Calcium Metabolism in Iguanas

Bruce Bogoslavsky, DVM
Animal Veterinary Hospital of Orlando
Orlando, FL 32809

Introduction

Calcium plays a key role in many biological processes, such as muscle contraction, egg shell production, blood clotting, enzyme activity, nervous system function, hormone release, and cell membrane permeability, in addition to being an essential component of bones. Calcium in the blood can be bound to other ions such as phosphate and citrate. It can also exist in the biologically active or free form. The blood concentration of calcium and its associated ions, as well as absorption and use by the body organs, is regulated by three major factors that interact independent of calcium intake. These factors are parathyroid hormone (PTH), calcitonin (CT, another hormone), and vitamin D. Parathyroid glands, which are located in the neck and which secrete PTH, and the thyroid gland, which secretes CT, are present in all air-breathing vertebrates.

Absorption

Vitamin D_3 (cholecalciferol) is converted by the liver and kidney to its biologically active form, 1, 25-dihydroxycholecalciferol (1,25 DHCC). This form is necessary for an iguana to properly absorb calcium from digested food in its intestine. Vitamin D_3 can be provided in the diet either as a preformed molecule or be converted from other molecules in the iguana's skin in the presence of ultraviolet stimulation. Dietary vitamin D can either be provided directly in specific food items or as part of a supplement added to the food prior to feeding. Iguanas utilize vitamin D_3 rather than ergocalciferol, vitamin D_2. Ergocalciferol is derived from plants and is less expensive to produce than cholecalciferol. Supplements listing vitamin D without a reference to the specific type usually contain ergocalciferol. Some food items such as commercial dog or cat food or monkey biscuits contain excessive amounts of vitamin D. When these items are fed to an iguana, hypervitaminosis D will occur. Likewise, if the iguana is over-supplemented with vitamin D, the condition will also occur.

Vitamin D_3 can be synthesized in the skin of an iguana from precursor molecules. Ultraviolet light at wavelengths of 290–320 nm (UVB), shining on the iguana, is necessary for this reaction to take place. Following this reaction, the vitamin D_3 from the skin is transported in the blood to the liver and kidney where the conversion process into the biologically active form, 1,25-DHCC, is completed. Necessary wavelengths of ultraviolet radiation can be provided either from direct, unfiltered sunlight or a high quality, full-spectrum light source. This is the preferred manner for vitamin D_3 to be provided because an overdose is less likely to occur.

