Short Communication

Strontium and Bone Development Under Conditions of Suboptimal Vitamin D* **

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An investigation involving chicks fed diets with 0.5 % Ca and 0.5 % Sr supplemented with various levels of vitamin D₃ suggests that one-half of the Ca requirement of body growth in the chick is met by Sr as long as the vitamin D₃ level was maintained at 500 to 1000 ICU/kg foodstuff. The entire Ca requirement for bone growth could not, however, be met by Sr. Even though Sr was incorporated into the bone when low levels of vitamin D₃ were fed in the diet, the total ash content, as well as Ca content, was reduced.

Key words: Bone — Strontium — Calcium — Vitamin D — Calcification.

Introduction

Wasserman (1962) has presented an exhaustive study of the relation of vitamin D₃ to the intestinal absorption of cations by chick intestine. He reported that the duodenum absorbed Ca and Sr to about the same degree and responded to vitamin D to about the same extent. Greenberg (1945) reported that vitamin D has a direct action on the mineralization of bone in rachitic rats, and promoted

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healing by increasing the absorption of calcium from the digestive tract. The effects of vitamin D on the absorption of Ca has been shown to be more pronounced when animals are maintained on low Ca diets [4]. Kodicek (1963) localized vitamin D in tissue cultures of chick embryo bone. However, the chemical similarity of Sr to Ca makes the substitution of limited amounts of Sr for Ca under various physiological conditions feasible. Storey (1965) observed that high Sr diets fed to rats produced bone lesions similar to avitaminosis D rickets. On the other hand, Ratsimamanga and Contenson (1963) observed that rats grew at a more rapid rate on low vitamin D diets when Sr was present, and that bone growth was enhanced in the absence of vitamin D when diets containing high levels of Sr were fed. The results of the above studies are contrary to what has been generally accepted as the mineral to vitamin D relationship and prompted this study in chicks.

**Materials and Methods**

Ninety day-old male chicks were divided into six groups of fifteen birds each and fed a semi-synthetic diet [2] modified to contain 0.5% Ca which is one-half of the recommended Ca level for the growing bird [9], and 0.5% P. Five of the groups received a diet containing 0.5% Ca and 0.5% Sr and supplemented with 3000, 1000, 500, 100, or 0 ICU vitamin D₃/kg of feed. The control group was fed a diet containing 0.5% Ca and no added Sr and was supplemented with 1000 ICU of vitamin D₃. The Sr was supplied as SrCO₃. At three weeks of age the chicks were weighed, killed, the right and left tibiotarsal bones were removed for analyses and all adhering tissues removed. Ash determinations were made on dry, fat-free bone ashed at 650°C for 20 h. Calcium determinations were made on the right tibiotarsus according to AOAC procedure [1]. Determinations of Sr were made on the left tibiotarsus using an atomic absorption spectrophotometer with an acetylene-rich, reducing flame and the absorption measured at 4607 Å with a 10 ma hollow cathode. Values for both Ca and Sr were reported as percent of dry bone. All values are reported as the mean values (± one standard deviation) of fifteen determinations per treatment. Statistical significance was determined on the basis of Duncan's Multiple Range Separation [5]. Since previous studies using radio-strontium did not indicate uptakes of Sr in any appreciable quantity in soft tissue of birds [3], they were not analyzed in this study.

**Results and Discussion**

The effects of various vitamin D₃ levels on body weights (Table) suggest a trend toward slightly heavier body weights when both Ca and Sr were fed in the presence of adequate vitamin D₃, but because of the number of animals used, this experiment was not sensitive to such small differences. When levels of vitamin D₃ below 500 units were fed, body weights were decreased significantly. Although slightly lower than would be expected when 1% Ca was available, the highest level of bone ash was obtained in the absence of Sr suggesting less efficient deposition of Sr; however, no significant differences were obtained until the vitamin D₃ level was reduced to 100 ICU/kg. The highest level of bone Ca was also observed when no Sr was present in the diet, but there was no significant change in either bone Ca or bone Sr when 0.5% Sr was fed and vitamin D₃ was varied from 500 to 3000 units. The body weights in Table 1 shows that the chicks gained the most weight when the diet contained 0.5% Ca and 0.5% Sr. The bone Ca decreased significantly when only 100 units of vitamin D₃ were available (\(P > 0.05\)) over the wide range in concentration of vitamin D₃ employed (500 ICU to 3000 ICU) with 0.5% Ca and 0.5% Sr. Little change in bone Ca and Sr occurred.