Bone Loss and Fracture Risk Among Patients Who Have Had Bariatric Surgery

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Obesity is on the rise in the United States. Given the various treatments available, there has been some promise that this epidemic can be stopped. One of every 3 Americans meets the criteria for obesity, and the number of bariatric surgeries performed in the United States has doubled in the past decade.[1] In 2009, a total of 220,000 bariatric surgeries were performed.[2] One of every 20 adults is morbidly obese. The most common surgical procedure performed for this patient population is gastric bypass.[3] There is an average of a 43-kg weight loss and a 17-point decrease in body mass index, amounting to a 35% decrease in initial body weight and a 62% to 75% decrease in excess body weight, with gastric bypass.[4,5]

Although gastric bypass is very effective, orthopedic surgeons must understand that surgical weight loss results in alteration to the complex mechanisms of calcium metabolism, potentially leading to a decrease in bone mineral density and an increase in both fracture risk and nonunion. Orthopedic surgeons are the practitioners most likely to see these patients if they sustain a fracture. Although these patients are younger than traditional osteoporotic patients, the issues surrounding bone health and fracture healing are the same. The number of patients in this population presenting for musculoskeletal care will likely increase as the number of bariatric surgeries increases. It is necessary to understand the changes that occur in calcium metabolism after bariatric surgery to correctly understand the potential impact on bone healing that may be encountered.

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Calcium Metabolism

After gastric bypass, calcium metabolism is hindered by several mechanisms. First, 80% of the active absorption of calcium in the intestines is lost.[5,6] Next, secondary hyperparathyroidism is induced. Additionally, vitamin D absorption is hindered, thereby decreasing the absorption of calcium in the intestines. Several studies have shown how these alterations wreak havoc on the musculoskeletal system. A study[7] of 60 women with a history of bariatric surgery found that serum osteoprotegerin (an inhibitor of osteoclastogenesis) inversely correlated with the bone remodeling markers osteocalcin, B-isomer of the C-terminal telopeptide of type 1 collagen cross-links, and N-terminal pro-peptide of procollagen 1. Fleischer et al[8] found that both urinary N-telopeptide and osteocalcin rose ($P<.01$), with parathyroid hormone rising 3 months postoperatively. Urinary calcium dropped, although calcium supplementation and vitamin D supplementation were doubled.[8] Liu et al[9] found a significant decrease in calcium and an increase in parathyroid hormone following bariatric surgery. Loss of bone mineral density was seen, bone turnover was elevated, and bone remodeling was accelerated. Liu et al[9] recommended that, preoperatively, basal bone metabolism be evaluated. They also recommended that calcium and vitamin D supplementation be closely monitored to prevent secondary hyperparathyroidism and bone loss.[9] Most important to the orthopedic surgeon, calcium malabsorption has been documented as early as 3 months, with reduced true fractional absorption of calcium and secondary hyperparathyroidism lead-

ing to a decrease in vitamin D as well.[10-12] Early studies found high rates of vitamin D deficiency despite vitamin D intake being increased 200% postoperatively, indicating malabsorption.[13] Calcium absorption is further reduced due to the reduced surface area of the stomach.[14]

Bone Loss

Bone loss via two main mechanisms after surgical weight loss is well documented in the literature. Because there is often a significant amount of weight lost in a short period, the skeletal system is affected. This results in skeletal unloading, with the hips being most affected. This loss of bone mineral density at the hips has been shown to be dependent on patient population. Yu,[4] using quantitative computed tomography and dual-energy x-ray absorptiometry, found that subjects with a history of gastric bypass had a 5% to 10% decrease in bone mineral density at the hips 24 months postoperatively.

Secondary Hyperparathyroidism

Cortical bone loss has been associated with secondary hyperparathyroidism, particularly with bone architecture.[5,6,15] Yu[4] found that cortical and trabecular microarchitecture at the distal radius and the tibia had approximately 9% lower bone strength at 24 months among patients who had bariatric surgery compared with a control group. Scibora,[16] using dual-energy x-ray absorptiometry, found that bone mineral density had declined by as much as 14% in the proximal femur. This was hypothesized to be attributed to a combination of induced hyperparathyroidism and skeletal unloading.

Fracture Risk

The issues most important to the orthopedic surgeon are fracture risk and bone healing. Only a handful of studies have focused on these. Lu et al[17] compared 2064 patients who had a history of gastric bypass with 5027 obese patients who did not. The surgical group had a 1.2 times increased risk of fracture. Gastric bypass procedures also contributed to a significantly higher risk of fracture (risk ratio, 1.47; 95% confidence interval, 1.01-2.15), with the highest risk only 1 to 2 years postoperatively.[17] Nakamura et al,[2] through a historical cohort study of 258 patients, found that bariatric surgery patients had a 2.3-fold increased risk of fracture. Seventy-nine patients had 132 new fractures—44 (56%) had a single fracture, 24 (30%) had 2 fractures, 6 (7.7%) had 3 fractures, and 5 (6.3%) had 4 or more fractures. The most common mechanism was a fall from a standing height. After 15 years, this patient population had a 58% chance of a new fracture (and a 2-fold fracture risk) compared with 24% in the general population.[2]

Regarding whether gastric bypass patients sustain fractures by the same mechanism as the general population, the authors, at their center, observed that 29 of 31 fractures in such patients were the result of low-energy trauma. Maghrabi et al[15] found that most of the fractures among patients with surgical weight loss were the result of low-energy trauma, whereas fractures among patients with medically induced weight loss were mainly the result of high-energy trauma. Four of 18 gastric bypass patients had new atraumatic fractures of the tarsals or metatarsals.[15] The most recent study, by Rousseau et al,[18] investigated the relationship between fracture, obesity, and surgical weight loss. This retrospective, nested case-control study included patients with a history of bariatric surgery (n=12,767), obese patients (n=32,028), and nonobese patients (n=126,760) matched for sex and age. The bariatric surgery patients were more likely than the obese patients to sustain a fracture after surgery. Also, fracture sites in bariatric patients more closely matched the distribution of those in osteoporotic patients compared with age-matched controls.[18] Berarducci et al[19] evaluated 167 patients and found that there was a significant effect on bone metabolism after surgery. Twenty-five percent of the patients had a decrease in height, 8% had a new diagnosis of osteopenia or osteoporosis, and 5% had fractures during a mean postoperative period of 2.4 years.[19]

Conclusion

Although not completely understood, surgical weight loss has significant metabolic effects on bone that likely place these patients at risk for fracture and potential deficits in bone healing. It has been shown that this patient population is at similar risk for fractures due to low-energy trauma as the geriatric population. Furthermore, orthopedic surgeons should view bariatric surgery as a comorbidity for bone loss and consider a referral to endocrinology as they routinely do for geriatric patients with fractures. These patients must be educated about the importance of monitoring bone health, as they may be at risk for osteoporosis and osteopenia at a younger age. The implications for both fracture care and elective procedures that depend on bone healing must be considered. Vitamin D and calcium supplementation should be recommended to these patients, and metabolic bone panels should be considered. As the number of gastric bypass patients increases, a large prospective study examining rates of nonunion and bone healing should be performed.

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