Dynamic Chiropractic

NUTRITION / DETOXIFICATION

Calcium: Requirements, Bioavailable Forms, Physiology and Clinical Aspects

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No other nutrient generates as much controversy in complementary medicine as the mineral calcium. We frequently hear such statements as: "Calcium from dairy products does not get absorbed due to the pasteurization"; "Dairy products, though high in calcium, leech more calcium out of bone than they deposit, and are the primary cause of osteoporosis in our society"; and "Calcium carbonate supplements are nothing more than chunks of insoluble chalk that simply travel through the gut like a stone and are not absorbed by the body." What is the validity of such statements? Health practitioners must be aware of the peer-reviewed scientific studies that have examined the clinical aspects of calcium requirements, bioavailability and other related factors to best advise their patients.

The Role of Calcium in Health

Calcium is the most abundant mineral in the body. It makes up approximately two percent of body weight, with 99 percent of it incorporated in the hard tissue, bones and teeth. The other one percent is present in the blood and extracellular fluids and within cells of soft tissue, and regulates many important metabolic functions. In addition to building and maintaining bones and teeth, calcium is necessary for muscle contraction; blood clotting (stimulating the release of thromboplastin from platelets and facilitating conversion of prothrombin to thrombin); cell membrane transport functions; the release of neurotransmitters; synthesis and secretion of protein, hormones and intracellular enzymes; nerve transmission; and the regulation of heartbeat. The proper balance of calcium, sodium, potassium and magnesium ions maintains muscle tone and controls irritability and a muscle membrane's electrical potential.

Calcium is present in bones in the form of hydroxyapitite crystals, composed of calcium phosphate; calcium carbonate; magnesium; zinc; sodium; and fluoride. These salt crystals are arranged around a framework of softer protein material (organic matrix). The hydroxyapitite crystals provide strength and rigidity to the softer protein matrix of bone. The same crystals are present in the enamel and dentin of teeth; however, the calcium from teeth is generally not reabsorbed into the bloodstream in times of need or in conjunction with low circulation levels of estrogen, progesterone or testosterone. Bone calcium can be reabsorbed into the blood- stream, weakening the skeleton and increasing susceptibility to osteoporotic fractures (often seen in the spine and neck of the femur).

Blood levels of calcium are maintained within a fixed range by various feedback mechanisms. A significant increase in serum calcium can cause cardiac or respiratory failure, and a hypocalcemic state leads to tetany (an involuntary muscle spasm that can cause asphyxia, even death from a spasm of the airway musculature).

Absorption and Metabolism

Calcium is absorbed primarily via active transport in the duodenum (some via passive diffusion). Active transport requires the assistance of vitamin D. The body normally absorbs 30-40 percent of

ingested calcium, but it can be as low as 10 percent from some organic sources, such as vegetables or grains with a high content of phytic or oxalic acid. Parathyroid hormone (PTH) increases calcium absorption by increasing the conversion of vitamin D to its active form. In general, factors that increase calcium absorption include: serum levels of vitamin D; PTH; lactose; intestinal acidity; and possibly fat intake. Factors that hinder calcium absorption include oxalic acid (chocolate, spinach, beet tops, collard greens, etc.), but this is not of great concern, as dietary calcium is usually far greater than dietary oxalate. The same is true for phytic acid found in whole grains (i.e., wheat bran and whole wheat). Low serum levels of vitamin D and/or PTH decrease calcium absorption.

Following absorption, calcium enters the bloodstream and is transported to body tissue. The major site of deposition is bone.[1] Unabsorbed calcium (approximately 60-70 percent of intake levels) is excreted in fecal matter, but may provide a protective role in regards to colon cancer prevention by binding to bile acids and other sterols, and blocking their conversion to cancer-causing secondary sterols (lithocholic acid, deoxycholic acid).

Calcium and Prevention of Colon Cancer

The role of calcium as a chemopre-ventive agent in the prevention of colorectal cancer may hold great significance. Colorectal cancer is the second leading cause of cancer death in much of the Western world, after lung cancer (in which 87 percent of cases develop in cigarette smokers). A number of epidemiological reviews, including those by Willett, Doll and Peto, indicate that as much as 70-90 percent of colorectal cancers may be avoidable through more health-promoting nutrition and other lifestyle practices (i.e., exercise). A high-fat diet, particularly saturated fat, is associated with a higher incidence of the disease in most countries studied. Higher fat intake results in greater secretion of bile acids into the small intestine (to emulsify the fat in the gut), and produces greater concentrations of bile acids reaching the large intestine. The acids are metabolized by large bowel bacteria, and converted into the cancer-causing secondary sterols mentioned earlier.

