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Bone health assessment of elderly patients undergoing bariatric surgery

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ABSTRACT – Background – Bariatric surgery promotes changes in body composition, that can include the loss of bone mineral density (BMD). There is a lack of studies on the evolution of bone health of elderly people who underwent bariatric surgery, in general, and when comparing the gastric bypass (GB) and sleeve gastrectomy (SG) techniques. **Objective** – To evaluate the bone health of elderly patients with obesity undergoing bariatric surgery. **Methods** – This is a prospective randomized clinical study, that was carried out with individuals of both sexes, ≥65 years, undergoing GB or SG and who met the inclusion criteria. Age, gender and comorbidities (type 2 diabetes mellitus, arterial hypertension, dyslipidemia and osteoarthrosis) were collected and analyzed at baseline. Anthropometric data (weight, body mass index, percentage of weight loss, percentage of excess weight loss), laboratory tests related to bone health and bone mineral density were analyzed before and 24 months after surgery. **Results** – A total of 36 patients (GB, n=18; SG, n=18) were evaluated. At baseline, except for sex and preoperative body mass index, which was higher in GB, groups were similar. After 24 months, GB was superior for weight loss (%WL) and excess weight loss (%EWL). Regarding bone health, a significant decrease of BMD was observed in the spine, total proximal femur and femoral neck in all groups, with an average decrease of 5.1%, 10.5% and 15.1%, respectively. In addition, the observed decrease in BMD was up to 25% in the total femur after 24 months, six patients went from normal BMD to osteopenia and one from osteopenia to osteoporosis. There was no difference in parathormone values. However, there was an association between the increase in parathormone and the decrease in BMD in the spine, mainly in the GB group. There was no association between %WL and %EWL with the reduction in BMD. **Conclusion** – Bariatric surgery was related to the reduction of BMD in elderly patients, but there was no statistical difference between the two surgical techniques.

Keywords – Bariatric surgery; elderly; bone mineral density.

INTRODUCTION

With aging, changes in body composition occur. In this process, an increase in total body fat is observed, concomitantly with a decrease in lean mass and bone mineral density (BMD). Other changes include a decrease in subcutaneous fat and an increase in its visceral component. These changes in body composition are associated with an increase in the frequency of chronic conditions and functional decline, observed in the elderly[(1)]. Obesity can worsen functional limitation, which can lead to an inability to perform daily activities[(2,3)]. Weight loss can bring benefits in this regard.

For the elderly, the goals of obesity treatment are to improve quality of life and increase survival with less disability. In this sense, reducing the amount of medication to control diseases, increasing mobility and improving functionality, with the ability to perform day-to-day activities are desired outcomes[(3,4)]. On the other hand, large weight loss in the elderly raises concerns, as it is associated with loss of lean mass and bone mineral density and increased risk of falls, fractures and osteoporosis[(3-5)]. Thus, elderly patients must be individually and carefully evaluated to establish the risk/benefit of treatment. The ideal weight loss should be one in which there is an improvement in quality of life, including functionality, minimizing excess weight loss[(4)].

Bariatric surgery is a safe and effective treatment option for individuals with severe obesity and its complications[(6,7)]. With the increase of elderly people with obesity, this has become a more common treatment option for this population[(8,9)]. There is no fixed age limit for bariatric surgery, but there is a perception that surgery in patients over 65 years of age may have greater morbidity and be less safe. However, studies indicate that bariatric surgery in this population can be safe and effective, in well-selected patients, with significant loss of excess weight and improvement in obesity-related comorbidities[(8-14)].

Bariatric surgery promotes important changes in body composition. The main objective is to reduce body fat, but this is also accompanied by loss of muscle and bone mass[(7)]. Changes in bone health observed after bariatric surgery are of greater concern in the elderly population. These changes, added to the body changes inherent to aging, increase the risk of excessive loss of BMD, which can lead to osteoporosis, fractures, loss of functionality, worsening of quality of life, vulnerability and even mortality. In this sense, the assessment of bone metabolism before and after bariatric surgery in elderly individuals is essential and should be further studied.

Although studies on the impact of bariatric surgery on bone health in adult populations have already been carried out, the same is not true for populations of patients operated on at older

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ages. There is a lack of knowledge regarding the evolution of bone health in elderly patients undergoing bariatric surgery, as well as on possible differences in this evolution, when comparing the two techniques most frequently used. In this context, this study aims to evaluate the bone health of elderly patients with obesity undergoing bariatric surgery.

METHODS

This is a prospective Randomized Clinical Trial (BASE study – Bariatric Surgery in the Elderly) that was carried out with elderly individuals of both sexes, who underwent bariatric surgery at the Bariatric and Metabolic Surgery Unit of the Gastroenterology Department, Surgical Division, *Hospital das Clínicas*, University of São Paulo School of Medicine, from February 2017 to June 2019. The total number was estimated based on the service's capacity and the estimated number of patients awaiting surgical treatment who met the inclusion criteria. No sample calculation was performed.