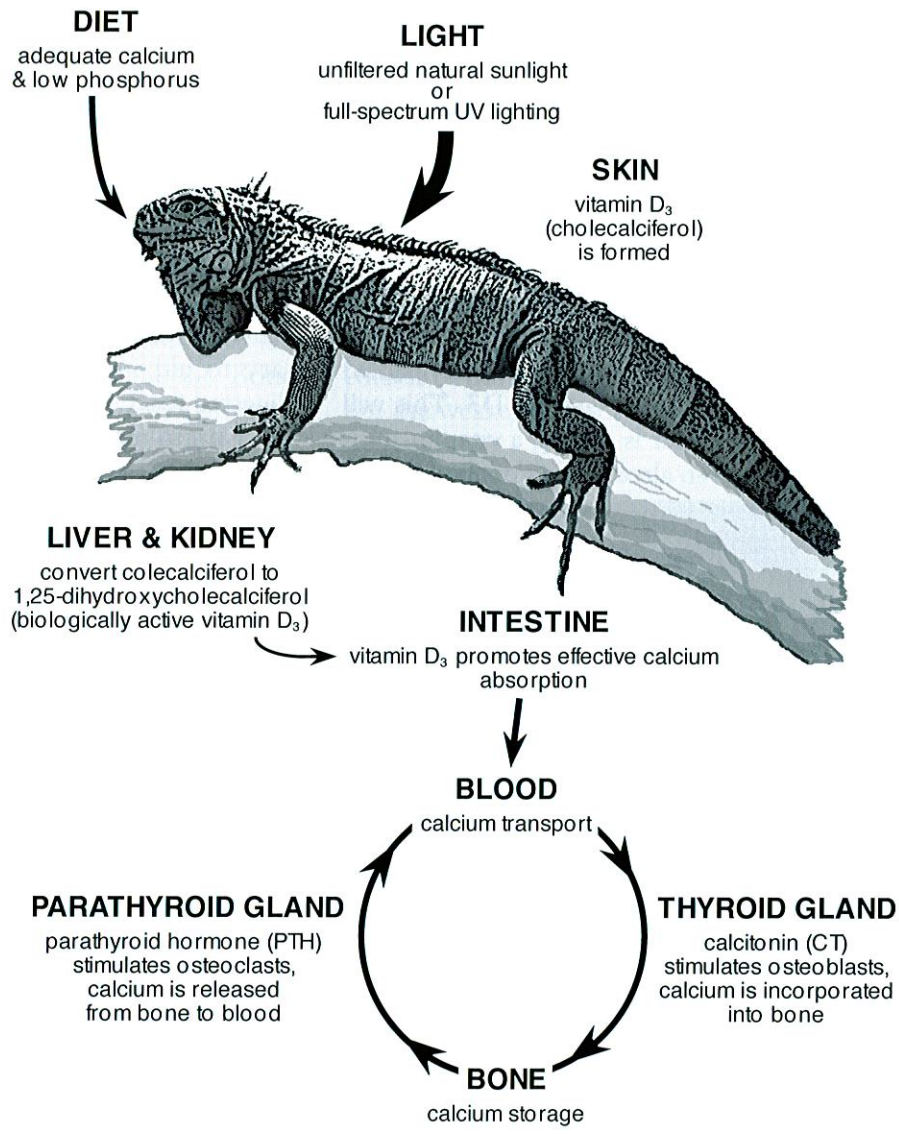
Unfortunately, glass or plastic will filter ultraviolet radiation out of sunlight, providing only heat and light. Likewise, poor quality or old ultraviolet lights will not provide adequate stimulation for proper vitamin D_3 conversion. Full-spectrum, ultraviolet strip lights will provide a better range of ultraviolet irradiation than incandescent or screw-in type bulbs. Currently, my favorite light is Zoo Med's Iguana Light 5.0 and Reptisun 5.0. These happen to be the same bulb with different packaging. Regardless of the brand you choose, the bulb should be replaced every 6–9 months. Although the bulb may still be producing light, the functional spectrum of ultraviolet irradiation will be insufficient for proper vitamin D_3 metabolism. Once the bulb develops a dark band near each end, the filament necessary to provide the ultraviolet spectrum has been burnt out. Remember, however, that no bulb can replace natural sunlight.

Storage

The main storage area for calcium in all vertebrates is in the bone matrix. The amount of calcium stored at any given time is a function of the action of two specific cell groups, the osteoblasts and the osteoclasts. Osteoblast cells are responsi-

ble for the resorption of calcium from blood and the production of bony matrix. Conversely, osteoclast cells are responsible for the demineralization of bone and a release of calcium into the blood.

When blood calcium levels decrease, the parathyroid gland secretes PTH. PTH stimulates osteoclast activity and inhibits osteoblast activity, which results in the release of stored calcium from the mineralized bone. PTH also causes an increase in phosphorus excretion by the kidneys. Lastly, PTH stimulates the final conversion of D_3 to metabolically useful 1,25 DHCC. The end result of all this activity is to increase the calcium absorption from digested food in the intestine. Once the blood calcium level returns to normal, the thyroid gland secretes CT. This hormone inhibits the release of stored calcium from bone by decreasing osteoclast activity. It also inhibits the excretion of phosphorus by the kidneys. Phosphorus is significant in that it can bind with free calcium and render it unavailable for use by the iguana's systems.



Cardiac Effect

Vertebrate cardiac function is also influenced by calcium ions within the myocardium (heart muscle). Calcium is rapidly exchanged within the myocardium. As calcium levels increase so does the animal's heart rate. Small elevations of calcium within the heart cells will result in increased contraction strength. However, as the concentration increases, the animal may develop a cardiac rhythm disturbance that may eventually lead to a cardiac arrest.

Reproductive Effect

Blood protein levels vary depending on the season, reproductive state, nutritional state, and temperature. The proteins in the blood that bind and transport calcium are highly influenced by the reproductive cycle. As a consequence of increased estrogen activity, blood calcium levels will increase in female iguanas as egg follicles are produced within the body. Thus the gravid iguana will not deplete its own calcium stores during reproduction.

