

Importance of Bioavailable Calcium and Other Minerals to Reduce the Calcium Deficiency Symptoms, Aging, and Other Pertinent Diseases

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Abstract

In this review/research article the effect of supplementation of bioavailable calcium to treat or eliminate osteopenia and osteoporosis has been discussed. Various ailments which can be corrected through supplementation of the bioavailable calcium have been documented. The transport of bioavailable calcium (both active and passive) and the conditions under which such transport systems get hampered have also been discussed. The importance of Multiple Mixed Strain Probiotics to improve not only the bioavailability but also absorption and assimilation of calcium and other major and minor minerals has also been stressed.

Keywords: Bioavailable calcium; Osteoporosis; Osteopenia; Probiotics; Nano particles; Anti-aging; Dr. M.S. Reddys Multiple Mixed Strain Probiotic Therapy

Introduction

The major mineral, calcium is highly essential to maintain the human skeletal structure. It is a divalent cation, which cannot be synthesized in the body and only way to get it is through food and supplementation. Thus it can be categorized as essential mineral like one of the essential amino acids. When the food is deficient in calcium, the calcium will be drawn from the bones. Majority of the calcium in the human body is stored in bones and teeth. Roughly about 1% is distributed throughout the body. This free calcium assists the functions of central nervous system, blood circulation, heart, kidneys, hormonal systems, and muscular system etc.

The deficiency of calcium in the body results in bone loss, which in mild cases is described as osteopenia and in severe cases as osteoporosis. These two diseases are silent since bone mass is lost without any sign of sickness. According to World Health Organization (WHO) the osteoporosis is defined as follows: "A Bone Mineral Density (BMD), which is 2.5 standard deviations below the peak bone mass (20 year old healthy human) as measured by dual energy x-ray absorptiometry (DXM)". Whereas, osteopenia is 1 to 2.5 standard deviations below the peak bone mass. Both the osteoporosis and osteopenia are expressed by T scores.

The following are the major symptoms of osteoporosis: Multiple fractures involving vertebrae, wrist and forearm, and hip fractures. Whereas, the minor symptoms include, insomnia, joint problems, nervousness, stunted growth of nails, hair loss, premature aging, dental problems, muscle spasms, fatigue, and irregular heart beat etc. Several osteoporosis patients have reported severe pain in the joints which not only disturbed their sleep all night and they could not even drive even 10 miles next day to go to work, due to severe pain in the ankles. Most of them have been diagnosed with severe osteoporosis with a T score of minus 3.5. The symptoms of osteopenia are much milder version of osteoporosis. The osteopenia is one step before osteoporosis and can be

easily corrected or reversed with calcium supplementation, at a much faster pace than osteoporosis.

What is the root cause of osteoporosis? After the peak bone mass development (at an early 20 years of age), human beings start losing the calcium from the bones. This is more prevalent in women than in men. In the case of women, when once the estrogen levels start dropping, the hydrochloride acid along with mucin also drops in the stomach. This drop in acidity will decrease the ionization of calcium in the stomach. Such a calcium, which is not fully ionized, when it is discharged into the duodenum, due to the high pH of bile and pancreatic juice will not get ionized further and thus cannot get absorbed fully through the Transcellular transport system. The ionized calcium must be transported through active transport system, before it is mixed thoroughly with bile and pancreatic juice.

In the case of men, the drop of the hydrochloric acid and other gastric secretions will be evident with age and andropause. This is the reason why women develop osteoporosis way ahead of time compared to men

Even [23,35] in women, if you look at world scale, one in 3 women are developing osteoporosis after menopause. Especially this statistic is true with Caucasians and Asians. This is due to their inherent and genetically controlled low bone mass at maturity. Even among the Caucasians, the Northern European ancestry women (irrespective of where they are living) will develop the osteoporosis at significantly higher percentage level. Since African women have the highest peak bone mass at their adolescence, they have less chances of developing osteoporosis. This is especially true in the case of American women of the African heritage [29].