The surgical technique used was Roux-en-Y gastrojejunal bypass (gastric bypass [GB]) or sleeve gastrectomy (SG), both by videolaparoscopy. Patients were randomized in a 1:1 ratio to the GB or SG group, consecutively, at the time of admission. For randomization, the Research Randomizer electronic platform (www.randomizer.org) was used.

The following inclusion criteria were considered: ≥65 years of age at the time of admission; BMI ≥40 kg/m^2 for at least 5 years, or a BMI ≥35 kg/m^2, with at least one comorbidity; having failed clinical treatment for obesity for at least 2 years; clinical/cardiological assessment of surgical risk; systematic geriatric evaluation, with functionality parameters and satisfactory cognitive tests for performing the surgery; and preoperative psychological assessment for the procedure.

Non-inclusion criteria were: previous abdominal surgery (exceptions: cholecystectomy, appendectomy or cesarean section), revision bariatric surgery, presence of giant ventral hernia, presence of moderate or severe gastroesophageal reflux, hiatal hernia greater than 2.0 cm, erosive esophagitis grade Los Angeles C or D, Barrett's esophagus, chronic use of proton pump inhibitor, bone densitometry with diagnosis of osteoporosis and refusal to participate in the study.

The present study was conducted according the guidelines of Declaration of Helsinki and was approved by the Research Ethics Committee of HCFMUSP under number 2.291.458, registered on *Plataforma Brasil* under number 68401117.4.0000.0068. Furthermore, this study was registered on ClinicalTrials.gov platform NCT03339791. All participants were informed about objectives and study procedures. Those that accepted provided written Informed Consent Form.

Collected data

Patient information was obtained through electronic medical records, interviews, anthropometry and body composition evaluation, and complementary exams. Age, gender, type of surgery performed, maximum weight achieved, maximum BMI reached, height, body fat before surgery and comorbidities (type 2 diabetes mellitus, arterial hypertension, dyslipidemia and osteoarthrosis) were collected and analysed at baseline. Anthropometric data such as body weight, BMI, percentage of weight loss (%WL), percentage of excess weight loss (%EWL) were collected before, 12 months and 24 months after surgery. Laboratory tests (albumin, parathormone, vitamin D, total calcium and ionic calcium) and assessment of bone mineral density were collected and analyzed before and after, on average, 24 months after surgery. Ideal weight considered to evaluate %EWL was that equivalent to BMI 25 kg/m^2, as it is still the most used reference in publications that evaluate the results of bariatric surgery in the elderly[13].

Assessment of body composition and bone mineral density

The assessment of body composition and bone mineral density was performed using dual energy X-ray absorptiometry (DXA). To diagnose patients with adequate BMD, osteopenia or osteoporosis, the lowest standard deviation value in relation to young adults (T-score) measured in the lumbar spine (L1/L4), femoral neck and total proximal femur was considered. In certain circumstances where it was not possible to use these regions for diagnosis, the radius 1/3 or 33% was used on the forearm. The minimum BMD variation of up to 3% in the spine and up to 5% in the femur was not considered a significant variation[15].

Statistical analysis

Statistical analyzes were performed using SPSS software (version 22.0, USA). The Shapiro-Wilk test was used to assess the normality of the variables. The paired t test or the Wilcoxon test were used to assess the effect of time on treatments. The independent samples *t* test or the Mann-Whitney U test were used to assess the differences between the groups. To assess the association between the prevalence of BMD loss and the surgical technique, the chi-square test (X^2) was used. Correlations between variables were evaluated using Pearson's or Spearman's correlation tests. Data were presented as mean ± standard error of the mean. A significance criterion of α= 5% was adopted.

RESULTS

A total of 36 patients were included in this study, with 18 subjects (50%) for each of the surgical techniques (GB and SG). The baseline characteristics of the total sample and separated by surgery are shown in TABLE 1.

Maximum BMI was similar between groups (*P*=0.416), but preoperative BMI was higher in the BP group (*P*=0.034). The body composition of the patients was homogeneous between the surgical techniques. The mean percentage of body fat was 48.4±0.8%, being 49.4±1.3% in the GB group and 47.5±1.0% in the SG group (*P*=0.266) (TABLE 1).

As expected, total weight loss (%WL) and excess weight loss (%EWL) after 12 and 24 months were significantly higher in GB than in SG (TABLE 2).

Regarding BMD, of the 36 patients who underwent bariatric surgery, 22 underwent DXA both preoperatively and postoperatively. However, in three patients it was necessary to use the radius 1/3 in the forearm for diagnosis and in five it was not possible to access the exam images, only the report. Therefore, for the analysis and assessment of BMD of the spine, femoral neck and total femur, a subsample of 14 patients (seven from the GB group and seven from the SG) was used (TABLE 3). The initial mean BMD for the lumbar spine was 1.09±0.04 g/cm^2, for the femoral neck was 0.86±0.04 g/cm^2 and for the total femur was 1.04±0.04 g/cm^2. After 2 years of surgery, there was a significant reduction in BMD in these three sites within both groups, GB and SG groups (*P*<0.05), but with no significant difference between them.

