COMMENTARY

HEALTH CARE FOR OUR BONES: A PRACTICAL NUTRITIONAL APPROACH TO PREVENTING OSTEOPOROSIS

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When patients and doctors think of osteoporosis, calcium immediately comes to mind. "Bones contain calcium, and, therefore, take calcium to protect your bones," is the battle cry that we hear most often from doctors, government agencies, and media sources. This commentary will provide a story of osteoporosis beyond calcium, which is one that practitioners and researchers need to consider when treating or investigating this pervasive condition.

The cost of managing osteoporotic fractures alone exceeds $14 billion per year,[1] or about $38 million per day. The extent of the osteoporotic problem becomes obvious when we consider the results of a recent study on bone mineral density (BMD), which is considered the single best predictor of fracture risk in asymptomatic postmenopausal women. Almost half of the 200,160 participants without known osteoporosis had low BMD, including approximately 7% who had osteoporosis. These results are consistent with the 50% to 68% estimated national prevalence of low-hip BMD observed among women aged 50 years or older.[1] Clearly, low BMD, osteoporosis, and related fractures are a national epidemic.

Despite the availability of densitometry, osteoporosis often remains undiagnosed until a fracture occurs, which is a great concern because the size of the population aged 50 years or older will increase during the next several decades. Thus, the direct and indirect costs of fractures are expected to increase correspondingly.[1] In this commentary, I consider important nutritional issues that profoundly impact bone health. Although calcium is important, it appears to be no more important than other key nutrients, such as magnesium and omega-3 fatty acids and specific food sources in our diet. It might be that calcium supplementation is overemphasized such that supplementing with calcium creates a false sense of security in women who believe that calcium will protect their bones. Consider that less bone fractures occur in other populations wherein women consume less calcium compared with women in the United States.[2] Clearly, there is more to nutritional modulation of osteoporosis than mere calcium supplementation.

Much of this information is not common knowledge among practitioners or the general population, which is most likely caused by the overemphasis on calcium above all other nutritional considerations for osteoporosis. The purpose of this commentary is to provide clinically useful information that is based on basic science, epidemiologic studies, and clinical trials.

Basics of Nutritional Modulation of Bone Metabolism

Watkins[3] describes bone as a multifunctional organ, which indicates that bone physiology is complex. Save for orthopedists and emergency room personnel, very few individuals will ever see living bone. For practitioners, such as chiropractors, gynecologists, and internists, most experience with bony tissue is related to bone palpation through skin and soft tissue, and viewing bony structures with various radiologic studies. Dry bone skeletal specimens that most of us studied in an osteology class offer little insight to the nature of living bone; that is, we never see living bone in action, reproducing itself, or being nourished with a rich blood supply. To most, bone is a hard substance that consists largely of calcium. Accordingly, it is not surprising that we actually believe the false notion that calcium intake can somehow be considered as a barometer of bone health and the key nutritional intervention for those with osteoporosis.

In general, osteoblasts are the cells responsible for bone formation, whereas bone resorption is accomplished by osteoclasts. Assuming that one has good bone density entering adulthood, bone integrity can be maintained so long as there is proper osteoblast/osteoclast activity. Regretfully, bone loss or resorption is typically the rule for most people as they enter middle age.

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Numerous mediators are responsible for tipping the balance toward bone loss. In particular, an acidic pH and omega-6 (n6) fatty acids play extremely important roles. Fruits and vegetables are known to contribute to an alkaline environment, and, as it turns out, research suggests that diets rich in fruits and vegetables improve bone density.[4,5] In vitro studies have helped to elucidate the relationship between pH and bone formation. Extracellular acidification increases the activity of osteoclasts and inhibits the activity of osteoblasts,[6] which leads to increased bone resorption and less bone formation.

Although studies have shown a relationship between bone density and fruit and vegetable intake, no similar trend was found with intake of milk and milk products,[5] a finding that may surprise many patients. Fruits and vegetables are known to promote an alkaline tissue environment, whereas meat/fish/fowl, cheese, and grains promote an acidic environment.[7] I would not recommend eliminating meat from the diet, but would suggest the reduction of grains. The United States Department of Agriculture Food Pyramid suggests that we consume 6 to 11 servings of grain products per day, which is significantly greater than the 1 to 3 servings of meat that one might have per day. Grains sneak into the diet on many levels, such as cake, cookies, bread, pasta, cereal, pretzels, crackers, and so on. Most people pack their cupboards with the bread family of foods and consume them liberally. Over a lifetime, this pattern can amount to a significant acid load.

