Available online at www.sciencedirect.com
ScienceDirect
Metabolism Clinical and Experimental 56 (2007) 1425–1430
Metabolism
Clinical and Experimental
www.elsevier.com/locate/metabol

Impact of bariatric surgery–induced weight loss on heart rate variability

Isabelle Nault[a], Eric Nadreau[c], Carmen Paquet[c], Patrice Brassard[c], Picard Marceau[b], Simon Marceau[b], Simon Biron[b], Frédéric Hould[b], Stéphane Lebel[b], Denis Richard[c], Paul Poirier[a,*]

[a]Department of cardiology, Institut Universitaire de Cardiologie et de Pneumologie, Hôpital Laval, Québec, Canada G1V 4G5
[b]Department of General surgery, Institut Universitaire de Cardiologie et de Pneumologie, Hôpital Laval, Québec, Canada G1V 4G5
[c]Clinical Research Center, Institut Universitaire de Cardiologie et de Pneumologie, Hôpital Laval, Québec, Canada G1V 4G5

Received 18 August 2006; accepted 1 June 2007

Abstract

Obesity is associated with an increased risk of sudden death that may be due to abnormal cardiac vagal modulation reflected by reduced heart rate variability (HRV). Few studies have been conducted analyzing the effect of bariatric surgery–induced weight loss on HRV assessed by 24-hour Holter monitoring. The aim of this study was to assess weight loss effect after bariatric surgery on HRV and ventricular size and function. Ten morbidly obese patients, 6 women and 4 men aged 24 to 47 years, underwent bariatric surgery. Seven morbidly obese patients without active obesity treatment were used as controls. Twenty-four–hour Holter monitoring and echocardiogram were obtained before and at 6 to 12 months after surgery or at follow-up in control patients. Changes in minimal, maximal, and mean heart rate along with HRV during daytime and nighttime were compared before and after surgery. Baseline characteristics in the control group did not differ significantly from the treatment group. Average weight in the treatment group was 141 ± 31 kg (mean ± SD) at baseline and decreased to 101 ± 18 kg at follow-up, corresponding to a body mass index of 52.3 ± 7.6 kg/m^2 at baseline and 37.7 ± 5.3 kg/m^2 at follow-up. There was a decrease in minimal heart rate (48 ± 10 vs 40 ± 6 beats per minute, $P = .021$) and mean heart rate (82 ± 7 vs 66 ± 10 beats per minute, $P < .001$) during the Holter monitoring. Spectral analysis showed a significant enhancement in HRV parameters (high- and low-frequency power) because there was an increase in the standard deviation of normal to normal R-R intervals (116 ± 25 vs 174 ± 56 milliseconds, $P < .001$), the standard deviation of the mean R-R intervals calculated over a 5-minute period (104 ± 25 vs 148 ± 45 milliseconds, $P < .001$), the square root of the mean of the squared differences between adjacent normal R-R intervals (25 ± 8 vs 50 ± 20 milliseconds, $P < .001$), and the percentage of differences between adjacent normal R-R intervals exceeding 50 milliseconds (5% ± 5% vs 22% ± 13%, $P < .001$). Echocardiographic measures remained unchanged when comparing the groups. Weight loss after bariatric surgery enhances HRV and decreases mean and minimal heart rate during Holter monitoring through a better cardiac parasympathetic modulation.

1. Introduction

In a search for a better assessment of risk factors of cardiovascular (CV) mortality, several studies have reported altered heart rate variability (HRV) to be an independent risk factor of cardiac death after myocardial infarction [1,2] or in patients with conventional CV risk factors [3]. Hence, lower HRV in different clinical settings (obesity, after myocardial infarction, population studies) revealed itself as a risk marker for total mortality, sudden death, and CV death [1,3-5]. Lower HRV is also a risk marker for ventricular arrhythmias [6,7].

Heart rate variability refers to the variation in intervals between heartbeats and reflects cardiac autonomic modulation, which is influenced in a favorable way by increased parasympathetic activity [8]. As stated, in asymptomatic subjects, lesser HRV is associated with a greater incidence of cardiac events [9]. Obesity is independently associated with an increased risk of CV death [10,11], as it is also associated with sudden cardiac death [10,11]. Altered autonomic

* Corresponding author. Institut Universitaire de Cardiologie et de Pneumologie/Hôpital Laval, Sainte-Foy, Québec, Canada G1V 4G5. Tel.: +1 418 656 4767; fax : +1 418 656 4562.
E-mail address: paul.poirier@crhl.ulaval.ca (P. Poirier).

0026-0495/$ – see front matter © 2007 Elsevier Inc. All rights reserved.
doi:10.1016/j.metabol.2007.06.006

nervous system activity has been reported in patients with obesity [12-14]. Indeed, sympathetic overactivity has also been described in association with obesity [15,16]; and spectral analysis showed decreased HRV with weight gain [17-19].