The Recommended Daily Allowance (RDA) for calcium is as follows: Babies new born to 6 months-200 mg; babies 7 to 12 months-260 mg; toddlers 1 to 3 years old-700 mg; children 4 to 8 years old-1000 mg; children 9 to 13 year old-1300 mg; teenagers 14 to 18 years old, include pregnant or nursing-1300 mg; adults 19 to 50 including women who are pregnant and nursing-1000 mg; women who are 51 and over-1200 mg; men 51 to 70 years old-1000 mg; men 71 and over-1200 mg. RDA does not take into account the bioavailability of

calcium. The RDA figures only reflect on how much elemental calcium is required per day. For example, if someone consumed 1200 mg of calcium (as elemental calcium in the form of calcium salt), and only 400 mg is absorbed into the body, due to non-bioavailability of calcium, the 800 mg deficiency will be overlooked. In reality, the RDA must specify 1200 mg of bioavailable calcium, rather than calling it calcium. This brings up another question. What is bioavailable calcium and how do we define it? This can be defined as the amount of calcium absorbed and assimilated in comparison to the level ingested. In other words, if 1200 mg of elemental calcium is supplemented, and out of which only 600 mg got absorbed and assimilated, it is construed as 50% bioavailable calcium supplement. If all 1200 mg of elemental calcium is absorbed and assimilated, we can call it is as 100 percent bioavailable calcium. The bioavailability of all most all the calcium salts has not been established because of several factors. For example, the calcium carbonate, although it has 40% elemental calcium, may not be bioavailable compared to organic salts of calcium such as calcium citrate, calcium maleate, calcium acetate, and calcium gluconate, and calcium lactate etc. Even, in order for these organic salts to be highly bioavailable, proper gastrointestinal micro flora has to be maintained. Undoubtedly the organic salts of calcium are more bioavailable than the inorganic calcium salts such as calcium carbonate. The consumer must also take into account the percentage of elemental calcium in a given calcium salt i.e. calcium citrate is significantly lower in elemental calcium compared to other calcium salts. Yet, it will be more bioavailable than its counterpart inorganic calcium salts with similar elemental calcium.

How does calcium get absorbed into body and what dictates its rate of absorption? In the first place calcium has to be ionized in the stomach. The ionization is the process, where an atom changes its structure so that it can combine with other elements. As an example, if the acidity is low in stomach, calcium carbonate will not ionize to form calcium chloride and thus cannot be absorbed well in the intestines. Whereas, the chelated calcium salts (calcium reacted with organic acids) ionize better because they do not need that much stomach acid for ionization as calcium carbonate, calcium oxide, and calcium hydroxide etc. The ionized form of calcium only gets absorbed in the duodenum through transcellular mechanism, with the aid of enterocytes. This transcellular mechanism is an active transport system which depends on vitamin-D, phosphorous and magnesium, besides the influence of parathyroid hormone. Most of the calcium is absorbed through the transcellular mechanism. Whereas, in the rest of the GI tract, the calcium is absorbed through the passive transport system through enterocyte cell junctions (para cellular). In most circumstances, the para cellular absorption is not as effective as the active transcellular transport system [4-8]. Small amounts of calcium also get absorbed in the caecum and ascending colon [9-11]. In order for the para cellular calcium transport to be most effective, the slightly acidic pH and biotransformation of chelated calcium salts in the ileum by the probiotic bacteria is an absolute must. This can only be accomplished through proper maintenance of the active acid production by the intestinal Probiotic bacteria in the GI tract.

The more paradoxical and mind boggling question which we can all ask is why do Americans get osteoporosis at an alarming rate of 55%, despite their calcium rich diet? The answer is simple. It is not how much calcium you consume; rather it is what kind of calcium (bioavailable or non-bioavailable) you consume and how much of that calcium you absorb efficiently? Absorption efficiency is far more important than the mere consumption of copious amount of calcium through diet or non-bioavailable calcium supplements.