Grains and Osteoporosis

Grains are problematic for bone health on several levels. First, it is important realize that grains promote an acidic pH, which, as mentioned above, may cause bone loss. Grains also contain gliadin and phytic acid, and grains are also quite imbalanced in the ratio of n6 to omega-3 (n3) fatty acids. Gliadin is the peptide fraction of gluten to which many are sensitive. Gliadin promotes gut inflammation that can be symptomatic or asymptomatic; celiac disease being the most severe manifestation. Research has shown that osteoporotic women are more prone to being gliadin sensitive than healthy controls; however, the precise relationship between the 2 conditions is not yet understood.[8]

Although calcium is not the entire nutritional story behind osteoporosis, calcium inadequacies reduce bone density. Whole grains as a family of foods are notoriously low in calcium and their high phytate content renders the existing calcium unavailable for absorption because phytate forms insoluble complexes with calcium. In populations in which cereal grains provide the major source of calories, osteomalacia, rickets, and osteoporosis are commonplace.[9]

Experts explain that we should consume a 1:1 ratio of n6 to n3 fatty acids; however, we currently tip the balance at about 20-30:1.[10] Below a 4:1 ratio is acceptable[11]; yet the United States Department of Agriculture's Food Pyramid diets create a 10:1 ratio,[12] which is caused by the heavy emphasis on grains and margarine.

An elevated ratio of n6 to n3 induces the expression and production of proinflammatory cytokines and eicosanoids,[10] which can significantly influence the balance of bone formation/resorption. For example, prostaglandin E2 (PGE2) is known to reduce the bone-forming activity of osteoblasts and to increase the bone-resorbing activity of osteoclasts, and PGE2 is thought to be the most potent bone-acting agent.[3]

PGE2 is formed from arachidonic acid (n6) that our body makes from the linoleic acid (n6) found in grains, all grain products (bread, pasta, cereal, and so on), and all seeds except for flaxseeds. Although the total fat content and the amount n6 fatty acids in grains is not significant, in terms of total fat calories, the n6 to n3 ratio determines whether production of proinflammatory eicosanoids such as PGE2 will be favored over antiinflammatory eicosanoids, such as PGE3. For example, in one fourth cup of rolled oats we consume .44 mg of linoleic acid (n6) and .02 mg of linolenic acid (n3), which reflects a 22:1 ratio of n6 to n3.[13] White bread provides a 21:1 ratio, whereas whole wheat contains a 27:1 ratio. Average potato chips boast a 60:1 ratio because of the addition of vegetable oil, and corn chips provide a 12:1 ratio.[13]

As with grains, the total fat content of vegetables and fruits is low; however, the fatty-acid ratios are quite favorable. Broccoli provides an impressive 1:3 ratio of n6 to n3, and kale offers a 1:1.3 ratio, whereas most lettuces give a 1:2 ratio.[13] The ratio of n6 to n3 in fruits generally ranges from 2:1 to 1:1. For example, the 4:3 ratio for blueberries and 1:1 for cherries, and bananas, one of the more commonly eaten fruits, possesses a 2:1 ratio.[13] Fish range from 1:1 to 1:7, which represents the most significant source of n3 fatty acids.[13] Obviously, this reflects the values found in fresh fish that is baked, broiled, or steamed, and not packaged fish found in the frozen food section or deep-fried at your local fast-food restaurant.

Based on the above information, it should be clear that we should recommend that our patients avoid grains and the large family of grain products, perhaps limiting grains to no more than 1 serving per day, which is a far cry from the 6 to 11 grain servings recommend by the food pyramid. A wise recommendation may be to avoid grains and, in their place, eat more vegetables and fruit that are alkaline, gliadin-free, phytate-free, and properly balanced in n6/n3 fatty acids. If patients feel the need to eat starchy foods, they should consider potatoes, which are known to be the most alkaline of all foods,[7] and they have 4:1 to 2.5:1 ratios of n6:n3 fatty acids.[13]

Additionally, supplementation with n3 fatty acids should be considered because they reduce inflammation and can reduce overactivity of osteoclasts.[3] Soft drinks should also be eliminated in favor of water, because soft drinks have an acidic pH.

