

Vitamin D: Myth or Magic?

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Orthopaedic surgeons are challenged to “own the bone,” yet many are confused by conflicting reports in both scientific literature and lay press regarding the importance and value of Vitamin D. While most Vitamin D researchers recommend routine Vitamin D supplementation, the Institute of Medicine, in 2010, issued a report suggesting that only nominal supplementation with Vitamin D is adequate for good health at all ages.¹

What advice should we offer patients?

History and Evolution

In evolution, the earliest phytoplankton forms produced provitamin D, and nonvertebrate species produced Vitamin D upon exposure to sun, which served to absorb damaging ultraviolet radiation.

In humans, Vitamin D is actually a hormone produced in the skin upon exposure to UV B radiation. Following hydroxylation in the liver and the kidney, the activated form is essential for absorption of calcium in the gut. Aside from its importance to bone, Vitamin D receptors are found on virtually every cell in the body. Vitamin D sufficiency has been implicated in multiple body systems, from muscle function, to susceptibility to certain cancers such as breast and prostate, to hypertension and psoriasis.

Vitamin D is offered as an evolutionary explanation for racial diversity: black skin, outdoors all day at the equator, produces the perfect amount of Vitamin D for good health. The further north one goes, the paler one's skin need be to produce the needed amount of Vitamin D in a day's sun exposure. In the extreme north and south of the planet, where sunlight is minimal, the primary food source is fish, which is the only naturally occurring food source of Vitamin D.

Modern lifestyle has taken a toll on our Vitamin D metabolism: our agrarian past has given way to indoor occupations. Children no longer play outside from dawn until dusk, but shelter indoors, in front of computers, video games, and televisions. Pollution filters the sun's rays. Where there is sun, sunscreen abounds, and dermatologists tout the importance of avoiding sun exposure at all ages. Increasing life expectancy plays a factor as well: skin loses its capacity to produce Vitamin D beginning at about 50.

Evidence Based Medicine

The medical literature is replete with Vitamin D studies. In most, hypovitaminosis D is implicated as either causative or contributory to human morbidity, from osteoporosis to diabetes. Unfortunately, many of these studies are anecdotal, retrospective, and uncontrolled.

The Institute of Medicine (IOM) issued a report in 2010 that attempted to summarize the known research on Vitamin D, and to offer recommendations that would be safe on universal grounds (see sidebar). The IOM recommended a daily vitamin D intake of 600 IU from ages 1 to 70 and identified a serum 25(OH) D concentration of 20 ng/mL (50 nmol/L) as “the level that is needed for good bone health for practically all individuals.” This is despite the fact that Vitamin D needs vary based on body size, obesity, and age.

Also at odds in the medical literature is what Vitamin D serum levels are optimal for good health. Looking at “normal” or “average” levels is meaningless if we accept the fact that modern humans experience less sun exposure than our predecessors: if everyone is Vitamin D deficient, then the “average” level is, by definition, suboptimal.

Serum parathyroid hormone levels rise with serum Vitamin D levels of 15-25 ng/mL (see sidebar regarding Vitamin D facts). Calcium absorption is increased by 65% if the serum level is increased from 25 ng/mL to 34 ng/mL.

While this evidence speaks to minimal Vitamin D sufficiency, a desired Vitamin D level for optimal bone health has not been well established.

In a Journal of Clinical Densitometry editorial titled “Vitamin D and Common Sense,” Binkley and Lewiecki² note that “our current human genetics are virtually identical to (our) hunter-gatherer ancestors,” and suggest that our ancestors serve as the paradigm for current Vitamin D goals. Extrapolating from studies of outdoor workers and tanners (who have been demonstrated to have statistically better bone density), the authors suggest that the “normal” 25 OH Vitamin D level range is from 20 to 60 ng/mL. Given that there are “no reports of Vitamin D toxicity from long-term sun/UVB exposure with levels up to 60 ng/mL,” they offer a “moderation-based” target of 40 ng/mL.

Vitamin D: What You Need to Know

What study do I order?

The 25-OH Vitamin D serum test is the only level that assesses Vitamin D status (the 1, 25 OH Vitamin D level may be elevated in the face of Vitamin D deficiency.) Be sure this is the study you look at.

What's the difference between D2 and D3?

D2 is plant derived, and D3 animal derived. Caution: D2 has only 40% the efficacy of D3, so that 50,000 IU of D2 is equivalent to only 20,000 IU of D3.

How are Vitamin D levels reported in the literature?

Serum Vitamin D is most commonly reported as ng/mL, BUT some studies use nm/L. These are VERY DIFFERENT units. To convert nmoles/L, multiply x 0.4: ergo 20 nmoles/L x 0.4 = 8 ng/mL.

How should Vitamin D be taken?

As a fat soluble vitamin, taking it in divided doses is unnecessary. It can be taken all at once, every other day, once weekly, or even large doses periodically.

What exactly did the Institute of Medicine recommend?

See IOM recommendations.

