

Calcium supplementation: the bare bones

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SYNOPSIS

An adequate calcium intake is an essential part of the prevention and treatment of osteoporosis. Two to three serves of calcium-rich foods each day provides sufficient calcium for most non-pregnant adults. If this target is not achievable, calcium supplementation is generally effective, cheap and safe for most people. Calcium carbonate (without vitamin and mineral additives) is the preferred supplement in most cases. Problems with calcium absorption arise due to factors including high-fibre vegetarian diets, achlorhydria, long-term glucocorticoid therapy and vitamin D deficiency. Vitamin D deficiency is extremely common in some ethnic groups and the elderly who are housebound or in residential care. These at-risk groups generally require vitamin D supplementation to achieve adequate intestinal absorption of calcium.

Index words: osteoporosis, diet, vitamin D.

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Introduction

There is strong evidence that an adequate calcium intake is important for healthy bones, and as part of the preventive strategy in individuals at high risk for osteoporosis (for example, patients receiving long-term glucocorticoid therapy). It is also an adjunctive treatment in patients with osteoporosis.¹ An adequate calcium intake (and vitamin D status) was a prerequisite for the clinical trials assessing the anti-fracture efficacy of all of the currently available medications for treating osteoporosis, with the exception of calcitriol. Patients being treated for osteoporosis should therefore always have an adequate intake of calcium, and a normal vitamin D status.

Dietary calcium

For most people, calcium requirements are in the range 800–1500 mg daily. These requirements are best met by consuming at least two or three servings of high calcium foods daily (for example, milk products, calcium-fortified soy products). A serving of dairy food contains 200–300 mg of elemental calcium.² (When checking the true calcium content of foods and supplements, it is the **elemental** calcium that matters.) Daily physiological needs may be at least 1000 mg during growth, in pregnancy and possibly in the late

postmenopausal stage of life. Recommended dietary intakes of calcium (under review) indicate an additional 300 mg daily in pregnancy and an additional 400 mg daily for lactation.

Currently, approximately 60% of dietary calcium comes from dairy foods² (although this proportion may fall with the introduction of more calcium-fortified foods). People who avoid dairy products usually have an inadequate dietary calcium intake. Where necessary, calcium intake should be boosted by increasing the intake of high calcium foods such as dairy products and calcium-fortified soy products if possible. These products also contain a range of other essential nutrients including protein, phosphorus, magnesium and some vitamins which are of particular importance during growth, pregnancy and ageing.

Calcium supplements: how much, which type, how taken?

Calcium supplements are a very useful way of helping individuals who are unable to consume sufficient calcium from dietary sources. An extra 500–700 mg elemental calcium per day will suffice for most people. The cheapest, easiest way to achieve this objective is with a single calcium carbonate tablet containing 600 mg elemental calcium.

Calcium carbonate contains 40% elemental calcium by weight compared with 21% in calcium citrate. Although calcium citrate is more soluble and its bioavailability may be approximately 25% greater than that of calcium carbonate³ it is also more expensive. Calcium citrate was found to be less cost-effective than a calcium carbonate preparation in a recent study.⁴ Clinical situations where calcium citrate may be preferred over calcium carbonate include achlorhydria (calcium carbonate requires an acid environment to dissolve, calcium citrate does not), and in patients who need calcium supplements but have a history of kidney stones (citrate in the urine inhibits calcium oxalate precipitation).⁵ Calcium phosphate preparations have not been studied extensively, but appear to be absorbed adequately.⁶

In general, it is recommended to prescribe or advise the use of widely available, major brand-name calcium preparations whose absorbability has been well documented. This is because the absorbability of some marketed products is only 40–60% of that of plain calcium carbonate.