Protein and Osteoporosis

Protein has been accused of causing osteoporosis because high protein consumption has been shown to increase calcium excretion in the urine; a relationship that has been known for 80 years.[14] Meat typically receives the blame, which leads many to believe that grains and legumes are innocuous foods. However, a vegan diet with protein derived equally from grains and legumes would deliver at least as many millimoles of sulfur per gram of protein as would a purely meat-based diet.[14] The key is to eat more alkaline vegetables and fruits, as mentioned earlier. In other words, patients should not necessarily avoid meats. Although meats are acidic, they do not contain gliadin or phytates and they offer better n6/n3 ratios than grains, and this is especially so if grass-fed meats or wild game is consumed.[15]

Additionally, an impressive body of literature indicates that protein tends to have a positive effect on bone metabolism. Two randomized controlled trials showed that increased protein intake dramatically improved outcomes after hip fracture. Subsequent work showed that protein supplements reduce bone loss at the contralateral hip in patients with upper-femoral fracture. The most likely explanation is a protein-induced increase in insulin-like growth factor 1, which is known to be osteotrophic.[14]

Nutritional Supplements and Bone Metabolism

Regarding the dietary relationships discussed above about osteoporosis, very little is known or communicated to patients. Instead, the call-to-arms focuses around eating more dairy and taking calcium supplements. As mentioned above, studies have shown a clear relationship between bone density and past fruit and vegetable intake, and not consumption of milk and milk products,[5] a point that should be emphasized to our patients.

What about calcium supplementation? Emphasize to patents that it is only part of the story. Although calcium supplementation has been the nutritional focus for osteoporosis for many years, it should be understood that such supplementation as a single intervention, at best, might serve to help counteract the bone-resorbing nature of the typical American diet that is acidic and rich in n6 fatty acids and phytates. No studies have convincingly shown that calcium supplementation can cure or reverse osteoporosis; instead, it appears that calcium supplementation can provide a modest increase in BMD.[2,16] Indeed, Ilich and Kerstetter[16] state that, "the complexity of the interactions is probably the reason why there are controversial or inconsistent findings regarding the contribution of a single or a group of nutrients in bone health."

As mentioned above, bone is a multifunctional organ.[3] Clearly, a multifunctional organ needs more than just milk and calcium supplements. In short, all cells make adenosine triphosphate, have biologically active cell membranes, are influenced by free radicals, and are under the influence of various hormonal mediators. Osteoblasts and osteoclasts are no different. Accordingly, we need to make sure that our patients are well nourished and receive optimal levels of all the basic nutrients required by all cells. Accordingly, it seems reasonable that osteoporotic patients should use a multiple vitamin/mineral supplement, because numerous studies now suggest that we would all do well to take a multivitamin.[17-22] A recent study showed that about 50% of female medical doctors surveyed take a multi.[23] n3 fatty acids, magnesium, ipriflavone, and hydroxyapatite supplements should be considered.

n3 Fatty Acids

A proper ratio of n6 to n3 fatty acids play an important role in regulating the activity of osteoblasts and osteoclasts. Research has shown that PGE2, leukotriene B4, interleukin-1, and tumor necrosis factor are all capable of promoting bone resorption.[3] It is well known that n6 fatty acids augment their production, whereas n3 fatty acids are inhibitory.[3,10,24]

I have seen few people achieve adequate n3 intake without supplementation (personal dietary assessment experience), which is consistent with published data on n6 to n3 ratios averaging about 25:1.[10] Accordingly, supplementing with 1 to 2 grams of eicosapentaenoic acid/docosahexaenoic acid per day is a reasonable recommendation. There are no known side effects with such levels.[25]

Magnesium

Magnesium is an important mineral for bone metabolism, and it has been described as the fifth but forgotten electrolyte.[26] People tend to supplement with calcium to a point that is excessive, and they also typically do not consider adding magnesium. Even standard osteoporosis trials rarely use magnesium, focusing exclusively on calcium.[27]

In 1995, Dreosti[28] reviewed the literature on magnesium supplementation and provided us with the following information. In a group of postmenopausal women in Israel suffering from osteoporosis who received magnesium supplements in the range of 250 to 750 mg/day for 24 months, either trabecular bone density increased up to 8% or bone loss was arrested (in 87%); in some cases, both an increase in bone density and arrested bone loss occurred. Untreated controls, on the other hand, lost bone density at an average of 1% a year. In a group of postmenopausal osteoporotic women in Czechoslovakia who received magnesium at levels ranging from 1500 to 3000 mg of magnesium lactate per day for 2 years, nearly 65% were classified totally free of pain and with no further deformity of vertebrae, with the condition in the remainder either arrested or slightly improved. Based on this information, it seems prudent to recommend supplementing with at least 500 to 1000 mg of magnesium per day.