A University of New Mexico (UNM) study published in 2011 demonstrated that only 14% of children in sunny New Mexico had Vitamin D levels at or above 40 ng/mL.³ An ongoing study looking at Vitamin D levels in UNM orthopaedic resident physicians demonstrated that 95% (38 of 40 residents studied) had winter Vitamin D levels that were <40 ng/mL.⁴

Vitamin D researchers⁵ have suggested that the body uses at least 3000-5000 IU of Vitamin D per day, and that, absent significant sun exposure, an intake of 1000 IU/d is needed by an average adult to maintain a serum level of at least 30 ng/mL.

The final confounding issue is that, given current levels of food fortification, *it is impossible to intake adequate Vitamin D from diet.* To intake 1000 IU of Vitamin D, one would need to drink ten 8-oz. glasses of milk: other dairy products are not routinely fortified. Certain species of fish (not all) offer around 300 IU of D per serving, so three fish meals per day could meet the 1000 IU requirement. Other foods are fortified at negligible levels.

In short, most individuals need Vitamin D supplementation. Vitamin D3, the most biologically potent form, is inexpensive and readily available without prescription, including child-friendly forms such as liquid and gummy preparations.

Conclusion

As orthopaedic surgeons, our task is to optimize bone health in our patients. While we have a variety of tools in our armamentarium, up to and including surgery, we should first and foremost use common sense in our advice to patients. Vitamin D and calcium are the building blocks of the musculoskeletal system. Suggesting complex bone surgery without recommending basic Vitamin D supplementation is analogous to trying to gain internet access using an abacus.

Recommendations

Own the bone, and keep it healthy by recommending at least 1000 IU of Vitamin D supplement per day to every patient. Patients with osteoporosis, obesity, metabolic bone disorder, delayed or nonunion of fracture, seizures, and chronic illness should receive individualized recommendations based on assessment of serum 25 (OH) Vitamin D, with a goal of maintaining the level between 40 and 60 ng/mL.

References

1. Food and Nutrition Board. Dietary reference intakes for calcium and vitamin D [Web page]. Institute of Medicine website. <http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-Calcium-and-Vitamin-D/DRI-Values.aspx>. Accessed April 25, 2012.
2. Binkley N, Lewiecki M. Vitamin D and common sense. *J Clin Dens.* 2011;14(2):95-99.
3. Szalay EA, Tryon EB, Pleacher MD, Whisler SL. Pediatric vitamin D deficiency in a southwestern luminous climate. *J. Pediatr. Orthop.* 2011;31(4):469-473.
4. Allen L, Godfrey J, Szalay E. Unpublished data.
5. Holick M. The influence of vitamin D on bone health across the life cycle. *J. Nutr.* 2005;135(11):2726S-2727S.

Table 1

Dietary Reference Intakes for Calcium and Vitamin D

| Life Stage Group | Calcium | | | Vitamin D | | |
|--|-------------|-------------|-------------|-------------|-------------|-------------|
| | Estimated | Recommended | | Estimated | Recommended | |
| | Average | Dietary | Upper Level | Average | Dietary | Upper Level |
| | Requirement | Allowance | Intake | Requirement | Allowance | Intake |
| | (mg/day) | (mg/day) | (mg/day) | (IU/day) | (IU/day) | (IU/day) |
| Infants 0 to 6 months | * | * | 1000 | ** | ** | 1000 |
| Infants 6 to 12 months | * | * | 1500 | ** | ** | 1500 |
| 1-3 years old | 500 | 700 | 2500 | 400 | 600 | 2500 |
| 4-8 years old | 800 | 1000 | 2500 | 400 | 600 | 3000 |
| 9-13 years old | 1100 | 1300 | 3000 | 400 | 600 | 4000 |
| 14-18 years old | 1100 | 1300 | 3000 | 400 | 600 | 4000 |
| 19-30 years old | 800 | 1000 | 2500 | 400 | 600 | 4000 |
| 31-50 years old | 800 | 1000 | 2500 | 400 | 600 | 4000 |
| 51-70 year old males | 800 | 1000 | 2000 | 400 | 600 | 4000 |
| 51-70 year old females | 1000 | 1200 | 2000 | 400 | 600 | 4000 |
| >70 years old | 1000 | 1200 | 2000 | 400 | 800 | 4000 |
| 14-18 years old, pregnant/lactating | 1100 | 1300 | 3000 | 400 | 600 | 4000 |
| 19-50 years old, Pregnant/lactating | 800 | 1000 | 2500 | 400 | 600 | 4000 |

*For infants, Adequate Intake is 200 mg/day for 0 to 6 months of age and 260 mg/day for 6 to 12 months of age.

**For infants, Adequate Intake is 400 IU/day for 0 to 6 months of age and 400 IU/day for 6 to 12 months of age.

Institute of Medicine. (November 2010). [Table of calcium and vitamin D dietary reference intakes for infants, children, and adults]. *Dietary Reference Intakes for Calcium and Vitamin D*. Retrieved from <http://www.iom.edu/Reports/2010/Dietary-Reference-Intakes-for-Calcium-and-Vitamin-D/DRI-Values.aspx>.