Epidemiological and experimental animal studies suggest that higher calcium intake can reduce risk of colorectal cancer by binding to bile acids in the gut, forming an insoluble calcium soap that is unavailable for conversion to secondary sterols by gut bacteria. Additionally, calcium and vitamin D have been shown to slow the rate of cell division of colonic epithelial cells, which is another biomarker suggestive of a cancer protective (chemoprevention) effect. A number of small intervention trials involving those at high-risk for colon cancer or polyp-prone have shown that supplementation with calcium (calcium carbonate), vitamin D and/or wheat bran fiber, can improve the histological profile of the colonic epithelium of these subjects in a manner consistent with a reduction in risk of colorectal cancer.

The calcium that does not get absorbed into the bloodstream from the intestinal tract may be as important to human health as the absorbed calcium. This is a good example of how misleading it can be to overemphasize the importance of a single aspect of nutrient behavior (i.e., bioavailability) in the body, without taking into consideration the complete clinical picture. Health authorities are reviewing the evidence and planning further studies to consider a health policy that encourages higher calcium intake, for the purpose of preventing primary and/or secondary colorectal cancer. [2-4] As will be shown later, calcium citrate is more bioavailable than calcium carbonate if ingested on an empty stomach, but when ingested with food, both have about the same degree of bioavailability. Thus, many of the half-truths extolled by nutrition companies, promoting their proprietary calcium formulations, should be critically examined by practitioners, using the criteria and other data derived from this scientific review.

Daily Calcium Requirements (NIH Recommendations)

The following are the most recent calcium recommendations outlined by the National Institutes of Health for the U.S. population, which tends to have a high animal-protein diet. These recommendations are suited to such a society, but one should keep in mind that in society's consuming less animal protein, calcium balance is attainable with much lower intakes of calcium than is suggested by the following chart. A number of variables must be factored in when assessing a person's need for calcium: animal protein intake; caffeine; alcohol; exercise behaviors; family history of osteoporosis; vitamin D and parathyroid hormone status; drug use; and possibly the risk profile regarding colon cancer. Knowledge of these and other related factors should help to place the following guidelines into proper perspective:

Age Group and Gender	Calcium (mg)
under six months	400
6-12 months, boys and girls	600
1-10 years, boys and girls	800
11-24 years, men and women	1,200-1,500
25-50 years, men and women	1,000
postmenopausal women, not taking estrogen replacement (ERT)	1,500
postmenopausal women, taking ERT	1,000
65+ years postmenopausal women, taking or not taking ERT	1,500
50-64 years, men	1,000
65+ years, men	1,500[4]

Calcium Preparations and Bioavailability

The bioavailability of various forms of calcium supplements has been evaluated using radio-isotopes, calcium excretion and other studies. The following is a summary of the key findings to date:

Calcium Type	Absorptive Fraction of Calcium in Normal Subjects (approx.) on empty stomach[3]
milk	33%
calcium carbonate	31%
calcium citrate	40%
calcium gluconate	26.6%

calcium lactate	34.5 %
tricalcium phosphate	25.2%
calcium citrate-malate	34.9%
calcium chloride	36.4%
average diet	32%

To capitalize on calcium's other potential benefits to bones, blood pressure regulation, and possibly chemoprevention of colorectal cancer, it is best to take calcium supplements with food. For example, calcium carbonate absorption is enhanced by approximately 10 percent when ingested with meals.[3]

Supplementation Studies and Clinical Applications

1. Osteoporosis

One in four women, and one in eight men over 50, have osteoporosis. Nearly one-third of all women and one-sixth of all men will fracture their hips. Women's mortality rates from osteoporotic fractures are greater than the combined mortality rates from cancer of the breasts and ovaries. Up to 20 percent of women and 34 percent of men who fracture a hip die in less than a year from complications secondary to these fractures (i.e., pneumonia).[5]

A large number of clinical trials have shown that calcium supplementation slows the rate of bone loss after menopause, and in conjunction with resistance training, can also increase bone mineral density even in women not taking hormone replacement therapy. Strict protocols have been established for strength training and the accretion of bone density for this age group.[4-6]

In general, a variety of calcium supplements (carbonate; citrate; citrate-malate; chloride; gluconate; lactate; and microcrystalline hydroxyapitite concentrate) have demonstrated the ability to retard age-related bone loss. The key factors appear to be meeting the NIH calcium intake recommendations from food and/or supplementation; ingesting supplements with meals; performing weightbearing or weight-resistance exercises 4-6 times per week; and ensuring adequate serum vitamin D levels. All of these factors enhance calcium absorption and/or retention in bone.[4,5,7,8]

2. High Blood Pressure

Various clinical studies indicate that calcium supplementation (i.e., calcium carbonate - 1,500 mg per day) can reduce blood pressure to a significant degree in sodium-sensitive hypertensive patients. Most of these trials were 8-12 weeks in duration and used 1,000-1,500 mg of calcium carbonate or citrate.9-11 This subject is currently under intensive study to clarify the potential of calcium supplementation as a natural intervention for specific cases of hypertension.