It is quite evident, that in order to eliminate bone loss or premature aging, a daily supplementation of bio-available calcium and proper Probiotics is a must. Once the bone mass is reduced, naturally the muscular strength and contour of the face and the body will also be altered making you look older. Thus the maintenance of bone mass is an essential requisite for health, physical appearance and anti-aging. Osteoporosis will also weaken the mandibular bone and create complicated dental teeth problems [12]. The bio-availability of a bioavailable calcium supplements can be enhanced with the fortification of vitamin-D [9], phosphorus [14,15], magnesium [16,17], strontium [18], zinc [6,39], and dairy related peptides and amino acids [21,44] etc.

Not all the calcium supplements available on the market are bio-available. No single calcium salt, such as calcium citrate, can be construed as the most efficient bioavailable source of calcium. In my opinion, a supplement consisting of a mixture of bioavailable calcium salts, essential minerals such as phosphorus and magnesium etc., nonspecific dairy related peptides and amino acids, along with probiotics is the best way to assure the absorption of calcium. This concept has been proven by Reddy and Reddy [29] through extensive clinical trials. The maximum calcium absorption was observed when bioavailable calcium was administered along with several major and minor bioavailable minerals. It confirms that several bioavailable minor minerals also participate in the absorption of bioavailable calcium, to prevent or treat osteoporosis.

Since calcium always exists in the form of salt, one can argue that any calcium salt supplement should be able to reduce the calcium deficiency. Thus why not use the cheaper calcium salts such as calcium carbonate, which will have about 40% of elemental calcium? Calcium carbonate is an inorganic salt which can only be solubilized and thus ionized at low pH due to acids [19]. To the best of my knowledge neither Probiotic nor non-Probiotic saprophytic intestinal bacteria can utilize calcium carbonate as nutrient, although it has carbon fraction in the carbonate. Calcium carbonate should be ionized, in order to release the elemental calcium fraction [45]. Since the stomach acid concentrations vary from individual to individual, male vs. female and young vs. old, the exact degree of the ionization of calcium carbonate cannot be predictable. For example, people who consume large amounts of alkaline foods and alkaline drugs may not be able to ionize the calcium carbonate in the stomach, since stomach acid is predominantly used to neutralize the alkaline and high protein amphoteric foods and alkaline drugs in the stomach.

Whereas the organic salts of calcium such as calcium gluconate, calcium acetate, calcium lactate, and calcium citrate etc. not only get ionized quickly in the stomach and thus gets absorbed very efficiently through active transport system in duodenum but also be used as sole source of carbon (nutrient) by several Probiotics and other gastrointestinal associated bacteria in the lower part of the GI tract, and thus also gets absorbed very efficiently through passive transport system. For example the Probiotic bacterium *Lactococcus lactis* var *lactis* subspecies diacetylactis can utilize citrate by breaking calcium citrate with the use of citrase permease enzyme and thus can consume the citrate as a sole source of carbon with the aid of citrate permease enzyme. The elemental calcium thus released is completely ionized and thus become totally bioavailable and can be easily absorbed in the ileum and in the distal part of the gastrointestinal tract. Similarly the Probiotic bacteria belonging to genus *Propionibacterium* can utilize lactate fraction as a sole source of carbon from salts such as sodium lactate and calcium lactate, thus releasing the metal fraction of the salt

to be absorbed in the gastrointestinal tract. Several Probiotic strains of enterococcus such as *Enterococcus faecium* can utilize acetate fraction from calcium acetate, gluconate fraction from calcium gluconate etc. to free up the calcium fraction so that it can gain entrance into blood. Such fermentations in the gastrointestinal tract, due to lactic acid producing Probiotics, helps to maintain mild acidic conditions in the distal end of the GI tract, which is essential to enhance the absorption of calcium and other minerals through passive transport system.

Calcium carbonate on the other hand, if it is not ionized fully in the stomach and stayed intact it will not get into the system and instead it will act as a buffer to raise the pH in the GI tract, which is not conducive for the calcium absorption and thus to the gastrointestinal health. In other words, it can do more damage than its help as a nutritional supplement. It is always preferable to include predominantly a mixture of organic calcium salts (rather than single salt) and some inorganic salts to maximize the ionization of calcium in the GI tract, since the bacterial composition of the gut varies from individual to individual. The best way to get around to this problem is to maintain proper Probiotic bacterial population in the gastrointestinal tract [27].

