The Effect of Vitamin D on Muscle Strength

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ABSTRACT

Vitamin D regulates calcium and phosphorus metabolism. Vitamin D deficiency results in rickets, which is often accompanied by muscle weakness. To determine if this weakness is due to vitamin D deficiency or calcium and phosphorus depletion, vitamin D deficient rats were maintained in filtered UV light, and serum calcium, serum phosphorus, and body weights were identical in both groups. Vitamin D deficient rats were maintained in filtered UV light, and vitamin D-sufficient rats were maintained in normal light. Both groups of animals were on a diet containing 20% lactose. Serum calcium concentrations were measured by atomic absorption spectrometry (Perkin Elmer 3110, Perkin Elmer, Norwalk, CT) in a 0.1% lithium chloride solution. Serum phosphorus concentrations were determined by a colorimetric assay using molybdate green and ammonium molybdate. Serum 25-hydroxyvitamin D concentrations were determined by a competitive binding assay.

INTRODUCTION

The physiologically active metabolite of vitamin D, 1,25-dihydroxyvitamin D (vitamin D), is crucial for maintenance of calcium homeostasis. Vitamin D deficiency results in a lowered serum calcium concentration, unmineralized bone matrix, loss of bone strength, skeletal malformations and ultimately hypocalcemic tetany. This disorder is often accompanied by muscular weakness that is usually confined to the trunk and proximal limb areas. Administration of vitamin D through diet results in recovery of muscle strength. The aim of this study is to determine if vitamin D, as opposed to calcium or phosphorus, has a direct effect on skeletal muscle strength.

METHODS

Animals. Two groups of male Wistar weanlings (n=30) were purchased from Stefan (Heidelberg, N.). All rats were fed a purified vitamin D-free diet containing 2% calcium, 1% phosphorus and supplemented with vitamins AEK or the same diet supplemented with 18.75 ng of vitamin D per day. Animals were raised for eight weeks in filtered UV light.

Fast Twitch Muscle Strength. The epitrochlearis muscle, a flat, thin muscle capable of absorbing nutrients from Ringer’s solution for testing in vitro, was carefully isolated and immediately placed in a bath of oxygenated Ringer’s solution. One end was attached to a stationary point and the other end was attached to the force transducer. Electrodes were positioned on either side of the muscle to surround it with an electrical field and stimulate it on command. In a position, the maximal voltage threshold was determined to assure stimulation of all fibers and sarcomere length was adjusted for ideal myofilament overlap. Five single twitches were recorded. From these, average values for maximal force (P), time to half contraction (T1/2), time to full contraction (Tc), stand time to half relaxation (T1/2r) were collected. (Fig. 1) (continued)

CONCLUSION

Vitamin D regulates calcium and phosphorus metabolism. Vitamin D deficiency results in rickets, which is often accompanied by muscle weakness. To determine if this weakness is due to vitamin D deficiency or calcium and phosphorus depletion, vitamin D deficient rats were maintained in filtered UV light, and serum calcium, serum phosphorus, and body weights were identical in both groups. Vitamin D deficient rats were maintained in filtered UV light, and vitamin D-sufficient rats were maintained in normal light. Both groups of animals were on a diet containing 20% lactose. Serum calcium concentrations were measured by atomic absorption spectrometry (Perkin Elmer 3110, Perkin Elmer, Norwalk, CT) in a 0.1% lithium chloride solution. Serum phosphorus concentrations were determined by a colorimetric assay using molybdate green and ammonium molybdate. Serum 25-hydroxyvitamin D concentrations were determined by a competitive binding assay.