Journal of Visceral Surgery (2013) **150**, 269—275

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www.sciencedirect.com

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ORIGINAL ARTICLE

Evolution of low-grade systemic inflammation, insulin resistance, anthropometrics, resting energy expenditure and metabolic syndrome after bariatric surgery: A comparative study between gastric bypass and sleeve gastrectomy

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KEYWORDS
Metabolic syndrome;
Gastric bypass;
Sleeve gastrectomy;
Inflammation;
Energy expenditure;
Insulin resistance

Summary
Background: Laparoscopic sleeve gastrectomy (LSG) for morbid obesity is gaining in popularity as it offers several advantages over laparoscopic Roux-en-Y gastric bypass (LRYGBP), but comparative data between these two procedures have rarely been reported.
Methods: This case control study compared the incidence of low-grade systemic inflammation, insulin resistance, anthropometrics, resting energy expenditure and metabolic syndrome in 30 patients undergoing LRYGBP and 30 patients undergoing LSG, matched for age, sex, body mass index (BMI), and glycosylated hemoglobin (HbA1c).
Results: At 1-year after surgery, the percent of excess weight loss was 67.8 ± 20.9 for LRYGBP and 61.6 ± 19.4 for LSG. Patients undergoing LRYGBP showed significantly lower plasma levels of C-reactive protein (3.3 ± 2.7 mg/dL vs. 5.3 ± 3.9 mg/dL; $P < 0.05$), waist circumference (97.4 ± 16.0 vs. 105.5 ± 14.7 cm; $P < 0.05$), total cholesterol (4.6 ± 1.0 vs. 5.7 ± 0.9 mmol/L; $P < 0.01$) and LDL cholesterol (2.6 ± 0.8 vs. 3.6 ± 0.8 mmol/L; $P < 0.01$). Insulin resistance (HOMA index 1.6 ± 1.0 after LRYGBP vs. 2.3 ± 2.4 after LSG), resting energy expenditure (1666.7 ± 320.5 after LRYGBP vs. 1600.4 ± 427.3 Kcal after LSG) and remission of metabolic syndrome (92.9% after LRYGBP vs. 80% after LSG) were not different between the two groups.
Conclusion: In this study, patients undergoing LRYGBP demonstrated significantly improved lipid profiles, decreased systemic low-grade inflammation compared with those undergoing LSG at 1-year follow-up.

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1878-7886/$ — see front matter © 2013 Published by Elsevier Masson SAS.
http://dx.doi.org/10.1016/j.jviscsurg.2013.08.005

Introduction

The epidemic of morbid obesity has become a public health problem and bariatric surgery is currently the only effective means to combat it, leading to effective weight loss and remission of obesity-related long-term co-morbidities [1,2]. The metabolic syndrome (MetS), consisting in the combination of hyperglycemia/insulin resistance, visceral obesity and dyslipidemia, identifies a subgroup of patients who are at risk of cardiovascular disease and type 2 diabetes (T2D) that share a common pathophysiology [3]. Adipose tissue is currently considered a true endocrine organ capable of secreting pro-inflammatory cytokines and adipokines responsible for a low-grade systemic inflammatory state associated with obesity [3]. Furthermore, the secretion of soluble mediators of the inflammatory response by the adipose tissue is strongly implicated in the pathogenesis of insulin resistance, a key feature of the metabolic disturbances linked to obesity and a main determinant of the MetS [3]. The inflammatory response is associated with an increased plasma level of C-reactive protein (CRP), a marker of inflammation that is also associated with an increased cardiovascular risk [4]. Weight loss following bariatric surgery induces the regression of chronic inflammation associated with obesity and is paralleled by the improvement in the components of the MetS indicating a strong relationship between obesity-related chronic inflammation and the metabolic co-morbidities associated with obesity [5]. Thus, although the loss of weight is generally considered as the main measure of the efficacy of bariatric surgery, the reversal of the MetS components and low-grade systemic inflammation associated with morbid obesity may also be taken as markers of the efficacy of weight loss surgery.

