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Original research

Bone mineral density and body composition after laparoscopic sleeve gastrectomy in men: A short-term longitudinal study

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HIGHLIGHTS

- Changes in bone mineralization and body composition in obese men after laparoscopic sleeve gastrectomy (LSG) were analyzed.
- FN BMD and TH BMD decreased, whereas spine BMD increased significantly and TB BMD did not change.
- TB BMC increased and all other parameters of body composition (fat, lean mass, lean BMC, total mass, fat mass) decreased.
- Body mass reduction in men after LSG is related to essential changes in bone mineralization and body composition.

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ABSTRACT

Introduction: Longitudinal changes in bone and body composition occurring in obese men after laparoscopic sleeve gastrectomy (LSG) has been evaluated.
Methods: In short-term longitudinal study, 25 obese men in mean baseline age 44.8 ± 10.9 years and mean body mass index (BMI) 43.3 ± 4.4 kg/m^{2}were assessed after undergoing LSG for obesity. Bone mineral density (BMD) (spine, femoral neck [FN], total hip [TH], and total body [TB]) and body composition (TB bone mineral content [BMC], fat, % of fat, lean, lean BMC, total mass) were assessed at baseline, and after three and six months.
Results: Mean body measurements, including weight, BMI, waist and hips, decreased significantly over the study period ($p < 0.0001$). FN BMD ($p < 0.01$) and TH BMD ($p < 0.001$) decreased, and spine BMD increased significantly ($p < 0.001$). TB BMD did not change. Weight decreased by 21.3 ± 7.3%, BMI by 21.2 ± 7.3%, FN BMD by 3.32 ± 6.35%, TH BMD by 3.51 ± 3.95% whereas spine BMD increased by 2.89 ± 5.1%. TB BMC increased by 2.4 ± 4.62%; all other variables relating to body composition decreased: fat by 33.0 ± 9.6%, lean mass by 12.8 ± 6.1%, lean BMC by 12.3 ± 5.9%, total mass by 20.1 ± 6.4%, and % fat by 15.8 ± 7.2%.
Conclusions: After LSG, body size and variables related to body composition (except for TB BMC) decreased with an accompanying decrease in FN BMD in the men in this study. Spine BMD increased, and TB BMD did not change.

1. Introduction

Obesity is an important medical problem. The number of obese individuals is increasing continuously in response to various environmental and genetic factors. For some morbidly obese patients, surgery is the only effective type of therapy. Despite bariatric

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surgery has good outcomes in terms of weight loss, it is associated with some adverse effects: several studies have reported subsequent alterations in bone metabolism and bone status [1–14]. Of the surgical techniques available (laparoscopic gastric banding, Roux-en-Y bypass, biliopancreatic diversion), laparoscopic sleeve gastrectomy (LSG) is currently the technique of choice. The advantages and limitations of sleeve gastrectomy were recently discussed at the Third International Summit [15]. Because restrictive procedures such as LSG do not involve bypassing segments of small bowel where micronutrient absorption takes place, fewer metabolic disturbances are expected than with other surgical techniques [14].

The observed changes in bone metabolism and status in post-bariatric surgery patients potentially involve several mechanisms, including reduced absorption of essential nutrients, diminished calcium absorption leading to secondary hyperparathyroidism, poor vitamin D absorption and restricted energy delivery. In addition, body weight protects against osteoporosis via the bone-strengthening effects of long-term weight bearing. However, long-term decreases in bone mineral density in patients who have undergone successful bariatric surgery are an unexpected, negative effect of this type of therapy. As was suggested by recent data from the UK [16]; bone loss after bariatric surgery may contribute to skeletal fractures; however, this possibility has not yet been confirmed. Therefore, longitudinal studies exploring bone changes after bariatric surgery are necessary. Some such studies of women alone [8–13] and several presenting combined data for women and men have been published [1–7,14]. Because no studies have been performed in men alone, there is little data on bone changes in men after bariatric surgery: to our knowledge, the current study is the first on men only.

In the current study we assessed bone mineral and body composition changes in a group of men for six months after LSG.