This is the concept behind Dr. M.S. Reddy's Multiple Mixed Strain Probiotic Therapy [3,30,31,38,41]. It is to be understood that the bioavailable calcium is not the only major mineral requirement for body to maintain good health and to reduce osteoporosis. There are several major and minor minerals which are essential requisites to the normal cellular metabolism and also to assist the absorption of calcium. Does all the food or supplement derived minor minerals are bioavailable? The answer is no. If they are not bioavailable, the lack of absorption of such minor minerals (which assists calcium absorption) can hamper the calcium transport systems, thus inducing calcium deficiency. It has also been proven that calcium phosphate salts lower the toxicity of secondary bile acids and certain fatty acids in the ileum and thus improve the growth of beneficial Probiotic cultures to produce acid and thus indirectly improve calcium absorption through passive transport system. In addition, it significantly improves the adhesion and colonization of Probiotic bacteria in the gastrointestinal tract.

The best way to improve the absorption of calcium and other minerals is to make all of them bioavailable (by converting them as Nano particles), to eliminate the mineral deficiencies [29]. Such a product has been produced and proven effective through clinical trials to reduce or treat osteopenia and osteoporosis successfully [3,29]. Any product which can suffice all these requirements should be the choice product to eliminate calcium and other essential and non-essential mineral deficiencies which lead to osteoporosis, osteopenia, irregular heartbeats, hypertension, and premature aging etc. Thus, consumption of such a nutritional supplement is an essential requisite for anti-aging [29].

It has been proven that several diseases, and the medications (antacids etc.) used to cure such diseases, may also have an adverse effect on the calcium absorption [1,13,26,29,32,34,37]. One such serious condition is food allergy. The calcium absorption gets severely hampered, when someone has food allergy involving the gastrointestinal tract. It has been cited in the literature that Probiotics have intrinsic capacity to reduce allergy [30,31]. Thus, taking bioavailable calcium and proper probiotic supplement, on a daily basis, is the best way to assure good absorption of calcium to improve health and anti-aging etc. Even the younger population should take supplements to ensure proper bone formation to override the future

problems [29]. Bioavailable calcium supplementation is a must to all age groups to eliminate or reduce the incidence of osteopenia and osteoporosis. As I have indicated earlier, this is especially true with Caucasians and Asians, since they are genetically programmed to have less bone density compared to African Americans.

In addition to reducing the risk of osteoporosis, calcium supplementation has also been credited with reducing hypertension [3,24,26], cholesterol and triglycerides [40], obesity, and the incidence of colon cancer [37,44]. The supplementation of 1000 mg of calcium on a daily basis for six months significantly reduced the bleeding of gums, tooth mobility and completely eliminated gingivitis. In addition, the researchers pointed out that new alveolar bone appeared in some cases [20]. In this connection, the use of bioavailable calcium and other minerals, will significantly reduce or can reverse the above specified diseases.

Reddy and Reddy [29] conducted an extensive clinical study using bioavailable milk derived calcium mineral complex (product of IMAC, Inc. USA) on 1000 subjects and proved that osteopenia and osteoporosis were reversed with using calcium supplements. According to their clinical study, most of the osteopenia patients showed excellent recovery after taking bioavailable calcium (900 mg/day) for a period of two months. Whereas, the advanced osteopenia patients who were taking 1350 mg bioavailable calcium per day showed excellent progress around 3.5 to 4 months period [29]. In the case of osteoporosis the mild osteoporosis patients recovered very well taking a dose of 1800 mg bioavailable calcium per day, for a period of 4 months. Whereas, in the case of advanced osteoporosis patients, the treatment had to be continued at a daily dose of 2250 mg calcium for a period of six months. According to the results of their clinical study, approximately 60-75% of the patients reported recovery from osteoporosis.

