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## Original article

## Hypertension remission 1 year after bariatric surgery: predictive factors

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## Abstract

**Background:** There is scarce information about predictive factors of hypertension (HT) remission after bariatric surgery (BS). The aims of this study were to determine the clinical characteristics differentiating obese patients with and without HT and to evaluate the predictive factors associated with the risk of persistence of HT after BS.

**Patients and Methods:** From January 2007 to December 2009, a review of patients who had undergone BS was performed. Patients were classified as hypertensive if having permanent use of antiHT drugs or clinical BP  $\geq 140/90$  mm Hg. Weight, waist circumference (WC), and blood pressure were determined with standardized procedures.

**Results:** Five hundred twenty-six patients met the inclusion criteria; 264 (50%) were hypertensive, 74 (34%) of whom had type 2 diabetes. Before BS, older age, male gender, and greater WC differentiated hypertensive from normotensive patients. The prevalence of HT significantly fell to 35% ( $P < .0001$ ) at 12 months after BS. The use of multivariate logistic regression showed that age  $\geq 40$ , male gender and WC  $\geq 130$  cm were significant predictors of having HT before surgery. Regarding persistence of HT at the 12-month follow-up, the only independent predictors observed were time since diagnosis of HT  $\geq 10$  years and the number of antiHT drugs used. Presurgical BMI, WC, excess weight (EW), EW loss, surgical procedure, type 2 diabetes, and vitamin D status were not significant predictors.

**Conclusions:** Bariatric surgery is associated with a high rate of HT remission. Older age, male gender, and higher WC differentiated hypertensive-obese from normotensive patients. After BS, longer duration and severity of HT were independently associated with no remission of HT. (Surg Obes Relat Dis 2014;■:00–00.) © 2014 American Society for Metabolic and Bariatric Surgery. All rights reserved.

## Keywords:

Hypertension; Obesity; Bariatric surgery; Vitamin D; Type 2 diabetes mellitus

The prevalence of overweight and obesity has increased dramatically around the world, and Spain is not an exception. According to the results of the Study on Nutrition and Cardiovascular Risk in Spain, an epidemiologic study

performed in Spain found 22.9% of the Spanish adult population to be obese [1]. It is well known that obesity increases the risk of many chronic diseases, such as hypertension (HT), type 2 diabetes mellitus (T2DM), dyslipidemia, heart disease, stroke, and several types of cancer. Of these conditions, HT is the most common co-morbidity associated with obesity [2].

A number of studies have shown that a reduction in weight is associated with a significant improvement or remission of many of the obesity-related co-morbid conditions [3,4].

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At present, weight loss is considered the main nonpharmacologic therapy to control blood pressure (BP) [5]. Bariatric surgery (BS) is currently the most effective treatment to obtain significant and sustained weight loss in severe obesity and has been associated with long-term resolution of obesity as well as improvement or resolution of co-morbidities associated with obesity [6–8]. Different studies have reported HT remission or improvement of 60%–70% at 1–2 years across all surgical procedures [6–10]. Risk factors for non-remission of HT have been described in only 4 studies, including increased age, lower excess weight loss (EWL), black ethnicity, duration of HT, diabetes status, and vitamin D depletion [10–13].

The aims of this study were to determine the clinical characteristics differentiating severe obese patients with and without HT and to evaluate the predictive factors, including diabetes status and vitamin D status associated with the risk of persistence of HT after BS.

## Patients and Methods

From January 2007 to December 2009, a review of patients with severe obesity, who underwent primary non-revisional laparoscopic gastric bypass (LYRGB) or sleeve gastrectomy in a tertiary hospital and had BP levels recorded before and 12 months after surgery, was performed. A prospectively maintained clinical database was used. This database includes demographic information, presurgical clinical measurements, co-morbid conditions at surgery, surgical procedures and outcomes (including complications), and weight loss after surgery of all patients who undergo BS in our hospital. Patients in the database were classified as hypertensive or nonhypertensive, with HT being defined as permanent use of antihypertensive drugs or having a clinical systolic BP of 140 mm Hg or higher, a diastolic BP of 90 mm Hg or higher, or both. Patients for whom BP or antihypertensive medications were not available were excluded from the analyses. Thereafter, the presence of T2DM and vitamin D (VD) status were also evaluated in those with HT. T2DM was defined as fasting glucose levels  $\geq 126$  mg/dL or  $\text{HbA}_{1c} \geq 6.5\%$  and/or diabetic medication use [14], and VD status was classified as VD sufficient [25 (OH)D  $\geq 30$  ng/mL or  $\geq 75$  nmol/L], VD insufficient [25(OH)D 20–29 ng/mL or 50–74 nmol/L] and VD deficient [25 (OH)D  $\leq 19$  ng/mL or  $\leq 49$  nmol/L]. These VD cut-points are currently the most commonly used classifications of VD status [15]. The policy of calcium and VD supplementation in our institution at the time of the study was calcium citrate 1200 mg/d and VD<sub>3</sub> 800 IU prescribed to all patients after BS.

The clinical data collected were age at surgery and gender. Weight (kg) and waist circumference (WC) were determined by standardized protocols. Both before and 12 months after BS, each patient underwent 3 BP measurements, and the average reading was recorded. The BP was

taken by a doctor using a validated automatic device (WatchBP home, Microlife Corporation, Barcelona, Spain) with an appropriate cuff size for the arm circumference. The patient remained seated during the BP measurements with the arm placed at the level of the heart with the legs uncrossed and in a comfortable environment. In addition, data related to HT and T2DM duration, antihypertensive treatment defined as 1, 2, or  $\geq 3$  drugs used, and T2DM treatment with diet, oral hypoglycemic agents, or insulin therapy were collected. The body mass index (BMI) and excess weight (EW) to BMI of 25 kg/m<sup>2</sup> were calculated, as were absolute weight loss (WL) and the percent of excess weight loss (EWL) after surgery. Finally, an improvement in HT was reported with a decrease in hypotensor drug requirements to control BP or remission was considered when office BP was  $\leq 140/90$  mm Hg associated with discontinuation of all antihypertensive treatment. No protocol was established for the reduction or discontinuation of antihypertensive medications. These drug adjustments were made at the discretion of the primary care physician of each patient.

## Statistical analysis

Data are expressed as mean (standard deviation) or standard error of the mean (SE) if numerical variables, or as the number of patients and their percentages (%), if categorical. Continuous variables were compared using the unpaired Student's *t* test. Analysis of categorical data was carried out by the  $\chi^2$  test. The univariate general linear model of SPSS (analysis of covariance) analysis and the estimated marginal means application was used to correct difference in other variables for gender and age in patients with and without HT. Multivariate logistic regression analysis was performed to determine significant independent predictors of having HT and HT remission after BS. The unadjusted association of each variable was first assessed to search for predictor variables; the results of these analyses are presented as OR (95% CI). A 2-tailed  $P < .05$  was considered to be statistically significant. All analyses were performed using SPSS.18 software.

## Results

Five hundred twenty-six patients met the inclusion criteria. This group of patients represented 82% of the cohort of patients who underwent BS during the study period. The clinical characteristics were [n (SD)]: age 43 (11) years, 72% females, weight 123 (21) kg, BMI 47 (6) kg/m<sup>2</sup>, EW 58 (18) kg, WC 131 (15) cms, systolic BP (SBP) 133 (17) mm Hg, and diastolic BP (DBP) 82 (12) mm Hg. A prevalence of HT of 50% was observed among the patients included.

On dividing patients into normotensive (n = 262) and hypertensive (n = 264), differences in age, gender, and WC

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