

## Effects of the partial gastrectomy associated to anterior truncal vagotomy in the metabolism of the iron in rats<sup>1</sup>

Efeitos da gastrectomia parcial e vagotomia troncular anterior no metabolismo de ferro de ratos

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### ABSTRACT

**Purpose:** To evaluate the effects of the partial gastrectomy associated to anterior truncal vagotomy in the absorption and metabolism of iron. **Methods:** Eighteen adults male Wistar rats were submitted to the partial gastrectomy associated to anterior truncal vagotomy (eight animals) and the sham operation (10 animals, control group). The diet consumption and the weight gains of the animals were monitored three times during the week. The animals received supplements of vitamin B12, for the prevention of the megaloblastic anemia, and a formulated experimental diet orally and denominated AIN-93M by 8 weeks. The fecal iron, apparent absorption of the iron, haematocrit, haemoglobin and serum iron were measured after 60 days. **Results:** The animals undergoing sham operation presented larger statistical averages ( $p < 0.05$ ) for the diet consumption, weight gains, apparent absorption of iron, haematocrit, haemoglobin and serum iron compared to the gastrectomized group. However, the excretion of iron in feces was larger in the gastrectomized group (+14.3%) ( $p < 0.05$ ) when compared to the control group. **Conclusion:** Partial gastrectomy associated to anterior truncal vagotomy showed to be a good experimental model the study of iron metabolism, decreasing the haematocrit, the haemoglobin and the iron absorption, consequently causing anemia.

**Key words:** Gastrectomy. Iron. Anemia. Rats, Wistar.

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### RESUMO

**Objetivo:** Avaliar os efeitos da gastrectomia parcial associada a vagotomia troncular anterior na absorção e metabolismo do ferro. **Métodos:** Dezoito ratos Wistar machos e adultos foram submetidos a gastrectomia parcial e vagotomia troncular anterior (oito animais) e à laparotomia simples como grupo controle (10 animais). O consumo de dieta e o peso dos animais foram monitorados três vezes por semana. Os animais receberam suplementos de vitamina B12 para prevenção de anemia megaloblástica, além de dieta oral formulada experimentalmente e denominada AIN-93M, durante 8 semanas. O ferro fecal, a absorção aparente de ferro, o hematócrito a hemoglobina e o ferro sérico foram mensurados, após 60 dias de observação. **Resultados:** Os animais controles apresentaram médias estatísticas maiores ( $p < 0.05$ ) para o consumo de dieta, ganho de peso, absorção aparente de ferro, hematócrito, hemoglobina e ferro sérico comparados aos animais gastrectomizados. Entretanto, a excreção de ferro nas fezes foi superior no grupo de animais gastrectomizados (+14.3%) ( $p < 0.05$ ) quando comparado com o grupo controle. **Conclusão:** A gastrectomia parcial associada a vagotomia troncular anterior mostrou ser um bom modelo experimental para o estudo do metabolismo do ferro, ocasionando diminuição do hematócrito, da hemoglobina e absorção de ferro, e conseqüentemente causando anemia.

**Descritores:** Gastrectomia. Ferro. Anemia. Ratos Wistar.

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### Introduction

The iron is the fourth more abundant element in the terrestrial crust and it is an essential nutrient for practically all the alive beings. Therefore, in spite of its abundance, it is not

captured easily by the alive organisms in reason of its insolubility in the water, except in acid solution<sup>1</sup>.

The total ou partial gastrectomy is employed in the surgical

treatment of benign ou malignant gastroduodenal diseases, including the gastric cancer<sup>2</sup>. The gastrointestinal transit after the partial gastrectomy is rebuilt through anastomosis with the duodenum (Billroth I-BI) or the jejunum (Billroth II-BII). The partial or total resection of the stomach includes the removal of the whole antrum and consequent decrease in the production of hydrochloric acid (HCl) and of the intrinsic factor, then the digestive function of the stomach and duodenum and the absorption processes are altered<sup>3-5</sup>.

Therefore, the absorption of the iron can be harmed after the gastrectomy, because its needs the hydrochloric acid to be better absorbed in the ferrous form in the duodenum<sup>6</sup>.

This research has as objective evaluates the effects of the partial gastrectomy associated to truncal anterior vagotomy in the metabolism of iron in rats, a model for anemia study.