2. Material and methods

2.1. Patients

Twenty-five obese men of mean baseline age 44.8 ± 10.9 years and mean body mass index (BMI) 43.3 ± 4.44 kg/m^2 years who were to undergo bariatric surgery at the Gastroenterology Care Center of the Department of Surgery at the Vitkovice Hospital in Ostrava, the Czech Republic were studied. The study was approved by the Ethics Committee of the Faculty of Medicine, University of Ostrava, Czech Republic, in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2000.

Selection of subjects for the surgical treatment of obesity was carried out in accordance with the guidelines of the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO). The subjects had either BMI $\geq$ 40 kg/m^2, BMI $\geq$ 35 kg/m^2 with associated co-morbidities, or BMI < 35 kg/m^2 with a history of weight loss resulting from intensive therapy followed by regaining of weight. Exclusion criteria for this study were thyroid disorders, gastrointestinal disorders associated with intestinal resorption dysfunction and disorders of renal function. Table 1 presents their clinical characteristics and bone densitometry measurements. None of the study subjects had concomitant diseases that affect bone metabolism. They underwent surgery between April 2011 and May 2012 as part of an open prospective clinical study monitoring metabolic changes in lipid and bone tissue following restrictive-type bariatric surgery. The follow-up period was planned for 6 months with clinical and densitometric assessment of subjects at baseline, after three months and finally after six months. There was no drop-out during the study period – all recruited 25 subjects attended three examinations. The patients enrolled in the study did not participate in a postoperative rehabilitation program. Their physical activity was studied neither in terms of aerobic exercise nor strength training. No detailed dietary recommendations were given to the patients. At discharge from the hospital they were just informed about the potential risk associated with surgery in terms of nutrition and advised to adopt a balanced diet with vitamin supplementation. No special protocol was used to control the intake of vitamin D, calcium or other diet supplements during follow-up period.

2.2. Anthropometric assessment

A basic anthropometric examination, including measurements of body weight, height, waist and hip circumference, and calculation of BMI, was performed after overnight fasting by a nurse trained in anthropometric measurements. Participants were weighed barefoot and in light clothing to the nearest 0.1 kg. Height was measured with a fixed wall stadiometer. Waist circumference was measured at the level of the iliac crest to the nearest 0.5 cm with a standard flexible, inelastic measuring tape. Hip circumference was measured to the nearest 0.1 cm at the maximum point at buttock level. BMI was calculated as weight (kg) divided by squared height (meters). Ideal body weight was calculated according to formula for adult men given by Miller: 61.36 kg + 0.54 kg for each additional centimeter of height above 159.6 cm [17].

2.3. Surgery

Surgery was performed under standard manner. The greater gastric curvature was mobilized with an ultrasound dissector (Harmonic Ace, Johnson and Johnson, Cincinnati, OH, USA), starting 4 cm proximal to the pylorus. The mobilization extended to the left diaphragmatic crus and the stomach was longitudinally resected with an Echelon endoscopic stapler (Johnson and Johnson). The size of the retained gastric cavity was limited by the anatomic border defined by the end of the short gastric vessels from the lesser curvature. The resected stomach was extracted without using a plastic bag.

2.4. Bone densitometry

Bone densitometry was performed with a Hologic Discovery W densitometer (USA) calibrated according to the manufacturer's recommendations. Spine and proximal femur femoral neck (FN) and total hip (TH) bone mineral density (BMD) were measured. Body composition (total body [TB] bone mineral content [BMC], fat, % of fat, lean, lean BMC, and total mass) was also assessed. The precision error of the densitometer was established by performing a series of measurements of FN, TH, and spine BMD in 15 patients with repositioning and calculating percentage of coefficient of variation (CV%) according to the following formula: CV%/SD/mean × 100%. CV% values were 0.66%, 1.49%, and 0.74% for spine, FN, and TH, respectively. All measurements were performed at baseline, and after three and six months.

2.5. Laboratory measurements

Biochemical parameters including vitamin D and calcium serum concentrations were measured. Serum samples were collected in the morning. Total 25-hydroxyvitamin D (calcidiol) concentration (sum of 25- hydroxyvitamin D3 and 25- hydroxyvitamin D2) was determined in ng/ml by a competitive electrochemiluminescence protein binding assay (Cobas E411, Roche Diagnostics GmbH, Mannheim, Germany). Precision of the analysis of 25-hydroxyvitamin D measurements was 1.9%. Total calcium serum