Weight loss after diet or gastroplasty in morbidly obese patients has been shown to reverse the deleterious impacts of obesity on cardiac autonomic nervous system modulation, with subjects showing enhanced HRV after reduction in body mass index (BMI), through increased cardiac vagal modulation [20,21]. Biliopancreatic diversion with duodenal switch (BPD-DS) surgery may not only cause a more prominent weight loss than other surgeries; the malabsorption created by the anatomical modifications in the gastrointestinal tract by BPD-DS brings a unique metabolic state. To our knowledge, no study has reported the influence of BPD on HRV. On the other hand, obesity is associated with cardiomyopathy, with increased left ventricular wall stress, left ventricular hypertrophy, diastolic dysfunction that can evolve to left ventricular dilatation, and left ventricular systolic dysfunction [22]. Furthermore, it was reported that diastolic dysfunction is associated with altered HRV in subjects with uncomplicated diabetes [23].

The aim of this study was to assess the weight loss effect after BPD-DS surgery on HRV assessed with a 24-hour Holter monitoring. Secondly, echocardiographic study was performed on subjects before and after surgery to verify the presence of such a cardiomyopathy and to assess left ventricular size and function.

2. Materials and methods

Ten patients submitted for BPD-DS, 6 women and 4 men aged 24 to 47 years, were enrolled in the treatment arm of this study; and 7 morbidly obese patients without active obesity treatment were enrolled as controls. Inclusion criteria were patients with a BMI >40 kg/m^2 or > 35 kg/m^2 with comorbid conditions before bariatric surgery. Data were collected before and after bariatric surgery. The time elapsed between the 2 evaluations varied from 6 to 12 months (mean, 6.8 ± 1.8 months). Twenty-four–hour Holter monitoring was performed at baseline and after surgery. Heart rate variability was established throughout numerous indices [24]. Parameters from the time domain and from the spectral domain were calculated from the Holter monitoring. Subanalysis of daytime and nighttime recordings was performed, as well as analysis for the full recording period [19]. In the time domain, R-R interval, standard deviation of R-R interval (SDNN), standard deviation of the mean R-R calculated over a 5-minute period (SDANN), square root of the mean squared difference of successive R-R intervals (rMSSD), number of adjacent N-N differing by more than 50 milliseconds (NN50), and NN50 divided by total number of N-N intervals (pNN50) were analyzed. The rMSSD and pNN50 indices are associated with high-frequency power (HF) and hence parasympathetic activity. In the spectral domain, low-frequency power (LF; 0.04-0.15 Hz), which is an index of both sympathetic and parasympathetic activity, and HF (0.15-0.4 Hz), representing the most efferent vagal (parasympathetic) activity to the sinus node, were analyzed. The LF/HF ratio, representing the sympathovagal balance, was also calculated [20].

All patients had an echocardiogram performed before and after surgery. Left ventricular mass, volume, and parietal thickness as well as ejection fraction (EF) and diastolic function were assessed. Biochemical analysis was performed post hoc on blood drawn before and after surgery, which was stored at −80°C. Fasting plasma glucose concentration, insulin levels, serum total cholesterol, high-density lipoprotein (HDL) cholesterol, and triglycerides were analyzed. Low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formula. Insulin sensitivity was calculated using the homeostasis model assessment (HOMA) [25].

The bariatric procedure can be described as a combination of a restrictive procedure (gastric volume reduction) and a malabsorptive procedure (duodenal switch). The gastric volume is reduced by ablation of a portion of the gastric wall along the greater curvature to create a gastric tube along the lesser curvature, commonly referred to as a *sleeve gastrectomy*. The duodenal switch diverts the flow of nutrients to the last 250 cm of the ileum through a duodenoileal anastomosis placed proximal to the Vater ampulla. The biliopancreatic secretions from the Vater ampulla are transported along the jejunum to meet the nutrients at an anastomosis created 100 cm from the ileocecal valve on the alimentary limb. Weight loss ensues over time to reach maximal effect at 18 months after operation [22].

3. Statistical analysis

Parameters were compared in both groups using a Student paired t test. Data are expressed as mean ± SD unless specified otherwise. A 2-way analysis of variance was used to compare the impact of surgery. P value < .05 was considered statistically significant. The spectral domain data from the Holter monitoring have been log-transformed to allow normal distribution.

4. Results

Ten patients with a baseline weight of 141 ± 30 kg and a BMI of 52.3 ± 7.6 kg/m^2 were included in the study (Table 1). Two had diabetes. Seven obese patients without any intervention were analyzed as controls. Baseline characteristics were similar between the control and treatment groups, and no significant changes were noted in the control group between the initial and follow-up data. Weight loss after surgery was on average 40 kg (P < .001), a relative reduction of 28.3%, corresponding to a difference in BMI of