TABLE 1. Baseline characteristics of the total sample and separated by surgical technique.

Variables	All n=36	GB n=18	SG n=18	*P*
Age (years)	67.3±0.4	66.8 0.4	67.7±0.7	0.317
Height (meters)	1.6±0.01	1.6±0.02	1.6±0.01	0.630
Maximum weight (kg)	126.3±3.7	127.3±4.2	125.3±6.2	0.790
BMI maximum (kg/m²)	49.8±1.2	50.8±1.3	48.8±1.9	0.416
Pre weight (kg)	114.0±3.0	118.0±4.2	110.0±4.1	0.181
BMI pre (kg)	45.0±0.9	46.9±1.1	43.1±1.2	0.034
Pre body fat (%)	48.4±0.8	49.4±1.3	47.5±1.0	0.266
Type 2 diabetes mellitus (%)	25 (69.4)	13 (72.2)	12 (66.7)	0.717
Hypertension (%)	34 (94.4)	16 (88.9)	18 (100)	0.146
Dyslipidemia (%)	12 (33.3)	6 (33.3)	6 (33.3)	1.000
Osteoarthritis (%)	25 (69.4)	10 (55.6)	15 (83.3)	0.070

BMI: body mass index; GB: gastric bypass; SG: sleeve gastrectomy. Data were presented as mean ± standard error of mean, absolute frequency (n) or relative frequency (%).

TABLE 2. Evolution of weight and weight loss of the total sample and separated by surgical technique.

Variables	All n=36	GB n=18	SG n=18	*P*
Weight 12 months (kg)	83.2±2.1	82.5±3.3	83.9±2.7	0.634
BMI 12 months (kg/m²)	32.9±0.6	32.8±0.8	32.94±0.8	0.887
%WL 12 months (%)	26.5±1.3	29.9±1.5	23.1±1.9	0.008
%EWL 12 months (%)	60.5±2.7	64.9±2.9	56.0±4.4	0.105
Weight 24 months (kg)	81.8±2.1	79.3±3.3	84.2±2.7	0.260
BMI 24 months (kg/m²)	32.3±0.6	31.5±0.6	33.1±0.9	0.153
%WL 24 months (%)	27.7±1.6	32.8±1.8	22.9±2.0	0.001
%EWL 24 months (%)	62.6±3.0	70.2±2.7	55.5±4.8	0.014

BMI: body mass index; %WL: percentage of weight loss; %EWL: percentage of excess weight loss. Data were presented as mean ± standard error of the mean.

The percentage of BMD reduction after bariatric surgery was, on average, 5.1% in the lumbar spine, 10.5% in the femoral neck and 15.1% in the total femur. A clinically significant reduction in BMD (>3% at the spine and >5% at the femur) was observed in 57.1% of patients at the spine, 71.4% at the femoral neck, and 100% at the total femur. This variation reached − 16.1% in the spine, − 22.6% in the femoral neck and − 25.1% in the total femur.

Of the 22 patients who underwent DXA before and after surgery, six developed osteopenia (27.3%) and one went from osteopenia to osteoporosis (4.5%). Of the 36 patients, a femur fracture (2.8%) was reported in a woman after four years of the GB surgical technique.

As for laboratory tests associated with bone health, only albumin showed a difference in the SG group. Individuals who underwent SG showed a significant increase of 0.2±0.08 in albumin levels at 24 months (*P*=0.013). Within the GB group, there was a significant increase in ionic calcium after following period (Δ= +0.2±0.07; *P*=0.046).

For vitamin D, a significant increase was observed when patients were not separated by surgical technique (*P*=0.029). This change does not occur when analyzed within the GB and SG groups (*P*=0.211 and *P*=0.064, respectively). When evaluating the individual values of the vitamin D, it was observed a deficiency of this vitamin in 29 (80.6%) patients before bariatric surgery. This deficiency decreases after surgery but was still found in 18 (50.0%) patients after 24 months.

There was no significant difference in PTH levels from the preoperative period to 24 months in each surgical technique and between them. However, at the second year after surgery, the GB had a higher PTH value than the SG group (*P*<0.05) (FIGURE 1).

The association between the laboratory tests (PTH, vitamin D, total calcium, ionic calcium) and BMD of the spine, femoral neck and total femur was evaluated (SUPPLEMENTAL TABLE 1, 2 and 3). A significant association was found only between PTH and the % change of BMD of the column. The higher the PTH value, the greater the loss of spine's BMD (FIGURE 2). When separated by surgical technique, this relationship was maintained in the GB group, but no longer in the SG group.

TABLE 3. Laboratory tests and bone mineral density of the total sample and separated by surgical technique.