Back in 1989, Mildred Seelig[29] described how excessive calcium supplementation will promote magnesium deficiency. Researchers suggest a 2:1 intake of calcium to magnesium[28,30]; however, with calcium supplementation at about 1000 mg per day for many, the ratio can exceed even 4:1. Using a 1:1 ratio of supplemental calcium to magnesium may be a prudent choice because calcium fortification is so common; however, research is needed to develop a better understanding of these important minerals and osteoporosis.

Ipriflavone

Ipriflavone is an isoflavone that has become popular in recent years. Several articles describe how ipriflavone favorably affects bone metabolism by increasing BMD.[31-33] The standard recommendation is 600 mg per day.

Ipriflavone is derived from soy isoflavones. As of 1997, a review article explained that 2769 patients had been treated with ipriflavone for a total of 3132 patient/years.[32] Sixty clinical studies were performed in Italy, Japan, and Hungary and reviewed for long-term safety assessment. The incidence of adverse reactions in ipriflavone-treated patients (14.5%) was similar to that observed in subjects receiving the placebo (16.1%). Side effects were mainly gastrointestinal. The data from the above studies show that long-term treatment with ipriflavone may be considered safe and may increase bone density and may possibly prevent fractures in elderly patients with established osteoporosis.[32] In another detailed review, we are told that "the extensive data on ipriflavone, suggest that it is a useful and safe alternative to estrogen therapy in treating existing low bone mass or osteoporosis in postmenopausal women."[33]

A more recent study with ipriflavone on postmeopausal osteoporosis did not confirm the previous bone density improvements and stated that ipriflavone caused significant lymphocytopenia, ie, a reduction from 33% to 27%,[34] both of which fall into the accepted normal 12% to 50% range for lymphocyte counts.[35] In particular, 29 women developed subclinical lymphocytopenia (<500/μL),[34] which seems to have accounted for the overall mean reduction in lymphocytes. This study has yet to be duplicated.

More research is needed to determine the appropriate usefulness of ipriflavone in the care of osteoporotic patients, especially in the context of the dietary and many supplemental factors that impact bone metabolism. Ipriflavone studies have not considered the nutritional factors discussed in this commentary, so we do not know if supplementation of ipriflavone is indicated in the context of a multimodal nutritional intervention.

Hydroxyapatite

Microcrystaline hydroxyapatite (MCHC) has been popular for many years and studies have shown the use of MCHC for improving bone density and protecting against bone loss.[36-38] MCHC is derived from whole bone and contains an organic and inorganic component. The organic component consists of collagen, glycosaminoglycans, peptides, and growth factors for bone. The inorganic component contains predominately calcium and phosphorus. Research on postmenopausal osteoporosis has shown that MCHC significantly reduces trabecular bone loss. Although calcium carbonate cuts the rate of bone loss in half, MCHC manages to nearly halt it.[38]

MCHC is often found in comprehensive bone support formulas that contain soy isoflavones, magnesium, and other nutrients that are important in bone metabolism, such as boron. The usefulness of such a combination supplement has yet to be assessed in the research setting.

Conclusion

Osteoporosis is a significant healthcare problem. Nutrition is one of the most important lifestyle factors that can influence the development and progression of osteoporosis. It seems that patients should avoid excessive bread and other grain products, consume liberal amounts of fruits and vegetables, and be wary about becoming protein deficient. Such measures are easy to incorporate into one's lifestyle; the problem is that few patients ever hear about such an approach and its positive impact on bone health. Osteoporotic patients may also benefit from taking several supplements including a multiple, magnesium, eicosapentaenoic acid/docosahexaenoic acid, ipriflavone, and hydroxyapatite. Side effects associated with these supplements appear to be insignificant, save for the potential for minor gastrointestinal upset.

Osteoporosis is clearly a lifestyle problem. We know that exercise and nutrition are critical modulating factors. It is time that a clinical trial is performed using a multimodal approach to bone health involving exercise, diet, and a spectrum supplements instead of calcium alone.

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