According to Reddy and Reddy [29] most of the women patients undergoing the treatment through supplementation of bioavailable calcium mineral complex of IMAC, Inc. USA reported that not only they have recovered from osteopenia and osteoporosis but also had excellent growth and thickness of their hair and also good growth of their nails. In addition, the skin complexion also greatly improved according to the study. In my opinion, it makes sense because the bioavailable minerals (both major, minor and trace) participate in various cellular enzymatic reactions and thus might have enhanced the cellular anabolic metabolism. Since skin is the largest organ and hair is the fastest growing organ in the body, the positive response was easily perceived in a short span.

In a separate study, Reddy and Reddy reported that supplementation of the bioavailable calcium mineral complex along with Multiple Mixed Strain Probiotics greatly improved the suppression of the hospital acquired infections due to *C. diff* and MRSA [30,31]. It has also been reported in the literature that cancer patients recovered faster when they were given bioavailable calcium and other major and minor minerals along with their regular cancer medications [3,30]. In the gastrointestinal tract, the bioavailability of calcium and other minerals will be significantly improved due to Probiotics. The exo enzymes and metabolic end products of Probiotic bacteria significantly reduce the size of the minerals to convert them into Nano size particles with greater bioavailability [38,41], to improve their absorption and assimilation.

In order to build health and long life span (anti-aging) you have to have a well thought out health plan, implement the plan, modify the implemented plan as needed, and finally you have to constantly guard

it. You have to plan way ahead of time, while you are young, regarding the kind of health (physical and mental) you would like to attain and maintain to extend your life (age) and to lead an excellent quality of life. Health can be built irrespective of age. However, it is advisable to start the program at an early age. You need good health to enjoy a great quality of life. The supplementation of bioavailable calcium and other bioavailable minerals is a must to maintain good health and long life (anti-aging). A human being can live up to 125 years or longer [26], provided their skeletal and muscular systems (along with central nervous system) are well maintained. Definitely bioavailable calcium mineral complex supplementation will improve the anti-aging process.

Conclusion

The loss of calcium in the old age is a natural phenomenon. However with the advent of knowledge, one can significantly delay the loss of calcium to improve the strength of the skeletal system. If the skeletal and muscular system is maintained in good health, the physical appearance and performance of the human being will be greatly improved. In addition, the life expectancy (anti-aging) can be increased significantly. The supplementation of the bioavailable calcium and other major and minor bioavailable minerals is an essential requisite for anti-aging. It is always a good practice to prepare the bioavailable calcium using a mixture of the majority of chelated organic calcium salts along with minor inorganic calcium salts. Such a combination of calcium salts and all other bioavailable major, minor and trace minerals will greatly assist the reduction or elimination of osteopenia and osteoporosis.

In addition, it is highly advisable to maintain proper multiple mixed strain Probiotics in the gastrointestinal tract, to improve the absorption and assimilation of the bioavailable mineral supplements. These are the prerequisites for anti-aging. For example, organic calcium salts ionize much faster than the inorganic calcium salts. Calcium phosphate reacts with hydrochloride acid in stomach to form soluble calcium chloride and phosphoric acid. The fraction of calcium phosphate which did not ionize and goes into the intestinal tract will react with primary and secondary bile acids to form calcium soaps etc., which may be absorbed. In addition, the calcium phosphate may react with lactic acid, produced by acid producing Probiotic bacteria in the ileum to form calcium lactate, which will be further metabolized by Propionibacterium to liberate calcium which can be absorbed through passive transport system. It has been clearly stated in the literature that calcium phosphate although quite insoluble its absorption rate is as good as highly ionisable and soluble calcium chloride *in vivo*. The calcium phosphate has an additional health benefits due to its ability to react with secondary bile acids and fatty acids, thus reducing toxicity to the Probiotic bacteria and the epithelial cells of the ileum.

Considering these diverse mechanisms of calcium absorption, multiple mixed bioavailable calcium salts should be supplemented as a mixture along with major and minor bioavailable minerals to increase the absorption both through active transport system and the passive transport system, to reduce or treat the calcium deficiency symptoms, osteopenia, and osteoporosis and thus improve anti-aging.

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