Variables	All n=36			*P*	GB n=18			*P*	SG n=18			*P*	GBxSG
	Pre	24 months	Δ		Pre	24 months	Δ		Pre	24 months	Δ		Δp
Alb (g/dL)	4.3±0.05	4.4±0.05	0.1±0.06	0.070	4.2±0.06	4.3±0.07	0.01±0.08	0.871	4.4±0.08	4.5±0.07	0.2±0.08	0.013	0.050
PTH (pg/mL)	57.2±3.8	64.3±4.7	7.1±4.0	0.070	61.7±5.8	69.8±4.9	8.3±5.1	0.073	52.5±4.8	58.1±8.2	5.8±6.6	0.660	0.240
VitD (ng/mL)	25.0±2.6	63.3±20.7	37.9±21.4	0.029	26.8±4.9	26.0±2.3	-0.9±5.5	0.211	23.3±2.0	105.9±42.2	82.1±4.2	0.064	0.257
TCa (mg/dL)	9.4±0.1	23.7±5.9	13.3±6.2	0.095	9.3±0.2	25.5±8.6	11.6±7.8	0.245	9.5±0.1	21.9±8.3	15.5±10.4	0.229	0.893
ICa (mg/dL)	5.0±0.04	5.1±0.04	0.1±0.05	0.007	4.9±0.06	5.1±0.05	0.2±0.07	0.046	5.0±0.06	5.2±0.06	0.1±0.06	0.094	0.689
Bone mineral density*													
Column (g/cm²)	1.09±0.04	1.03±0.03	-0.06±0.02	0.005	1.10±0.05	1.03±0.05	-0.08±0.03	0.042	1.07±0.06	1.03±0.06	-0.04±0.01	0.025	0.283
Femur neck (g/cm²)	0.86±0.04	0.76±0.04	-0.10±0.02	0.000	0.86±0.08	0.74±0.06	-0.12±0.03	0.008	0.86±0.04	0.78±0.04	-0.09±0.03	0.025	0.532
Total femur (g/cm²)	1.04±0.04	0.88±0.04	-0.16±0.01	0.000	1.05±0.06	0.89±0.06	-0.16±0.02	0.000	1.04±0.06	0.87±0.05	-0.17±0.02	0.000	0.702

Δ: delta (difference between 24 months and pre); Alb: albumin; PTH: parathormone; VitD: Vitamin D; TCa: total calcium; Ica: ionic calcium. *Analysis performed on a subsample (all n=14, GB n=7 and SG n=7). Data were presented as mean ± standard error of the mean.

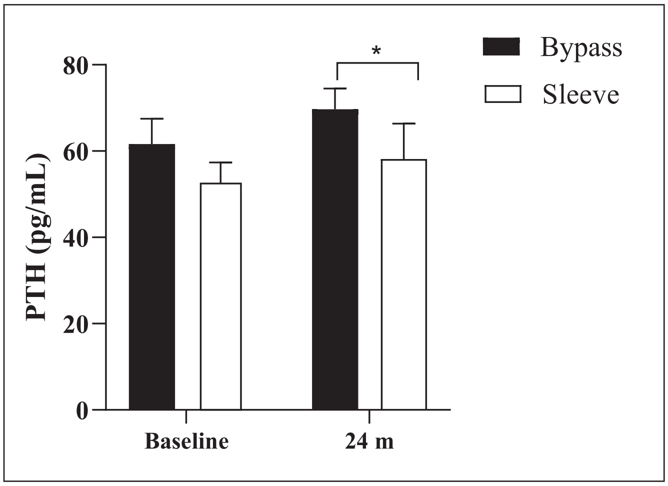

FIGURE 1. PTH means at baseline and 24 months of gastric bypass and sleeve groups.
PTH: parathyroid hormone. *$P<0.05$.

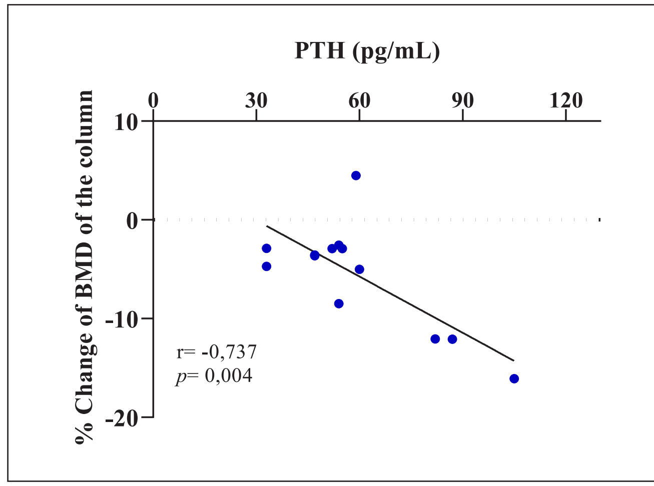

FIGURE 2. Association between PTH and %change of BMD of the column.
PTH: parathyroid hormone; BMD: bone mineral density.

SUPPLEMENTAL TABLE 1. Association between laboratory tests and BMD of the spine, femoral neck and total femur of the total sample.

