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Review

The effects of bariatric surgery on bone and nephrolithiasis

Khashayar Sakhaee *, John Poindexter, Crystal Aguirre

Department of Internal Medicine, Division of Mineral Metabolism, Charles & Jane Pak Center for Mineral Metabolism & Clinical Research,University of Texas Southwestern Medical Center, Dallas, TX, United States

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ABSTRACT

The impact of bariatric surgery on cardiovascular and diabetic complications associated with an improvement in survival has overshadowed the adverse skeletal health and development of kidney stone disease in this population.

All longitudinal based studies in the literature reporting the incidence of bone fractures or kidney stones following bariatric surgery were reviewed. Moreover, all publications over the past decade which assessed changes in bone mineral density and bone quality, or explored underlying pathophysiologic mechanisms of bone and kidney stone disease were carefully reviewed.

This review provides sufficient data to support that osteoporotic fractures and kidney stone disease are associated with Roux-en-Y gastric bypass surgery. However, due to the limited data available to date, no definitive conclusion could yet be drawn whether sleeve gastrectomy or adjustable gastric banding is associated with bone fractures and kidney stones.

Bariatric surgery has emerged as the most effective and sustained treatment for weight reduction. This treatment modality has been recognized to diminish the risk of cardiovascular morbidity and mortality and ameliorate diabetes mellitus complications. The derangement in mineral metabolism has emerged as a major complication following bariatric surgery.

Contents

* Corresponding author at: 5323 Harry Hines Blvd, Dallas, TX 75390, United States.
E-mail address: khashayar.sakhaee@utsouthwestern.edu (K. Sakhaee).

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1. Introduction

Since the early 1960s, the prevalence of obesity among adults has more than doubled with an increase from 13.4 to 35.7% in the U.S. [1]. The epidemic of obesity plateaued between 1999 and 2010 [2], yet the prevalence of extreme obesity is significantly high as 14.5% of U.S. adults have a body mass index (BMI) of 35 or greater. Compared with normal weight adults, the cost of health care in this population has been estimated to be significantly high.

Life style modifications and pharmacological treatments have been largely ineffective in treatment of extremely obese subjects. Bariatric surgery has emerged as the most effective treatment modality in promoting weight loss, and reducing morbidities and mortalities [3,4]. As a result, an increasing number of bariatric surgeries have been performed worldwide over the past three decades. In recent years, Roux-en-Y gastric bypass (RYGB) exceeded the number of other procedures including sleeve gastrectomy (SG) and adjustable gastric banding (AGB). However, recent reports have established an increasing use of SG in this population [5]. The impact of bariatric surgery on cardiovascular and diabetic complications accompanied with improvement in survival has overshadowed the adverse skeletal health and development of kidney stones.

2. Bone fractures after bariatric surgery

To date, there are limited longitudinal population-based studies available to estimate the incidence of bone fractures in patients following bariatric surgery. In one retrospective cohort study in the United Kingdom, a large number of bariatric surgery patients and matched control subjects were examined [6]. This study did not disclose an increase in fracture risk following surgery compared with obese weight match control subjects. In contrast, population based study from Minnesota (MN) reported that bariatric surgery is associated with a 2.3 fold increase in the risk of first fracture at any site [7]. The cumulative incidence of any new fracture was reported to be 58% over the 15 year follow-up period. Over 50% of the fractures reported were spontaneous vertebral fractures. The discrepancy between these two studies could be due to inclusion of predominately AGB patients and a short median interval of follow-up of 2.2 years in the United Kingdom cohort but inclusion of predominately RYGB patients in the MN cohort with a longer mean follow-up of approximately 8.9 years [6].

Moreover, in a recent study in which 120 uncontrolled diabetics were randomized into intensive lifestyle and medical management alone, or lifestyle and medical management plus RYGB showed the latter cohort had more fractures associated with falls compared with the cohort without RYGB. All fractures occurred in women and nutritional deficiencies were more prevalent in the RYGB group, despite use of nutritional support. Although the results were suggestive, this study was not statistically powered to indicate significance [8].

3. Changes in bone mineral density, microarchitecture and strength at the spine & the proximal hip following RYGB

Bone strength is clinically determined by BMD analysis, however additional factors including alteration in microarchitecture, bone turnover, and bone mineralization will change the quality of the bone, which may independently increase the risk of bone fragility fractures.

It has been misconstrued that modern bariatric surgeries will overcome the skeletal complications caused by jejunoileal bypass and biliopancreatic diversions, which were abandoned in the 1980s [9]. At present, 12 studies have demonstrated robust changes following RYGB in vertebral and hip BMD ranging from −0.03 to −12.0% and 0 to −11%, respectively [10–23] (Fig. 1a & b).

Although fat mass and changes in fat mass may affect areal bone density measurements by DEXA, some studies have averted this problem by utilizing volumetric bone mineral density. A few studies highlighted the deterioration of volumetric bone mineral density and microarchitecture following bariatric surgery [16,20,24]. In a recent one-year longitudinal study of RYGB patients, bone density using DXA and volumetric BMD with quantitative computed tomography (QCT) showed no change in BMD at the proximal hip using QCT compared with matched obese subjects [16]. This finding indicates that the decreases in BMD using DXA are influenced by high fat mass. In an extension of this study for 24 months it was shown that these changes were associated with alterations in microarchitecture and bone strength using high-resolution peripheral QCT (HR-pQCT) [24]. The microarchitectural changes were accompanied by significant trabecular involvement at the radius and a prominent increase in cortical porosity at the tibia [24]. In addition, bone strength, assessed by microfinite element analysis used to estimate failure load was significantly lower at both the radius and tibia in RYGB patients compared to the obese-controls [24]. The changes in the cortical bone property of the tibia were consistent with a previous study suggesting similar changes following bariatric surgery [20].

4. Changes in bone mineral density at spine & proximal hip following SG & AGB

With an increasing trend to perform SG, concern has been aroused towards the development of bone loss in this population [25,26]. The clinical experiences with BMD changes following SG and AGB have been very limited. The results of the three reported studies in literature have been inconsistent, two studies demonstrated BMD changes at the

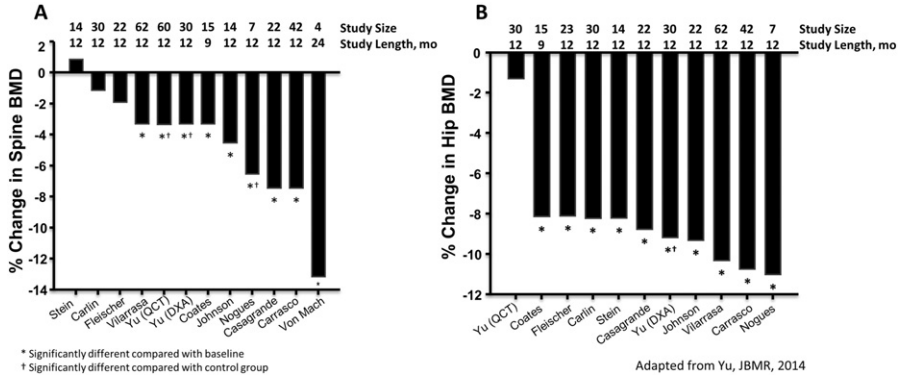

Fig. 1. Bone mineral density changes at spine (panel a) and hip (panel b) following RYGB. Adapted from Yu, JBMR, 2014. Needs permission.