## Methods

### Experimental protocol

Eighteen adult male Wistar adult rats 250.0 ± 5g of corporal weight were submitted to anterior truncal vagotomy and to partial gastrectomy (Billroth II), being divided in two groups: gastrectomized (eight animals, GXT) and operated sham (10 animals, CO). After 15 days of the procedure, the animals received the formulated experimental diet orally and denominated AIN-93M by 8 weeks, which have a better balance of essential nutrients and it is better choice for studies with laboratory rodents<sup>6-8</sup>. The animals were maintained in collective boxes at room with controlled temperature (22 ± 1°C), humidity (60-70%), cycle of 12 hours day-night (lights on at 7:00 am), with diet and deionized water *ad libitum*.

The weight gain and the consumption of the diet of the animals were monitored three times a week, for eight weeks.

After 60 days from the beginning of the diet, were performed apparent absorption of the iron, haematocrit and haemoglobin and serum iron analysis.

The experimental protocol was previously approved by the Committee of Ethics in Animal Experimentation (CEEAA) of the State University of Campinas - UNICAMP (record n°. 839-1, 08/06/2005).

### Gastrectomy

Eight rats with 250g were anesthetized with sodic thiopental (25mg/Kg of weight / intravenous) and they were submitted to the gastrectomy Billroth II plus anterior truncal vagotomy. An end-lateral isoperistaltic gastroenteroanastomosis was performed with the jejunum for transit reconstruction. The Sham group (10 animals) was submitted to the same surgical stress, where the abdominal cavity was maintained open for approximately 45 minutes, which it is the duration of a gastrectomy.

### Administration of Vitamin B12 (Cianocobalamin)

For the prevention of the megaloblastic anemia, the rats received supplements of vitamin B12 (Cianocobalamin / 0.5mg/Kg / intramuscular) to every two weeks, beginning one week after surgery. In the Sham group was administered saline solution (0.9%).

### Determination of diet and fecal iron

The determinations of diet and fecal iron were performed in an Optic Emission IRIS-AP (Thermo Jarrell Ash) at the specialized Laboratory of Biominerals Chemical Analyses, Campinas, Sao Paulo - Brazil. For feces collection the animals were placed into individual metabolic cages, for a three days periods<sup>9</sup>.

### Apparent absorption

The apparent absorption of the iron was determined by the following equation: Apparent absorption (mg/day) = ingestion of iron (mg/day) - excretion of fecal iron (mg/day)<sup>10</sup>.

### Haematocrit and haemoglobin

Haematocrit and haemoglobin analysis were performed with a Haematological Analyzer Advia TM 120 - Bayer®.

### Serum iron

The serum iron contents were determined by a commercially available colorimeter method (KIT LABORLAB) Registration: M.S. n°. 10.246.810.020, Lot: 421, using an espectrofotometer Beckman DU® - 70 to 560 nm.

### Statistical analysis

The results were submitted to the variance analysis ANOVA, with the use of the test of Duncan's test for the comparison of the averages. The used software STATISTICA 6.0® goes Windows20 was used, considering p<0.05 as the acceptable minimum probability for the difference among averages<sup>11</sup>.

## Results

The medium consumption of the oral diet (g/day) (Figure 1) as well as the weight gains of the gastrectomized rats (GXT) (Figure 2) were reduced (p<0.05) as compared to the controlled animals (CO).

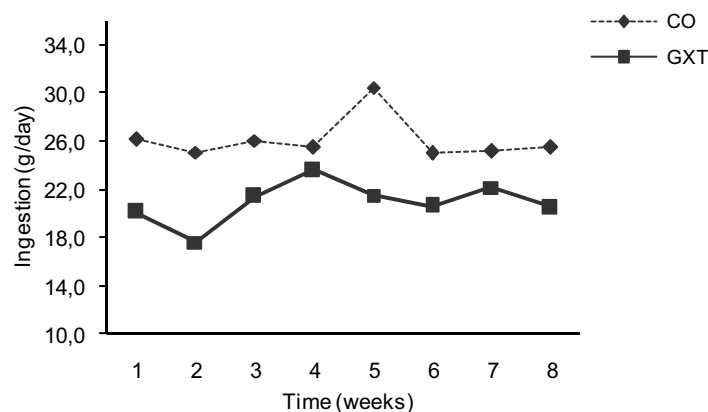


FIGURE 1 - Medium consumption of the oral diet (g/day); (a versus b p<0.05)