All	PTH (pg/mL)	Vit D (ng/mL)	Total calcium (mmol/L)	Ionic calcium (mmol/L)	% change of BMD – column	% change of BMD – femur neck	% change of BMD – total femur
PTH (pg/mL)	1.000	-0.388	-0.088	-0.329	-737.000	-0.293	-0.038
Vit D (ng/mL)	-0.388	1.000	0.508	-0.113	0.134	0.053	-0.141
Total calcium (mmol/L)	-0.088	0.508	1.000	-0.296	-0.008	0.419	0.434
Ionic calcium (mmol/L)	-0.329	-0.113	-0.296	1.000	0.446	0.150	-0.363
% change of BMD – column	-737.000	0.134	-0.008	0.446	1.000	0.510	-0.161
% change of BMD – femur neck	-0.293	0.053	0.419	0.150	0.510	1.000	0.368
% change of BMD – total femur	-0.038	-0.141	0.434	-0.363	-0.161	0.368	1.000

PTH: parathormone; VitD: Vitamin D; BMD: bone mineral density.

SUPPLEMENTAL TABLE 2. Association between laboratory tests and BMD of the spine, femoral neck and total femur of the gastric bypass group.

Gastric bypass	PTH (pg/mL)	Vit D (ng/mL)	Total calcium (mmol/L)	Ionic calcium (mmol/L)	% change of BMD – column	% change of BMD – femur neck	% change of BMD – total femur
PTH (pg/mL)	1.000	0.262	-0.078	-0.150	-851.000	-0.460	-0.134
Vit D (ng/mL)	0.262	1.000	-0.032	-0.781	-0.626	-0.698	0.251
Total calcium (mmol/L)	-0.078	-0.032	1.000	-0.340	-0.066	0.598	0.703
Ionic calcium (mmol/L)	-0.150	-0.781	-0.340	1.000	0.589	0.263	-0.700
% change of BMD – column	-851.000	-0.626	-0.066	0.589	1.000	0.490	-0.280
% change of BMD – femur neck	-0.460	-0.698	0.598	0.263	0.490	1.000	0.429
% change of BMD – total femur	-0.134	0.251	0.703	-0.700	-0.280	0.429	1.000

PTH: parathormone; VitD: Vitamin D; BMD: bone mineral density.

SUPPLEMENTAL TABLE 3. Association between laboratory tests and BMD of the spine, femoral neck and total femur of the sleeve gastrectomy group.

Sleeve gastrectomy	PTH (pg/mL)	Vit D (ng/mL)	Total calcium (mmol/L)	Ionic calcium (mmol/L)	% change of BMD – column	% change of BMD – femur neck	% change of BMD – total femur
PTH (pg/mL)	1.000	-0.577	-0.603	-0.542	-0.421	0.067	-0.296
Vit D (ng/mL)	-0.577	1.000	0.999	-0.320	0.379	0.118	-0.220
Total calcium (mmol/L)	-0.603	0.999	1.000	-0.296	0.398	0.109	-0.196
Ionic calcium (mmol/L)	-0.542	-0.320	-0.296	1.000	-0.137	-0.092	0.393
% change of BMD – column	-0.421	0.379	0.398	-0.137	1.000	0.580	0.494
% change of BMD – femur neck	0.067	0.118	0.109	-0.092	0.580	1.000	0.372
% change of BMD – total femur	-0.296	-0.220	-0.196	0.393	0.494	0.372	1.000

PTH: parathormone; VitD: Vitamin D; BMD: bone mineral density.

The correlation between %WL and %EWL with the change in BMD in the spine, femoral neck and total femur was also performed (FIGURE 3). From these analyses, no significant association was found.

DISCUSSION

There are not many studies on bone health specifically in elderly individuals with obesity who have undergone bariatric surgery. In this aspect, the present study was able to demonstrate the effect of this surgery in this population. After 2 years, both techniques promoted statistical reductions in bone mineral density, but with no difference between them.

The baseline characteristics of the sample of the present study are predominantly homogeneous, since, except for sex and preoperative BMI, all the variables analyzed before surgery did not show statistical difference between the surgical techniques. The difference in BMI was due to the weight loss of patients in the preoperative period. While in the SG group, individuals lost an average of 11.8% of their total weight, those in the GB group lost 7.6%. Thus, the preoperative BMI was lower in the SG group, which may have interfered with the results.

