Bras Cir Dig* 2003;16(2):57-60.
5. Ferraz AAB, Martins-Filho ED, Arruda PCL, Lima MHOLA, Araújo Jr. JGC, Nóbrega Jr. BG, Ferraz EM. Surgical cost of the Fobi-Capella gastric bypass in the University hospital, Recife, PE, Brazil. *ABCD Arq Bras Cir Dig* 2002; 15(2): 71-73.
6. Maruja ND. Weight loss after bariatric surgery and renal parameters. *J Am Soc Nephrol* 2006;17:S213-17.
7. Melinda AM. Meta-Analysis: surgical treatment of obesity. *Ann I M* 2005; 142(5) ;557-59.
8. Pareja JC, Pillo VF, Geloneze Neto B. Mecanismo de funcionamento das cirurgias anti-obesidade. *Einstein*, 2006;supl 1:S120-S124.
9. The SBU on overweight and obesity. Huge increase of overweight-related diseases. *Lakartidningen*. 2002;99:3188-3192.
10. Topart P. Iron deficiency and anemia after bariatric surgery. *Surg Obes Relat Dis* 2008;4:715-20.
11. Torten O, Björkman S, Lindroos A, Maleckas A, Lönn L, Sjöström L, Lönroth H. Body composition, dietary intake, and energy expenditure after laparoscopic Roux-en-Y gastric bypass and laparoscopic vertical banded gastroplasty: a randomized Clinical trial. *Ann Surg*. 2006 Nov;244(5):715-22.
12. Vázquez PA, Garcia FA, Montalvá Orón EM. Evolution of the blood parameters after morbid obesity surgery with the duodenal crossing technique. *Nut Hosp* 2008;23(5):449-57.
13. Von Drygalshi A, andris DA. Anemia after bariatric surgery: more than just iron deficiency. *Nutr Clin Pract*, 2009;24(2):217-26.