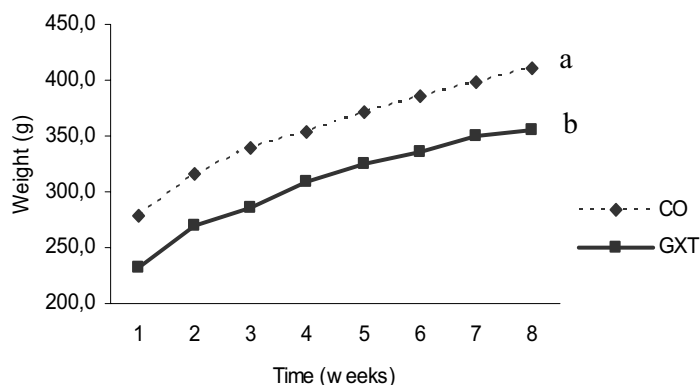


FIGURE 2 - Weight gains of the rats (g). (a versus b p<0.05)

The ingestion of iron of the GXT group was reduced (-18.7%) (CO=1.55±0.01; GXT=1.26±0,01 mg Fe/day) and the excretion of iron in feces was larger (+14.3%) (CO=0.72±0.05; GXT=0.84±0.02 mgFe/gr. of feces) when compared to the CO group. The apparent absorption (CO=0.83±0.05; GXT=0.42±0.02 mg/day) was decreased in 49.4% (p <0.05), as compared to the animals of the control group (CO) (Table 1).

TABLE 1 - Iron ingestion (mg/day), faecal iron (mg Fe/g feces) and apparent absorption of the iron (mg/day)\*

Experimentals groups	Iron Ingestion (mg/day)	Iron faecal (mg Fe/g feces)	Apparent absorption (mg/day)
CO	1.55±0.01 <sup>a</sup>	0.72±0.05 <sup>b</sup>	0.83±0.05 <sup>a</sup>
GXT	1.26±0.01 <sup>b</sup>	0.84±0.02 <sup>a</sup>	0.42±0.02 <sup>b</sup>

\* Median +/- SD (p<0.05); a versus b p<0.05

The gastrectomy reduced the haematocrit (Figure 3) and the haemoglobin (Figure 4) significantly compared to control group (p < 0.05), suggesting that the Billroth II gastrectomy is a good model for studying of disorders in the metabolism of iron.

The concentration of serum iron of the GXT group (GXT=41.76±11.76 µg/dL) was smaller, when compared to the CO group (CO=198.75±7.64 µg/dL) (Figure 5).

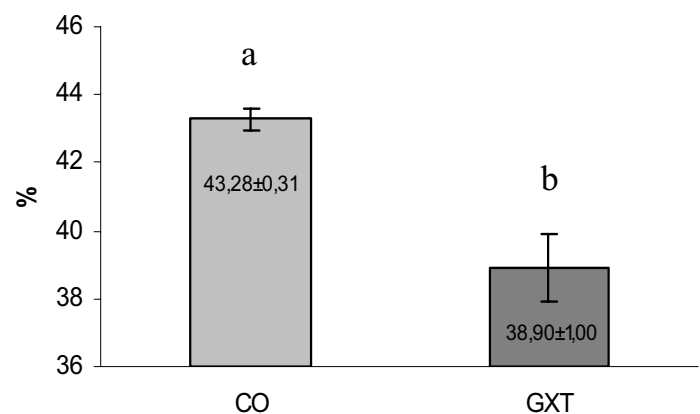


FIGURE 3 - Haematocrit analysis (%); (a versus b p<0.05)

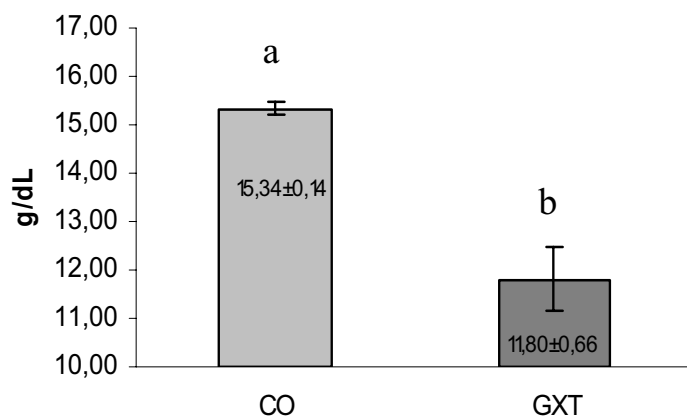


FIGURE 4 - Haemoglobin analysis (g/dL); (a versus b p<0.05)

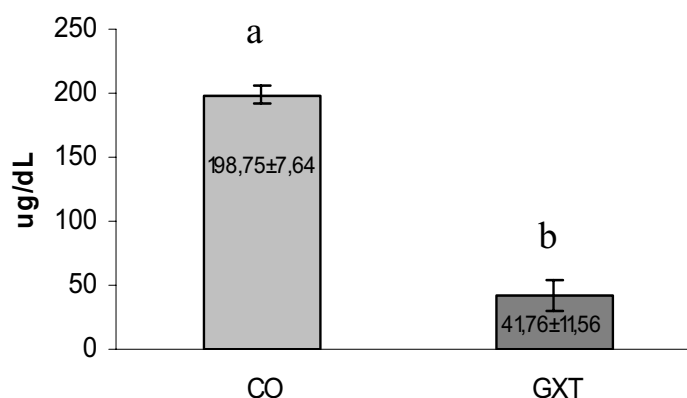


FIGURE 5 - Concentration of serum iron (µg/dL); (a versus b p<0.05)

### Discussion

The results of this research confirmed the information previously recorded already in the literature by Ohta *et al.*<sup>12</sup> for the consumption and smaller ponderal gains in gastrectomized animals.

The deficiency of iron occurs in up to 70% of the patients submitted to Billroth II gastrectomy, providing a smaller gastric capacity and absence of the duodenum in the intestinal transit, reducing the alimentary use as the absorption of nutrients<sup>4,5,6,10,13</sup>.

These results are an indicative that this experimental protocol really causes a depletion in the absorption of the mineral iron, despite of a better balance of essential nutrients ingested in the formulated AIN-93M. Boccio *et al.*<sup>14</sup> described that a smaller absorption of iron is common after some gastrointestinal surgeries. The absorption of iron occurs in all of portions of the small intestine, predominantly in the duodenum and proximal segment of the jejunum<sup>4</sup>.

Some authors confirmed a correspondence of 30 days of the man's life to one day of life of the Wistar rat<sup>15-18</sup>. Therefore, the gastrectomized rat is an excellent experimental model for studies of the metabolism of iron, as only 2 (two) months after the surgery were enough to modify statistically the haematocrit and the haemoglobin among the groups, being smaller in the animals of the GXT group<sup>4,5,6,19,20</sup>.

When the reserves of iron are decreased any additional decline in the corporal iron is accompanied by a reduction in the concentration of the serum iron. Therefore, the serum iron is a parameter frequently used in the diagnosis of anemia<sup>4,6,21</sup>.

Haematological parameters are widely used in the diagnosis of anemia and are the parameters that best reflects the values of serum iron.

### Conclusion

Partial gastrectomy has a significant effect on haematological parameters, as it decreased in 11% the haematocrit, 30% the haemoglobin and in 3 times the serum iron in relation to the control groups. The animals were particularly vulnerable to the poor absorption of iron, proving the efficiency of the experimental model.

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### Acknowledgments

Laboratory Biominerals Chemical Analyses Ltda, in special thanks to Rosângela Costa Massarotto Baptista, Adriane Castro Pereira e Cristiane Garcia da Silva from Haematology Laboratory of the Hemocentro (UNICAMP), in special Monica Almeida Falconi and Johnson & Johnson for the surgical sutures.

Conflict of interest: none

Financial source: CNPq

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Received: March 7, 2008

Review: May 8, 2008

Accepted: June 10, 2008

### How to cite this article

Santos EF, Tsuboi KH, Palu BF, Araújo MR, Andreollo NA, Mivasaka CK. Effects of the partial gastrectomy associated to anterior truncal vagotomy in the metabolism of the iron in rats. *Acta Cir Bras.* [serial on the Internet] 2008 Sept-Oct;23(5). Available from URL: <http://www.scielo.br/acb>