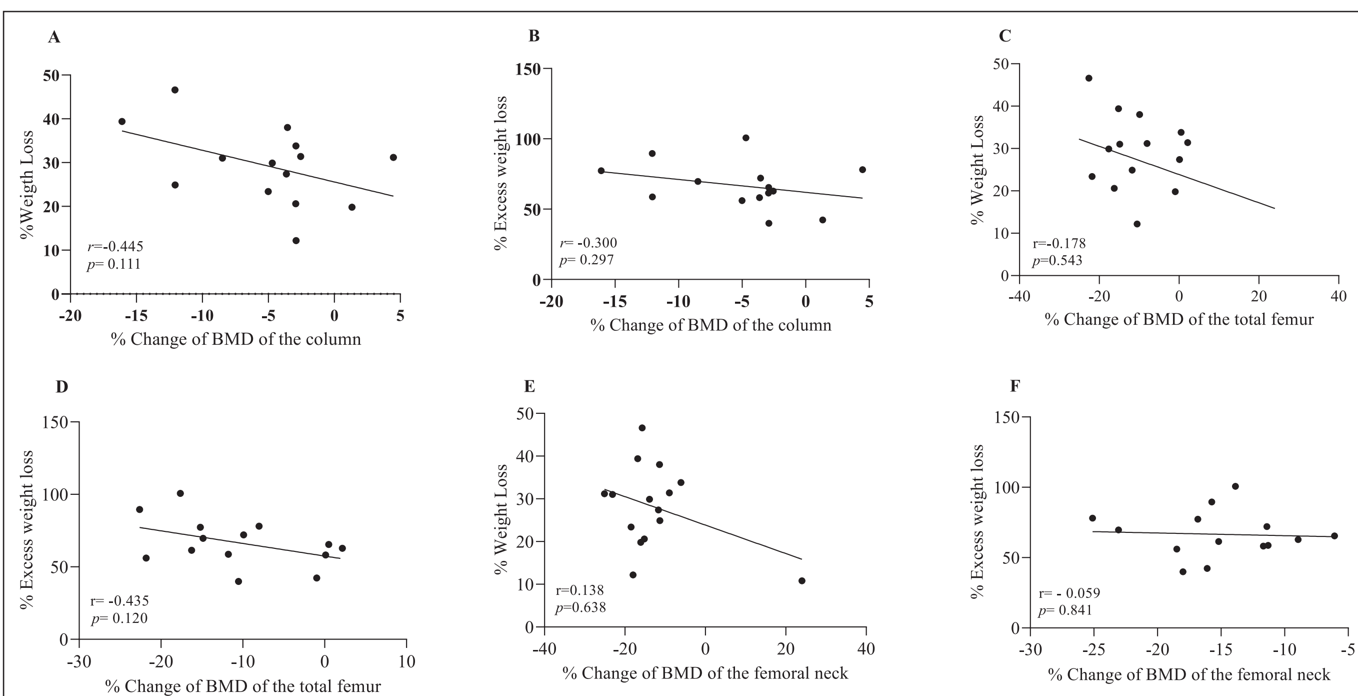

FIGURE 3. Association between %WL and %EWL with % change of BMD. A) Association between %WL and % change of BMD of the column. B) Association between %EWL and % change of BMD of the column. C) Association between %WL and % change of BMD of the total femur. D) Association between %EWL and % change of BMD of the total femur. E) Association between %WL and % change of BMD of the femoral neck. F) Association between %EWL and % change of BMD of the femoral neck.

%WL: percentage of weight loss; %EWL: percentage of excess weight loss; BMD: bone mineral density.

The %WL and %EWL are variables that were not affected by this difference in preoperative BMI. In this study, the %EWL at 12 months was 64.9±2.9% for the GB group and 56.0±4.4% for the SG group. Similarly, in the study by Susmallian et al.[10] 451 patients aged 65 years or older undergoing bariatric surgery were evaluated, of whom 346 underwent sleeve gastrectomy and 33 Roux-en-Y gastrojejunal bypass. After 1 year, the mean %EWL of the SG group was 57.1% and that of the GB group was 67.9%. In the present study, both techniques showed good results in weight loss and excess weight loss. However, the GB group was superior as it had a higher %WL at 12 and 24 months and a higher %EWL at 24 months than the SG group. In systematic reviews, this difference in the higher percentage of weight loss between GB and SG up to 24 months after the surgical procedure was also observed in the adult population[16,17].

In elderly population, the excessive loss of lean mass that can occur with bariatric surgery, together with the loss of total weight, can be particularly harmful to the patient's functionality. Therefore, long-term follow-up of these patients will allow to determine whether the difference in weight loss between surgical techniques will impact quality of life.

Regarding bone health, to classify BMD as adequate, osteopenia or osteoporosis in women aged 40 years or older and/or postmenopausal women and men aged 50 years and over, the T-score is used, standard deviation in relation to young adults. Z-score means the standard deviation in relation to people of the same age group, sex and ethnicity. Z-score <-2.0 is defined as BMD below that estimated for age and >-2.0, within the expected limits for the age group[15]. In the population of this study, no patient was classified as below the expected age range before or after surgery. Still, although no patient had a lower BMD than expected in their population, the loss of BMD due to the bariatric surgery was high. In the present study, it was observed a clinically significant decrease in BMD in all evaluated patients, in at least one site, regardless of surgical technique.

Similarly to this study, a literature review found that after 1-2 years of bariatric surgery there is a significant decline in BMD estimated at 5–9% in the spine[18]. In agreement with our results, Yu et al.[19] evaluated patients 24 months after GB surgery and discussed that, although a T-score below the normal range was not found, there was a statistical significance of the reduction in BMD of these patients compared to the control, with a reduction variation of 5 to 7% in the spine. In another study, the authors evaluated changes in bone mineral density through DXA in 24 patients undergoing Roux-en-Y gastroplasty and 16 individuals undergoing sleeve gastrectomy. They found a significant decrease in bone mineral density of 8% in the femoral neck and 3.5% in the lumbar spine after one year of GB and 5.9% in the femoral neck after one year of SG[20].

Most of the cited studies, nevertheless, have assessed the population ≥18 years old, without differentiating the elderly. In a study that evaluated 28 postmenopausal women who underwent bariatric surgery (GB and SG), a significant variation in spinal BMD of 8.8% was found after 1 year[21].

A possible explanation for bariatric surgery worsening bone health is due to the effect in bone metabolism, acceleration of bone remodeling with increased resorption, deterioration in microarchitecture and bone strength. These phenomena have a multifactorial cause, related to changes in hormones and nutritional deficiencies, particularly in calcium and vitamin D, which can lead to secondary hyperparathyroidism and an increase in bone resorption markers. Furthermore, evidence suggests that bone health depends on the degree of weight loss and the type of procedure, due to the potential for micronutrient deficiencies that each can cause[18,22-24].

The population of this study had a high percentage of vitamin D deficiency before surgery (80.6%). This data is not different from that found by Geoffroy et al.[25], with only 20% of patients with an adequate preoperative level of this vitamin. After surgery, this prevalence of deficiency decreased, but it was still found in 50% of patients. This is explained by the low adherence to supplementation after surgery (52.4% were following the instructions). Furthermore, according to the literature, some individuals may have difficulty in normalizing the vitamin D level after bariatric surgery depending on the technique. GB is the surgery with the highest risk of vitamin deficiency, as a part of the intestine where absorption of this nutrient occurs is excluded. Thus, a single supplementation approach will not optimize adequacy in all patients, and therefore, the dosage must be individualized and the serum level must be constantly monitored[26].

Deficiency of nutrients such as calcium and vitamin D can also lead to secondary hyperparathyroidism (SHPT). SHPT is characterized by increased secretion of parathormone due to parathyroid hyperplasia and is associated with worsening bone health, as it increases osteoclast activity and bone resorption[27]. In this study, no significant increase in PTH was found after 24 months of bariatric surgery. However, a higher PTH value was found in the GB group in the 2nd year after surgery and a significant association between the increase of this marker and the greater loss of spine BMD was observed. When separated by surgical technique, this relationship was maintained in the GB group, but no longer in the SG group.

The prevalence of hyperparathyroidism increases continuously after bariatric surgery[28,29]. The period of this 24-month study may have been too short to observe a significant difference in PTH between the times, but it was enough to identify the relationship between this hormone and the reduction of BMD. According to Salman et al.[29] after 2 years, hyperparathyroidism was significantly more common in patients who underwent gastric bypass compared to those who underwent sleeve gastrectomy and the authors also found an association with the reduction of BMD, but with the total femur.

In the present study, a fracture was reported after bariatric surgery. The 69-year-old female patient at the time and with a previous comorbidity of diabetes mellitus 2 and knee osteoarthrosis underwent the GB technique in 2017. After 1 year, she had 54.9% of excess weight loss and 77.8% after 2 years, being in both times, considered a successful treatment. After 4 years, in 2021, she suffered a femur fracture. Regarding the patient's bone health, she went from normal BMD in the pre-surgery period to osteopenia. In addition, she did not have total calcium, ionic calcium, vitamin D deficiency and did not have elevated PTH before surgery. Specifically, she had vitamin D of 100 ng/mL and PTH of 40 pg/mL. In the year of the femur fracture, she developed vitamin D deficiency, with a value of 24 ng/mL, and high PTH value (119 pg/mL), indicating secondary hyperparathyroidism.

According to the literature, the risk of fracture is higher in patients undergoing bariatric surgery, especially with GB[18,24,30-33]. A review and meta-analysis published this year showed a significantly higher risk of any type of fracture in patients undergoing bariatric surgery than in nonsurgical patients (relative risk 1.20, 95% confidence interval and P<0.00001). In addition, in the meta-analysis with four observational studies, it was reported that individuals undergoing GB have a higher risk of fractures compared to those undergoing SG (relative risk of 1.77, with a 95% confidence interval and P<0.00001)[30].

To optimize the results of bariatric surgery and minimize complications and adverse effects, such as worsening bone health, it is important to be careful with diet, supplementation and exercise before and after bariatric surgery. Muschitz et al.[34] conducted a multifaceted intervention combining vitamin D and calcium citrate supplementation before and after surgery, individualized protein supplementation after surgery, and physical exercise after GB or SG surgery. After 2 years of intervention, the levels of bone turnover markers and the loss of BMD and lean mass were significantly lower than in the control group. In another randomized controlled clinical trial, aimed to specifically investigate the role of exercise in attenuating bone loss, 35 patients were assigned to 6 months of supervised exercise and another 35 patients to standard care, in which patients were only encouraged to improve their physical activity level during follow-up. At the end of the study, physical exercise attenuated the percentage of BMD loss in the femoral neck (estimated average difference of 2.91%, P=0.007) and in the total femur (estimated average difference of 2.26%, P=0.009), in addition to attenuating bone resorption markers, such as CTx (-0.20 ng/mL, P=0.002) compared to the group without supervised physical exercise. Exercise did not affect vitamin D and PTH levels[35].

