

Possible Evidence of Pregnancy and or Famine in an Ancient Nubian Female

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Abstract

A female Nubian femur from the Manchester Mummy Collection exhibits periodic features of bone resorption, bone apposition and then bone resorption as demonstrated by bone histology. Bone is a metabolically active, dynamic, structural tissue whose development and maintenance is influenced by many factors, including nutrition, sunlight, hormonal secretions, and physical exercise. When biochemical or mechanical stresses occur bone cells respond either producing or resorbing bone. When food becomes scarce or of poor nutritional quality, for example in times of famine or flood, malnutrition and concurrent low calcium intake occur. In low blood calcium conditions, parathyroid hormone is released. This stimulates osteoclasts to break down bone tissue. When nutritional state normalises, bone is laid down again and this cycle recurs. