

# Digestive adaptation: A new surgical proposal to treat obesity based on physiology and evolution

Adaptação digestiva: Uma nova proposta cirúrgica para tratar a obesidade com base em fisiologia e evolução\*

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## ABSTRACT

**Objective:** To report on a new surgical technique to treat obesity - Digestive Adaptation - and to present its preliminary results.

**Method:** The technique includes a vertical (sleeve) gastrectomy, omentectomy and enterectomy maintaining the initial 150-cm-portion of the jejunum and the final 150-cm-portion of the ileum. The three first obese patients operated on are described. **Results:** With a minimum follow-up of 6 months, all patients refer early satiety, are free of symptoms and have a BMI < 31 Kg/m<sup>2</sup>. **Conclusions:** This procedure does not use prostheses and does not cause exclusion of gastrointestinal segments. It does not create subocclusions neither malabsorption nor blind endoscopic areas and above all, it causes no harm to important digestive functions. Conversely, it aims at moderate restriction with early satiety by distension, and at interfering in the neuroendocrine profile, resulting in slow gastric emptying, early and prolonged satiety, as well as positive changes in the metabolic profile. Based on recent physiological data, the procedure aims at decreasing the production of ghrelin, plasminogen activator inhibitor-1 (PAI-1) and resistin, and at raising the levels of glucagon-like peptide-1 (GLP-1). The patients operated on do not need nutritional support or to take drugs because of the procedure, which is easy and safe to perform.

**Keywords:** Obesity, morbid/surgery; Plasminogen activator inhibitor 1; Omentum/physiology; Adipose tissue/physiopathology; Gastrectomy/methods, Peptide hormones; Citokines/physiology

## RESUMO

**Objetivo:** Esta é a comunicação preliminar, com resultados iniciais, de uma nova técnica cirúrgica para tratar a obesidade: Adaptação Digestiva. **Método:** A técnica inclui uma gastrectomia vertical, a

omentectomia e enterectomia que mantém os primeiros 150 cm de jejuno e os últimos 150 cm de íleo. Os três primeiros pacientes obesos tratados por esta técnica são apresentados. **Resultados:** Com seguimento mínimo de seis meses, todos os pacientes estão livres de sintomas, referem saciedade mais precocemente e já estão com IMC menor que 31 Kg/m<sup>2</sup>. **Conclusões:** Este procedimento evita criar subestenoses, colocar próteses, excluir segmentos digestivos do trânsito de nutrientes, gerar malabsorção e fundamentalmente, evita prejudicar funções digestivas. O procedimento visa gerar uma restrição moderada, o que colabora para a saciedade precoce por distensão gástrica com menores volumes e visa também modificar as circunstâncias neuroendócrinas, retardando o esvaziamento gástrico, e gerando saciedade precoce e prolongada, paralelamente a mudanças positivas no perfil metabólico. Baseado em dados fisiológicos recentemente descobertos, o procedimento pretende diminuir a produção de grelina, do inibidor da ativação do plasminogênio 1 (PAI-1), da resistina e finalmente promover a secreção mais efetiva do glucagon-like peptide 1 (GLP-1). O paciente operado não necessita de suporte nutricional nem de uso crônico de medicações por causa do procedimento, que é simples e fácil de ser realizado.

**DESCRIPTORES:** Obesidade mórbida/cirurgia; Inibidor 1 de ativador de plasminogênio; Omento/fisiologia; Tecido adiposo/fisiopatologia; Gastrectomia/métodos; Hormônios peptídicos; Citocinas/fisiologia

## INTRODUCTION

**In the 20<sup>th</sup> century, we observed a great increase in the incidence of obesity, hypertension, diabetes, hypertriglyceridemia, hypercholesterolemia, and other conditions associated with changes in human diet. Nutritional education and medical treatment have failed to avoid**

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Received on September 4, 2003 - Accepted on November 14, 2003

obesity, and many surgical techniques to treat extreme obesity have been presented although none has been satisfactory. Current surgical treatment causes “another disease” to counterbalance obesity. Some techniques result in malabsorption, yet unspecific, leading to loss of non-caloric nutrients, such as calcium, iron, folic acid, etc., and to diarrhea<sup>(1)</sup>. Some procedures pose obstacles to ingestion of food, and others use prosthesis that may cause subocclusions<sup>(2)</sup>, and consequently, dysphagia, vomiting, stasis esophagitis, etc. Many current procedures involve exclusion of digestive system segments, which causes atrophy of mucosa with bacterial proliferation; this, in turn, leads to intense flatulence and bacterial translocation to the portal system, which may be related to hepatic fibrosis<sup>(3)</sup>. Additionally, exclusion of segments hinders endoscopy.

We searched new surgical alternatives, which could be easy to perform, require no exclusion of any segment, prevent endoscopic blind areas, avoid strangling prosthesis and cause no subocclusions. Moreover, the technique should avoid malabsorption and above all, not harm important digestive functions. We rather searched procedures that could positively interfere with the neuroendocrine control of hunger and satiety.

#### Physiological Background

**GLP-1:** Glucagon-like peptide 1 (GLP-1) is a hormone released by the enteroendocrine L-cells of the gut in response to food ingestion. GLP-1 increases both insulin secretion and insulin gene expression and growth of pancreatic beta-cells<sup>(4-6)</sup>. GLP-1 is secreted mainly by the distal intestine and the nutrients that reach this point are a major stimulus to release this hormone<sup>(7)</sup>.

GLP-1 is a potent agent that could improve or even cure type II diabetes<sup>(4,8)</sup>. When obese diabetic patients are submitted to biliopancreatic diversion (Scopinaro Technique)<sup>(9)</sup>, the ileogastric anastomosis provides nutrients straight into the ileum and just after the operation, and diabetes is markedly improved or cured before patients lose any significant weight. Efficient production of GLP-1 is thought to cause this major benefit.

GLP-1 also has other important actions. It inhibits gastric emptying<sup>(7)</sup> and crosses the blood-brain barrier causing satiety<sup>(4,10)</sup>. In sum, after a big meal, when nutrients reach the distal intestine, GLP-1 is produced, increasing the release of insulin and delaying gastric emptying and causing central satiety.

**Ghrelin:** It is a 28-amino peptide, predominantly produced by the stomach and it has intense growth hormone (GH) releasing activity. Moreover, it stimulates gastric acid secretion, and can induce excess adipose tissue by activating a central mechanism to

increase food intake and decrease use of fat<sup>(11-13)</sup>. Ghrelin production drops after a meal and later on, it increases - this has been demonstrated as taking part in the mechanism of hunger<sup>(14)</sup>. High ghrelin levels are not a common cause of obesity since it was demonstrated that obese individuals present low levels of this hormone. However in case of significant weight loss, the levels of ghrelin raise, resulting in hunger and, probably, contributing in gaining weight again<sup>(15)</sup>.

**PAI-1:** Plasminogen activator inhibitor 1 (PAI-1) is the primary physiological inhibitor of plasminogen activation and has procoagulation activity. Circulating PAI-1 levels are elevated in patients with coronary heart disease and play an important role in the development of arterial thrombosis by decreasing fibrin degradation<sup>(16)</sup>. PAI-1 is produced by visceral fat tissue, mainly the omentum and mesenteric fat<sup>(16-18)</sup>. Procedures causing decrease in PAI-1 levels have already been demonstrated as improving metabolic profile and reducing cardiovascular risk<sup>(19-20)</sup>.

**Resistin:** It is clear today that adipose tissue is an endocrine gland and it produces many substances that could act like hormones, such as leptin, interleukin-6, adiponectin (also called ACRP30 and adipoQ), angiotensin II and resistin. Resistin acts on skeletal muscle myocytes, hepatocytes, and adipocytes, reducing their sensitivity to insulin; thus, it is related to diabetes<sup>(21-22)</sup>. Abdominal fat is the main source of resistin<sup>(22-23)</sup>.

**Visceral obesity:** Abdominal fat tissue was clearly related to the so-called plurimetabolic syndrome. The waist/hip ratio has been used to quantify cardiovascular risk and many epidemiological studies have indicated its relation with high blood pressure, hypertriglyceridemia, insulin resistance and arterial thrombosis. Visceral fat is insulin-resistant and therefore releases free fatty acids (FFA) to the portal system. It is believed that insulin resistance of the liver derives from a relative increase in delivery of FFA from the omental fat depot to the liver (via portal vein)<sup>(24)</sup>. Many extreme obese patients have quite good metabolic profile because they have mostly subcutaneous fat. Except for orthopedic and respiratory complications, as well as reflux, most metabolic complications of obesity are related to visceral fat.

#### Evolutionary Background

Primitive diet was raw, full of poorly digestible fiber and very hypocaloric. The stomachs had to be big enough to keep an amount of food and handle long fasting periods. Hence, the volume of food ingested had to be expressive. The intestines had to be very long in order to take and process more food and to be efficient and not loose nutrients. However, the human diet has deeply changed in few centuries. Fire control

made food more digestible. Agriculture gave us some abundance and increased the amount of carbohydrates. Refined sugar may be given to us in considerable amounts, whereas nature could give us just minimal portions. Saturated fat and industrialized food made the picture even worse. The development of electricity has allowed us to eat also at night. Marketing, restaurants, cookies, and the other goodies of civilization have represented a very quick change that our digestive system and our eating instincts could not follow yet.

Modern diet is hypercaloric, poor in fiber and easy to absorb. After a meal with these characteristics, absorption occurs in the proximal portions of the bowel, resulting in a peak of nutrient absorption. Distal bowel tends to absorb less nutrients, and this reduces production of GLP-1. Indeed, it was noticed that diabetic<sup>(25)</sup> and obese people<sup>(26)</sup> have reduced postprandial production of GLP-1.

It has also been shown that obese individuals tend to have longer small bowel than slim patients, and this is not related to height but to weight<sup>(27)</sup>. This fact probably contributes to smaller amounts of nutrients reaching the distal bowel, implying in less signaling of being fed due to less GLP-1.

Nature now performs what it does best - selection. Individuals with strong eating instincts are being killed by lack of adaptation of their digestive system and its neuroendocrine control.

#### **A new surgical proposal to treat obesity**

We have been searching a manner to adapt the digestive system and eating instincts to abundance, without causing damage to important digestive functions, like those performed by the stomach, pylorus, duodenum, ileum and colon. The duodenum and the proximal intestine have functions different from the distal gut. Some current techniques to treat obesity resect or exclude the pylorus (Scopinaro's biliopancreatic bypass<sup>(9)</sup>, Fobi<sup>(28)</sup> or Capella<sup>(29)</sup> Roux-en-Y gastric bypass). In biliopancreatic bypass, using Scopinaro's technique or the Duodenal Switch technique<sup>(30)</sup>, the entire proximal intestine is excluded and the procedure may cause unspecific malabsorption that leads to nutritional deficiencies<sup>(1)</sup>. In gastric bypass, most of the stomach is excluded. Other techniques involve no exclusion but may cause subocclusion, such as gastric banding<sup>(2)</sup>.

In our point of view, the several digestive functions are essential, even to obese patients. However, we know that the gastric capacity is bigger than what modern diet requires<sup>(31)</sup>. Even the intestines are too long to modern diet<sup>(32)</sup>. Therefore, we propose a vertical gastric resection (similar to the extensively used "Duodenal Switch" technique)<sup>(30,33)</sup> associated to omentectomy and

a midgut enterectomy that leaves 150 cm of proximal small bowel and 150 cm of distal small bowel, totaling 3 meters of small bowel, which is still considered a normal length.

The Research Ethics Committee of Hospital da Polícia Militar do Estado de São Paulo approved the protocol. A detailed informed consent was signed by patients, and it stated weight loss could not be predicted due to lack of experience.

#### **METHOD**

**Technique:** the procedure may be performed either through a supraumbilical midline incision or laparoscopy. The open technique is described here. The first step is to release the great omentum from the colon. The gastric fundus is released by cutting the short gastric vessels with a harmonic scalpel. Later, the gastroepiploic arcade is interrupted at 6 cm proximal to the pylorus. Gastroepiploic vessels will remain intact in the antrum. A 12-mm Fouchet tube is passed through the esophagus until the duodenum by the lesser curvature. A linear cutting stapler is used in order to resect the gastric fundus and most of the gastric body, leaving a gastric tube of 3 to 4 cm of diameter in the lesser curvature (figure 1). Gastric specimen and the great omentum are removed as shown in figure 2.

A protective continuous seromuscular polypropylene suture is performed over the gastric stapling line. The procedure is completed with an enterectomy that removes the midgut, at 150 cm away from Treitz angle



Figure 1. Diagram of partial gastric resection



Figure 2. Specimen of gastroepiploic resection



Figure 3. Specimen of enterectomy. Small bowel of 150 cm in length (patient MZF)

and at 150 cm proximal to the ileocecal valve, with its mesentery (figure 3). And end-to-end (entero-enteral) anastomosis is the last step.

**First patients and results:** We report the first three patients submitted to surgery and their follow-up of at least 6 months.

**Patient 1:** MZF, female, 39 years old, weight= 104 kg (229,27 pounds), height = 169 cm (5ft7), BMI: 36.4 kg/m<sup>2</sup>, total cholesterol= 210 mg/dl, triglycerides= 200 mg/dl. She had been under clinical treatment for ten years. When surgery was indicated she was taking Orlistat, and had used sibutramine and others drugs before. She could not loose any weight and complained of pain related to disk herniation. The patient was operated in October 2002. In August 2003, her weight was 69 kg (152 pounds), BMI= 24.1 kg/m<sup>2</sup>; cholesterol= 174 mg/dl, triglycerides= 161 mg/dl. She used no medicine and back pain disappeared.

**Patient 2:** RJSB, male, 40 years old, weight= 143 kg (315 pounds), height= 182 cm (6ft), BMI= 43.1 kg/m<sup>2</sup>, total cholesterol= 247 mg/dl, triglycerides= 295 mg/dl. The patient had been on clinical treatment for ten years, and was taking Fenproporex. He complained of pain in the knees and low back pain, and was submitted to surgery in January 2003. In August 2003, he weighed 100 kg (220 pounds), BMI= 30.1 kg/m<sup>2</sup>, cholesterol= 197 mg/dl; triglycerides= 102 mg/dl. The patient was still loosing when this article was submitted to publication.

**Patient 3:** WVBG, male, 44 years old, weight= 123 kg (271 pounds), height= 178 cm (5ft10), BMI= 38.6 kg/m<sup>2</sup>, total cholesterol= 247 mg/dl, triglycerides= 295 mg/dl. The patient had been on clinical treatment for ten years, and had recently been in use of Orlistat, Fenproporex and amphetamine. He complained of pain in the knees and low back pain. The patient was operated in February 2003. On the 23<sup>rd</sup> postoperative day, he returned to hospital due to an abscess that was drained. In August 2003, he weighed 99 kg (218.2 pounds), BMI= 31.2 kg/m<sup>2</sup>, cholesterol= 142 mg/dl; triglycerides= 67 mg/dl.

All patients received cefazolin for 24 hours as prophylaxis and were discharged on the third postoperative day. They were oriented to take only liquids, a maximum volume of 150 ml each time, during one week; later they were allowed to eat solid food. They were recommended to start meals with a portion of salad; fruits, vegetables and fish and chicken were also prescribed. No patient had diarrhea, and two of them had mild obstipation for eating less. All patients referred early satiety, had no symptoms and were very satisfied.

## Discussion

The procedure has many advantages and we believe it could adapt the digestive system to modern diet. Since current foods are much more caloric than primitive diet, the gastric capacity is reduced by 1 to 1.8 liters. However, there is no subocclusion, no stenosis and no use of prosthesis. The stomach is proportionally reduced, but keeping its general structure (cardia, body, antrum and pylorus) and innervation by the lesser curvature is intact. Early satiety by gastric distension tends to occur. When significant weight loss occurs, no raise in ghrelin production is expected since its major source is removed<sup>(14-15)</sup>.

The enterectomy presented does not aim at causing malabsorption. There is no report of enteric insufficiency with 300 cm of a proportional bowel (with duodenum, jejunum, ileum, ileocecal valve and colon). In fact, some normal people have just three meters of small bowel

(in humans, the small bowel length ranges from 3 to 8 meters)<sup>(34)</sup>.

The intention of this procedure is to create a proportionally smaller intestine that is still normal and takes less contents; moreover, it takes nutrients to the ileum, resulting in a more effective secretion of GLP-1, which, in turn, reduces gastric emptying speed, improves insulin secretion and promotes central satiety. Triglycerides and cholesterol levels are usually reduced by bowel resections<sup>(35)</sup>.

When enterectomy is performed, the mesentery is excised and visceral fat is removed. Omentectomy promotes additional resection of visceral fat<sup>(17)</sup> and reduction of a source of PAI-1<sup>(22)</sup>, reducing the risk of arterial thrombosis. It provides a reduction in the source of resistin and free fat acids to the portal vein. Both events are thought to reduce hyperinsulinism and insulin resistance<sup>(21,24)</sup>. As the specimens removed are bulky and the intraabdominal pressure (IAP) is reduced. High IAP is related to respiratory and hemodynamic problems and reflux.

These preliminary results are very encouraging since patients achieved weight loss as expected and presented neither subocclusions nor malabsorption. We should evaluate the drop in ghrelin, resistin, PAI-1 levels and early raise in GLP-1 levels. Besides the benefits of weight loss, we observed the expected fall in cholesterol and triglycerides levels. However, improvement of metabolic profile must be assessed in a larger sample and in the long run.

Furthermore, very obese patients may not loose the amount of weight required with this technique for it is not aggressive to digestive functions. However, most techniques previously mentioned may still be used after the procedure described.

The current surgical procedures for obesity are so aggressive that may not be recommended to patients who are not extremely obese. Hence, when these procedures are performed the patients already present damaged arteries and joints, and suffer from the consequences of diabetes, hypertension, dyslipidemia, gastroesophageal reflux and other conditions associated with obesity, apart from psychosocial problems. The surgical risk is higher.

Since the procedure proposed is simple and safe, preserves the general structure of the organs and important digestive functions and requires no nutritional support, it could be recommended to patients who are not extremely obese, reducing surgical risk. The procedure itself does not pose much risk. Extreme obesity is a severe condition, with some irreversible physical and psychological damage developed over years. Current treatments comprise

surgeries that are physiologically aggressive. The technique reported may be a physiologically acceptable procedure to treat extreme obesity. It could also be used to prevent extreme obesity in cases it is eminent and patients already have associated diseases.

This is the first surgical procedure that does not aim at curing an affected or deficient organ, but it intends to adapt a system to modern circumstances in cases nutritional and medical treatment failed. In fact, this is an evolutionary and adaptative surgery that would not be necessary if we had not changed our primitive diet. It might become a very important procedure since it can early prevent the development of obesity, hypertriglyceridemia, hypercholesterolemia, type II diabetes, hypertension, arterial thrombosis and other typical conditions of modern life.

## CONCLUSION

The procedure presented is the association of three well-known techniques: vertical gastrectomy, omentectomy and enterectomy. All are very simple and safe. Together, they produce a proportionally reduced digestive system, however not changing its general structure as observed in other obesity surgery techniques. No stenosis, subocclusions, excluded segments, malabsorption, blind endoscopic areas were created, and no prosthesis was used. Above all, no harm was caused to important digestive functions. The patient submitted to surgery need no nutritional support or chronic use of drugs due to the procedure. The preliminary results are very encouraging.

## ACKNOWLEDGEMENTS

We would like to thank U.S. Surgical for donating the disposable surgical equipment used in the procedures performed at Hospital da Polícia Militar de São Paulo.

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