Calcium supplementation (1,000-2,000 mg per day, calcium carbonate) may also help to prevent pregnancy-induced hypertension or function to reverse existing hypertension during pregnancy. This function is also presently under review.[12-13]

Dosage Range to Consider for Calcium Supplements

Most young adult and adult North Americans lack 500-800 mg per day of calcium needed to match the NIH recommended intake levels. Calcium supplementation represents a viable way to meet the recommendation in many cases.[4,5]

1. Osteoporosis Prevention and Management - Meet the NIH recommended intake levels for calcium, based upon age and gender. Whatever calcium level is missing from food should be compensated for through supplementation.[4]

2. Hypertension - Sodium-sensitive hypertensive patients may try 800-1,500 mg of calcium supplementation (8-12-week trial period) to test response.[9-11]

Side Effects and Toxicity

It is generally acknowledged that calcium intake up to 2,000 mg per day is safe for most people. The efficiency of calcium absorption decreases as intake increases, thereby providing a protective mechanism to lessen the chances of calcium intoxication. This adaptive mechanism can, however, be overcome by a calcium intake of greater than 4,000 mg per day.[4] High intake of calcium may increase soft-tissue calcification (4,000+ mg, or in combination with hyperparathyroidism). In 1981, the FDA cautioned the public to limit its intake of calcium supplements derived from dolomite or bone meal because of the potentially high lead levels in these calcium supplements.[1]

Drug-Nutrient and Other Interactions

Dietary factors such as alcohol, caffeine, sodium and a high protein diet can increase calcium loss from the body. However, studies show that these factors can be compensated for by ingestion of 250-500 mg of additional calcium, in most instances.[4, 5, 13, 14]

Drug-Nutrient Interactions

The following drugs have been shown to deplete calcium or reduce its absorption into the body:

Ethylenediaminetetraacetic acid;[15]
tetracycline;[16]
aminoglycosides;[17]
amphotericin B;[18]
anticonvulsants;[19-21]
salicylates (ASA, etc.);[22]
bile sequestrants (cholestyramine);[23]
colchicine;[24]
corticosteroid drugs;[25 -26]
cimetidine;[27,28]
isoniazid;[29]
loop diuretics;[30]
magnesium and aluminum antacids;[31]
potassium-sparing diuretics;[32]
and digoxin (in animal studies only).[33]

The following are drugs that are interfered with if taken at the same time as calcium:

1. Fluoroquinolone antibiotics - Calcium can decrease absorption of these drugs, therefore calcium supplements and dairy products should not be taken within two hours of ingesting these drugs.[34,35]

2. Levothyroxine - Calcium carbonate can decrease drug absorption if taken at the same time.[36]

Nutrient - Nutrient Interactions

1. Iron - High doses of calcium can reduce iron absorption.[37]
2. Zinc - High doses of calcium can reduce zinc absorption.[38]

Summary

As indicated in this review, there are many factors to consider when discussing calcium needs with patients. It is best for them to fill out a seven-day diet history to assess their current food intake. At that point, the patient can be instructed to consume additional calcium from food or supplements, if necessary. Other secondary issues can also be discussed at this time, such as exercise habits, vitamin D supplementation, caffeine and alcohol intake, smoking, etc. In women over 50 years of age, a bone density test should be performed to assess current bone mineral density status. In general, the patient's age; gender; health history; dietary and lifestyle patterns; family health history; medication history; and bone mineral status all factor into the recommendations regarding calcium intake.

Responsible practitioners should be aware of the interaction of these factors, and help patients arrive at a calcium intake that best suits their needs. Failure to address calcium and vitamin D requirements has largely been responsible for the disproportionately high incidence of osteoporosis and osteomalacia seen in modern society. As the population ages, these problems are predicted to reach epidemic proportions and thus, health professionals should engage patients in a discussion of these matters and aid them in identifying their specific needs - especially those such as chiropractors, who are viewed as "bone and joint doctors" by the general public.

Please take time to listen to Dr. Meschino's interviews on ChiroWeb.com. The subjects of the first three are: Combining Traditional, Complementary and Natural Interventions, The Benefits of Melatonin, and Using Natural Remedies to Manage Women's Health Issues. Each interview is packed with important information available to you and your patients. You can listen to the interviews at
[url=http://www.chiroweb.com/audio/meschino]http://www.chiroweb.com/audio/meschino[/url].
There is a link on the directory page for your feedback.

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