Excretion

In a normal metabolic situation, a dietary excess of soluble calcium will not be absorbed by the intestine and will be excreted in fecal material. Additionally, a small amount of calcium is excreted with the urates. Likewise, only trace levels of calcium are present in the iguana's salt gland excretions.

Hypercalcemia

Excessive amounts of calcium in an iguana's diet will only cause a problem if it is accompanied by an excessive amount of vitamin D3. This will happen when an owner is adding a vitamin-mineral supplement to an already high quality diet. In addition, the owner may be providing direct unfiltered, natural sunlight or full-spectrum, ultraviolet lighting. This can result in an excessively high amount of calcium being absorbed from digested food within the iguana's intestines. Ultimately, this will cause calcium salts to be deposited in various soft tissues. The most commonly affected sites include the aorta, heart muscle, pulmonary airways, gastrointestinal tract, and urinary system.

Hypocalcemia

Hypocalcemia (low blood calcium levels) can be caused by a number of different factors. Growing iguanas require a quality diet containing an adequate amount of calcium without an excess of phosphorus. Because calcium and phosphorus compete for the same binding sites in the blood, a diet high in phosphorus will result in low blood calcium levels. Sensing this decrease in circulating blood calcium, the parathyroid gland will secrete PTH. PTH stimulates the release of calcium stored in the iguana's bones. If the blood phosphorus level is still elevated at this time, the majority of freed calcium will be unable to find free binding sites. This results in the excretion of calcium within stool, leaching it away from bone and leaving the iguana with very soft bones. Some commonly fed items that are excessively high in phosphorus are lettuce, spinach, sprouts, tofu, peas, grapes, banana, mealworms, and crickets.

Oxalic acid in the diet should also be monitored as it will bind with calcium and prevent its absorption from the intestine. Foods containing oxalic acid such as spinach, rhubarb, cabbage, peas, potatoes, and beet greens should be fed in small amounts or avoided entirely.

Conclusion

Calcium metabolism in iguanas is a complex process with several variables. Specific wavelengths of ultraviolet stimulation from either direct, unfiltered sunlight or a high quality, full spectrum light source are necessary to convert vitamin D_3 within the iguana's skin. Vitamin D_3 must then be transferred first to the liver and then to the kidneys before it is finally converted into its biologically active form. Biologically active vitamin D is necessary to aid in the absorption of calcium from digested food in the iguana's intestine.

I try to make my clients visualize their iguana in the middle of a triangle with ultraviolet stimulation, optimum environmental temperature, and a high quality diet on the three corners. An optimal environmental temperature is necessary to activate intestinal microbes for proper digestion. A high quality diet, rich in calcium and low in phosphorus, should be provided. If all of these factors are provided, an iguana will have solid bones, a good growth rate, a strong cardiovascular system, and will be a fine specimen for breeding.

References

Frye, F. 1991. *Reptile Care. An Atlas of Diseases and Treatments.* T.F.H. Publications Inc., Neptune City, New Jersey.

Frye, F. 1993. *A Practical Guide for Feeding Captive Reptiles.* Krieger Publishing Co., Malabar, Florida.

Frye, F. and W. Townsend. 1993. *Iguanas: A Guide to Their Biology and Captive Care.* Krieger Publishing Co., Malabar, Florida.

Gans, C. and F.H. Pough. 1982. *Biology of the Reptilia. Volume 12. Physiology C.* Academic Press Inc., London.

Mader, D. 1996. *Reptile Medicine and Surgery.* W.B. Saunders Co., Philadelphia, Pennsylvania.

Marcus, L. 1981. *Veterinary Biology and Medicine of Captive Amphibians and Reptiles.* Lea & Febiger, Philadelphia, Pennsylvania.

McDonald, L.E. 1980. *Veterinary Endocrinology and Reproduction.* Lea & Febiger, Philadelphia, Pennsylvania.

Iguana Times

THE JOURNAL OF THE INTERNATIONAL IGUANA SOCIETY
WWW.IGUANASOCIETY.ORG

VOLUME 9, NUMBERS 1 AND 2
MARCH/JUNE 2002
$12.00

A large male spiny-tailed iguana, *Ctenosaura conspicuosa*, basks atop a cardon cactus, *Pachycereus pringlei*, on Isla San Esteban, a small island in the Gulf of California. *Photograph: L. Lee Grismer*