EFFECTS OF ARTIFICIAL ULTRAVIOLET RADIATION ON SERUM 25-HYDROXYVITAMIN D_3 CONCENTRATIONS IN CAPTIVE GUINEA PIGS (*CAVIA PORCELLUS*)

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Abstract

Under natural conditions, guinea pigs (*Cavia porcellus*) are exposed to ultraviolet B (UVB) radiation. Although the role of UVB radiation in the photobiochemical synthesis of vitamin D is well documented in humans and other vertebrates, to date it has not been evaluated in guinea pigs. The purpose of this study was to determine whether artificial UVB radiation has an effect on serum 25-hydroxyvitamin D_3 levels in guinea pigs. A total of 12 juvenile guinea pigs were randomly assigned to 1 of 2 treatment groups: Group A was exposed to 12 hours of artificial UVB radiation (290 to 315 nm) daily and Group B received ambient fluorescent light with no UVB supplementation for 12 hours/day. Blood samples were collected under anesthesia on days 0 and 18 to measure serum 25-hydroxyvitamin D_3 levels. Animals in both groups were offered the same diet. There was a significant difference in 25-hydroxyvitamin D_3 concentrations over time ($F = 399.3$, $P = 0.0001$) and by group ($F = 63.6$, $P = 0.0001$), with an average increase between sampling periods of 56.5 nmol/L in Group A (UVB) and 2.33 nmol/L in Group B (no UVB). This study represents the first attempt to measure the effect of UVB radiation on 25-hydroxyvitamin D_3 levels in guinea pigs. In vertebrates, vitamin D is an essential hormone that regulates many physiologic functions within the body. These preliminary findings confirm that guinea pigs can obtain vitamin D via photobiochemical synthesis, but additional work is needed to determine the physiologic importance of this finding and potential risks associated with UVB exposure in these rodents. Copyright 2015 Published by Elsevier Inc.

Key words: *Cavia porcellus*; guinea pig; lighting; vitamin D; ultraviolet B

Vitamin D is a fat-soluble hormone that plays an important role in a variety of biological processes. One essential function of vitamin D is to serve as a regulator of calcium homeostasis through active intestinal and renal absorption of calcium.[1] Vitamin D is also considered to have important roles in immune function, prevention of neoplasia, cardiovascular health, and mental wellness, among others.[2-4]

Vertebrates can obtain vitamin D through their diet (e.g., ingestion of prey or plant matter containing vitamin D), exposure to ultraviolet B (UVB, 290 to 315 nm) radiation, or a combination of both methods.[1,2] Ultimately, the method(s) used by vertebrates to obtain or generate

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vitamin D is species-dependent. In domestic dogs and cats, vitamin D is obtained from the diet, while in llamas and alpacas, photobiochemical conversion from exposure to UVB radiation is required to maintain adequate concentrations of vitamin D in the body.[2] In reptile species that have been studied, a combination of diet and exposure to UVB radiation are thought to be ideal for maintaining appropriate levels of this hormone.[1,5–7] To date, no scientific investigation has evaluated the method(s) used by guinea pigs to obtain their vitamin D supplementation. However, guinea pigs are an herbivorous, diurnal species that are native to the Andes Mountains, much like the New World camelids (e.g., llama and alpaca), and likewise, may benefit from exposure to UVB radiation. Rabbits, chinchillas, and green iguanas, 3 other examples of nondomestic captively managed herbivores, have also been found to produce vitamin D following exposure to UVB radiation.[7-9]

The purpose of this study was to determine whether guinea pigs exposed to commercial UVB-producing fluorescent lighting would have higher serum 25-hydroxyvitamin D_3 concentrations compared with control guinea pigs that were not exposed to UVB radiation. The specific hypothesis tested in this study was that guinea pigs exposed to UVB radiation would have significantly higher serum 25-hydroxyvitamin D_3 concentrations as compared with control guinea pigs.

MATERIALS AND METHODS

This project was performed in accordance with the regulations established by the Institutional Animal Care and Use Committee at the University of Illinois (Protocol no. 11 – 146). A total of 12 8-week-old guinea pigs (6 male and 6 female) acquired from a private source (Sailfin Pet Store, Champaign, IL USA) were used for this study. All the guinea pigs had pigmented fur and irises (no albino animals). The hair coat color varieties of the animals were also diverse; therefore, it was not possible to further categorize based on pigmentation owing to sample size. The guinea pigs were housed in groups of 3 in plastic bottom cages ($71 \times 44 \times 41.5$ cm^3) with a coated wire top. Pine shavings (Sunseed Company, Bowling Green, OH USA) were used as bedding. Diet consisted of ad-lib timothy hay (Western Timothy Hay, Oxbow Animal Health, Murdock, NE USA) and ¼ cup of timothy-based pellets (Young Guinea Pig Food, Oxbow Animal Health) daily, as per the manufacturer's recommendation. Fresh water was supplied via a water sipper bottle suspended from the side of the cage. The cage substrate, food, and water were replaced daily. The temperature in the room was approximately 23°C to 26 °C (73°F to 78 °F), and a 12-hour light-dark cycle (0800 to 2000 hours) was maintained. General room lighting was provided using non–UVB-producing fluorescent lighting. The animals were conditioned for at least 72 hours before the start of the study.

After the initial 72-hour conditioning period, a physical examination was performed on each individual. The guinea pigs were then anesthetized using isoflurane gas (Butler Animal Health Supply, Dublin, OH USA) via a facemask for blood collection. Animals were induced with 5% isoflurane and 1 L oxygen and maintained on 1.5% to2% isoflurane and 1 L oxygen. The guinea pigs were placed in dorsal recumbency and blood was collected from the jugular vein or cranial vena cava using a 25-gauge needle (Tyco Healthcare Group LP, Mansfield, MA USA) attached to a 3-cc syringe (Tyco Healthcare Group LP). The total blood sample volume was $<1\%$ of body weight (totaling 2.0 to2.5 mL of whole blood per sample collection). Blood was placed into a 3-mL serum tube (Tyco Healthcare Group LP) and centrifuged (IEC HN-SII Centrifuge, Thermo Electron Corporation, Milford, MA USA) within 90 minutes of collection at approximately 2200 rpm for 25 minutes. The resulting serum was then removed, placed into a Cryo-Vial (CryoTube vials, 1.8 mL, Nunc A/S, DK-4000 Roskilde, Denmark), and stored in a −17°C freezer until being submitted for analysis at the conclusion of the study. All of the samples were collected between 1630 and1900 hours to minimize any potential bias associated with the circadian rhythm.

After the initial blood sample was collected, the guinea pigs were placed into 1 of 2 groups (Group A and Group B) using a random number generator (www.random.org). During the 18-day study period, animals in Group A ($n = 6$) were provided supplemental UVB lighting (Sun-Glow Coil Lantern, 20 W 5.0 UVB, Fluker Farms, Port Allen, LA USA), whereas animals in Group B ($n = 6$) were not. Supplemental UVB lighting was provided from 3 bulbs evenly distributed along the cage top at a distance of approximately 46.5 cm from the cage bottom. The supplemental UVB light was provided for 12 continuous hours (0800 to 2000 hours) daily throughout the study period. For both the groups, UVB radiation was measured using a radiometer (UV meter: Model 1400, International Light Inc, Newburyport, MA USA) at the substrate surface along the center and edges of the cage