Thus, individualized and frequent monitoring for sufficient calcium, vitamin D and protein intake and adequate physical activity before and after all bariatric procedures are necessary to reduce negative impacts on bone. Laboratory and DXA tests before and after surgery and then annually or as often as needed are also appropriate.

As previously mentioned, changes in bone health after bariatric surgery, in addition to body changes caused by aging, cause greater concern in the elderly. Therefore, especially for this population, taking bone health into account to assess the real benefit of this treatment, determining the most appropriate procedure and performing the necessary care to reduce the negative impacts of surgery is to ensure the best result for patients. Elderly people who already have a bone problem may not be a recommended group for bariatric surgery due to worsening bone health.

This work had limitations. Due to the Covid-19 pandemic, few data from some patients, such as adherence to supplementation and weight at 24 months after surgery, had to be collected by telephone contact. For the same reason, the average time to perform the DXA (pre-determined in 24 months), had to be flexible and was only possible in a subsample. Finally, according to the literature, the period of analysis of the study may not have been long enough to find a significant variation in PTH after surgery and for the occurrence of more fractures, occurrences that increase with time. Thus, prospective studies with a greater number of patients and especially in this population of elderly people and with a later period are necessary.

CONCLUSION

In this studied population that evaluated elderly people with obesity, bariatric surgery was related to the reduction of BMD patterns, but with no statistical difference when comparing the two surgical techniques. No association was observed between most laboratory test, %WL and %EWL with BMD reduction. Only PTH was associated with a reduction in spine's BMD in patients undergoing bariatric surgery and specifically in GB. Therefore, bone worsening after bariatric surgery in elderly patients is an important aspect that must be considered.

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Authors' contribution

Corsi GC and Pajecki D were responsible for the study concept. Corsi GC and Pinheiro MCA contributed to the acquisition and interpretation of the data. Caldas APS was responsible for the analysis of the data. Corsi GC wrote the manuscript. All authors read, revised and approved the final manuscript.

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Corsi GC, Pinheiro MCA, Caldas APS, Dias MCG, Santo MA, Pajecki D. Avaliação da saúde óssea de pacientes idosos submetidos a cirurgia bariátrica. Arq Gastroenterol. 2022;59(4):513-21.

RESUMO – Contexto – A cirurgia bariátrica promove mudanças na composição corporal, que incluem a perda de densidade mineral óssea (DMO). Faltam estudos que avaliem a evolução da saúde óssea de idosos que foram submetidos a cirurgia bariátrica, e sobre eventuais diferenças nessa evolução, quando comparadas as técnicas *Bypass* gástrico (BP) e gastrectomia vertical (GV). **Objetivo –** Avaliar a saúde óssea de pacientes idosos com obesidade submetidos a cirurgia bariátrica. **Métodos –** Trata-se de estudo prospectivo randomizado, realizado com indivíduos de ambos os sexos, ≥65 anos, submetidos a BP ou GV e que atendiam os critérios de inclusão. Idade, sexo e comorbidades (diabetes mellitus tipo 2, hipertensão arterial, dislipidemia e osteoartrose) foram coletados no momento da cirurgia bariátrica. Dados antropométricos (peso, índice de massa corporal, percentual de perda de peso, percentual de excesso de peso), exames laboratoriais relacionados a saúde óssea e densitometria óssea foram realizados antes e com 24 meses de pós-operatório. A evolução das variáveis estudadas foi feita comparando o pré e pós-operatório da casuística como um todo e dos grupos separadamente e entre si. **Resultados –** Um total de 36 pacientes (BP, n=18; GV, n=18) foram avaliados. As características basais da amostra, exceto pelo sexo e índice de massa corporal, que era maior no BP, foram homogêneas. Após 24 meses, o BP foi superior para perda de peso (%PP) e perda de excesso de peso (%PEP). Quanto à saúde óssea, observou-se uma diminuição significante da DMO na coluna, fêmur proximal total e colo do fêmur em ambos os grupos, com uma média de queda de 5,1%, 10,5% e 15,1%, respectivamente. Além disso, a queda da DMO observada foi de até 25% no fêmur total após 24 meses, seis pacientes passaram de DMO normal para osteopenia e um de osteopenia para osteoporose. Não houve diferença nos valores de paratormônio. Entretanto, houve associação entre o aumento do paratormônio e a redução da DMO na coluna, particularmente no grupo BP. Não foi observado associação entre %PP e %PEP com a redução da DMO. **Conclusão –** A cirurgia bariátrica se relacionou com a redução da DMO, porém sem diferença estatística entre as duas técnicas cirúrgicas.

Palavras-chave – Cirurgia bariátrica; idosos; densidade mineral óssea.

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