A Study of Parathyroid Hormone Secretion Patterns on Bone Density in Hibernating Black Bears (*Ursus americanus*)

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Abstract

Black Bears (*Ursus americanus*) have the unique ability to preserve bone structure and strength over the course of hibernation. In other hibernating mammals, decreased load on the skeleton causes a loss of bone density. Parathyroid hormone (PTH) has been identified as an important regulator in bone metabolism. Theoretical modeling of PTH secretion cycling suggests that this hormone allows bears to maintain bone strength during hibernation. Our objective is to identify PTH secretion cycles and analyze their correlation with predicted optimal interval release. We will conduct our study by collecting blood samples from hibernating and non-hibernating populations of American black bears and measuring their serum PTH levels over both a daily period and throughout hibernation. This research is closely linked to medical research surrounding disuse osteoporosis, as well as environmental research concerned with identifying a baseline for biological function of these bears moving into climate driven environmental pressures.

Research Question

We propose to conduct a comparative study that analyzes Kroll's theoretical optimal PTH secretion cycle with experimental data collected in the field. We predict that bear PTH secretion cycles will closely adhere to the proposed mathematical models during hibernation, and express a distinct difference during non-hibernating months to offset extended periods of inactivity.

Inigo Arndt/Minden Pictures/CORBIS

Introduction

We aim to identify the PTH secretion cycle exhibited by American Black bears during hibernation. This hormone has been identified as an important component of the unique bone metabolism that allows these bears to avoid the effects of prolonged bone disuse. A theoretical cycle has been proposed using mathematical models, our study intends to determine an observed cycle to support or reject this model. We plan to monitor PTH levels and analyze how these hormone levels change throughout the day and over the course of hibernation. We aim to identify flux patterns in order to compare them to these mathematical models. This research has the propensity to aid in the development of potential pre-osteoporosis treatments for those at high risk of developing disuse osteoporosis, such as bedridden patients and astronauts.

NPS Photo / J. Mills

Methods

We will find and track American black bears in the Uncompahgre Wilderness by sedating them with tranquilizer and attaching GPS collars. We will collect blood samples during two periods of hibernation and one summer non-hibernating course for control. The samples will be taken during early and late denning periods. Summer samples will be also be collected. Blood samples will be taken from the femoral vein or the jugular vein depending on accessibility. During the summer course, bears will be sedated administered via dart. All blood samples collected will be kept in coolers for transport.

Once the blood samples are collected, the tubes will be cold centrifuged. Serum will be separated and stored at -25℃. PTH hormone levels will be assessed using an ELISA kit and enzyme stock on petri dishes.

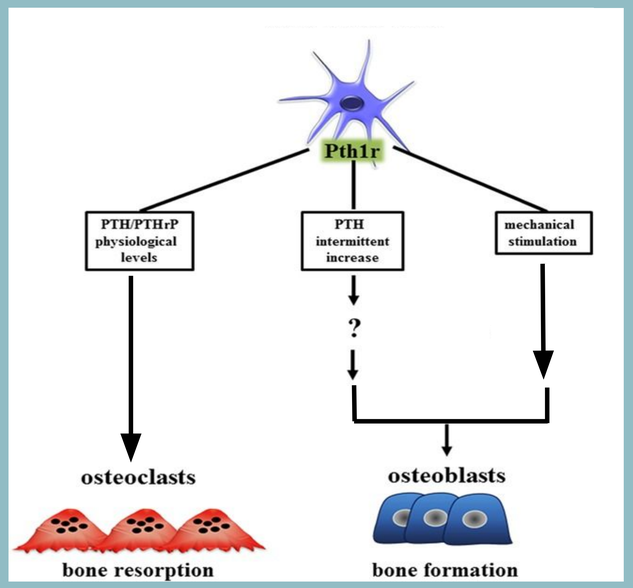

Figure 1. PTH at physiological levels favors bone catabolism, while intermittent PTH increases mimic normal bone load to favor bone maintenance and formation through an unknown mechanism (Delgado-Calle).

Justifications and Future Research

The overarching goal of this study is to utilize prior studies on bone density and integrate their findings into a new research question that furthers the knowledge of dynamic bone metabolism. By understanding how bears utilize PTH secretion cycles, we can then begin to understand how they are uniquely able to maintain bone density during prolonged periods of disuse. Understanding this physiological mechanism could aid in the collaborative efforts in developing preventive treatments for those at risk of osteopenia and osteoporosis. Osteoporosis affects more than 54 million Americans annually (NOF, 2018). Furthermore, this study will aid in a greater understanding of the mechanisms involved in hibernation. Due to climate force on bear habitats, understanding bear metabolism during hibernation becomes critical in the preservation of all hibernating animals.

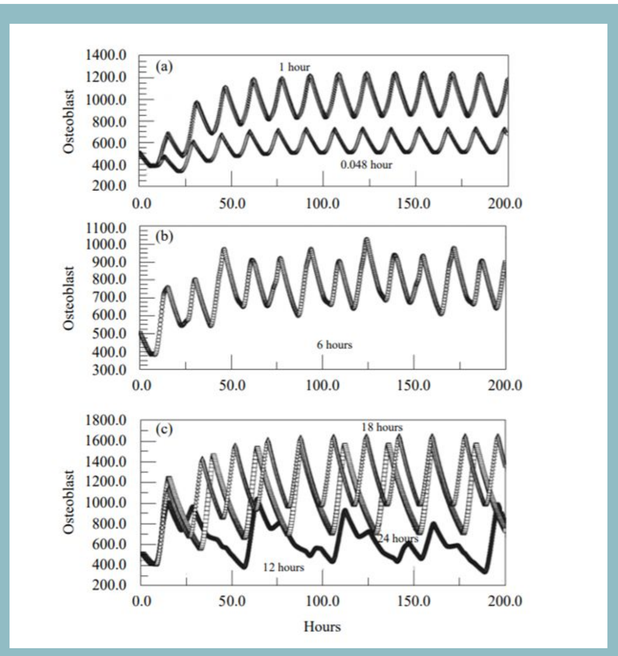

Figure 2. Kroll's mathematical models illustrate that PTH administered every six hours should have the greatest average production of osteoblasts, along with an osteoblast to osteoclast ratio that favors bone formation. PTH administered continuously or at other intervals produces erratic production patterns and/or unfavorable bone metabolism decoupling.

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