The laparoscopic sleeve gastrectomy (LSG) is a recent bariatric procedure that has been shown to be associated with short and mid-term weight loss similar to that following the laparoscopic Roux-en-Y gastric bypass (LRYGBP) [1,6—9]. LSG has rapidly become a popular procedure for morbid obesity due to several advantages that it offers over the LRYGBP including an easier surgical technique, the avoidance of intestinal bypass with the preservation of the pylorus, the possibility of conversion at a second procedure in case of failure, such as a duodenal switch or a RYGBP, and the normal absorption of minerals, vitamins, nutrients and drugs [10]. Another theoretical advantage of the LSG over the LRYGBP consists in the better absorption of proteins after LSG that may influence the body composition during the process of weight loss in terms of loss of free fatty mass (FFM). This is of particular importance as the loss of FFM correlates with a decrease of the resting energy expenditure (REE); that, in turn, is implicated in the mechanism of regaining weight after surgery [11]. However, these two procedures have seldom been compared and the choice of one procedure over the other still depends on patient and/or surgeon preferences.

In this case control study, we compared the incidence of low-grade systemic inflammation, insulin resistance, anthropometrics, REE and MetS between LRYGBP and LSG.

Materials and methods

Study protocol

The study was performed in accordance with French legislation regarding Ethics and Human Research, and was approved by the local Ethics Committee (Huriet-Serusclat law, DGS 2003/0395). All patients met the 1991 NIH Consensus Conference guidelines [12] and gave written, informed consent. Data were collected prospectively in a database.

Patients with a history of inflammatory disease including, but not limited to, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, current infections, recent (< 5 years) history of cancer, severe pulmonary or cardiac disease were not enrolled in the study.

Preoperative work-up included medical history and physical examination, endocrine and biochemical evaluation to detect dysthyroidism or hypo/hyper cortisolism, psychiatric and nutritional evaluation, blood pressure determination, anthropometric investigations, chest radiography, electrocardiogram, abdominal ultrasonography, and upper gastrointestinal endoscopy. Before operation and after overnight fasting, blood samples were obtained and used for the determination of glucose, insulin, glycosylated hemoglobin C-peptide (HbA1c), alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma glutamyl transferase (gGT), triglycerides (TG), high-density lipoprotein (HDL) cholesterol (HDL-C), low-density lipoprotein (LDL) cholesterol (LDL-C), albumin, leucocyte count, and C-reactive protein (CRP). To assess insulin resistance, the homeostasis model assessment of insulin resistance (HOMA1-IR) was used, which is the product of fasting plasma insulin concentration (mIU/L) and glucose concentration (mmol/L) divided by 22.5.

The MetS was diagnosed according to the latest international definition proposed by Alberti et al. [13]. Any three criteria among the following are needed:

- central obesity defined by a increased waist circumference ($\geq$ 80 cm in European women and $\geq$ 94 cm in European men);
- triglycerides $\geq$ 1.7 mmol/L or treatment for hypertriglyceridemia;
- HDL-C < 1.29 mmol/L in women and < 1.03 mmol/L in men;
- systolic blood pressure (BP) $\geq$ 130 mmHg systolic or $\geq$ 85 mmHg diastolic or treatment for hypertension;
- fasting plasma glucose $\geq$ 5.6 mmol/L or previously diagnosed T2D.

Remission of T2D was defined as fasting glucose levels < 5.6 mmol/L in addition to a HbA1c value < 6% without the use of oral hypoglycemics or insulin.

Anthropometric measurements included body weight (measured to the nearest 0.5 kg at the same time of morning, post-voiding, in light clothing and without shoes, using a digital electronic scale) (SECA, Birmingham, UK); height, measured to the nearest 0.5 cm with a wall mounted stadiometer; waist circumference, measured to the nearest 0.5 cm at the midpoint between the lower border of the rib cage and the iliac crest. Body mass index (BMI) was calculated as kg/m^2.

Body composition was assessed by bioelectric impedance analysis (BIA) using an alternating electric current of 50 mA at two frequencies, 1 MHz and 5 KHz, as previously described and validated by Boulier et al. [14]. A portable impedance analyzer (IMP BO1, L'impulsion, Caen, France) was used to measure impedance and calculate body composition (FFM, and fatty mass [FM]). Measurements were taken with patients lying in the supine position for 30 min, arms relaxed at the sides without touching the body after a 12-hour overnight fast. Two adhesive electrodes were affixed to a hand and two other electrodes were placed on the opposite foot.