Administration

It is generally not important when calcium supplements are taken in relation to meals. Patients with achlorhydria appear to be an exception. Calcium carbonate is very poorly absorbed in these patients when fasting, but is absorbed satisfactorily when ingested with a meal.⁵ There is some evidence that taking calcium supplements in the evening may be advantageous, by suppressing the nocturnal rise in bone resorption. It is critical that calcium and oral bisphosphonates are taken at least several hours apart as calcium binds with these medications and prevents their absorption.

Factors that impair the absorption of calcium supplements

Some dietary constituents can impair calcium bioavailability by forming insoluble calcium complexes.⁷ These substances include phytates (found in cereals, bran, soybeans, seeds) and oxalates (found in spinach, rhubarb, walnuts). Some vegetarian diets may therefore adversely affect calcium balance, particularly if the calcium content is low due to the avoidance of dairy products.

Inadequate vitamin D nutrition is associated with impaired intestinal calcium absorption and must be corrected for ingested calcium to be effective. As the vitamin D content of our diet is generally low, people with low levels of sunlight exposure (the chronically-ill, housebound, people in residential care, some ethnic groups) are at high risk for vitamin D deficiency. Dark-skinned people, especially veiled women, are an important risk group. Their vitamin D status in pregnancy is a particular concern. Daily needs are probably of the order of 800 IU in these high-risk groups. This can be given as oral vitamin D₂ 1000 IU daily.

Long-term glucocorticoid treatment also causes calcium malabsorption. In general, when calcium supplements are recommended, vitamin D nutritional adequacy should be assured and other bone-protective interventions may be indicated. Renal impairment is associated with calcium malabsorption and this aspect of the care of patients with renal disease requires specialist advice. Achlorhydria reduces the absorption of calcium carbonate. In theory, proton pump inhibitors might impair calcium absorption, but evidence is lacking. It may be preferable for patients taking proton pump inhibitors to take calcium supplements with meals and perhaps to take calcium in the form of calcium citrate.

Adverse effects

Calcium supplements are usually well tolerated. Occasional adverse effects include constipation, bloating and flatulence. Changing preparations (for example, from calcium carbonate to calcium citrate) may alleviate these adverse effects. Calcium supplementation is contraindicated in the presence of hypercalcaemia or marked hypercalciuria, and during calcitriol therapy for osteoporosis, because of the risk of inducing hypercalcaemia or hypercalciuria. Measurement of the serum calcium, albumin and creatinine should therefore be part of the pre-treatment evaluation of patients presenting with apparent osteoporosis. Caution is also required in renal impairment, sarcoidosis and when there is a history of nephrolithiasis.

Other than the above circumstances, ingested calcium has very low toxicity and over-consumption of calcium is very uncommon. Historically, milk-alkali syndrome (hypercalcaemia, alkalosis and renal failure) was described in the context of peptic ulcer treatment with large amounts of milk and sodium bicarbonate. The ingestion of large amounts of calcium carbonate, sometimes in combination with dairy products, also can cause this syndrome. Typically, affected patients have ingested 5000 to 15 000 mg calcium daily.

What about the additives?

Evidence is lacking that the small amounts of various mineral and vitamin additives present in some marketed calcium supplements improve the effectiveness of the supplements. In theory, the addition of vitamin D might be beneficial, but the amount of vitamin D added (100–200 IU) is insufficient to prevent vitamin D deficiency in someone at risk. An adequate vitamin D supplement of 1000 IU is therefore recommended for these individuals.

Conclusion

There is a strong case in favour of calcium supplementation when an adequate dietary calcium intake cannot be achieved. In most non-pregnant adults, a daily supplement of 600 mg elemental calcium as calcium carbonate is sufficient, though occasionally more may be required. Coexisting vitamin D deficiency is common, particularly in the elderly in residential care, and also needs to be corrected.

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Conflict of interest: none declared

Self-test questions

The following statements are either true or false (answers on page 151)

1. Weight for weight, supplements containing calcium carbonate contain more elemental calcium than calcium citrate supplements.
2. Calcium supplements and oral bisphosphonates should not be taken simultaneously.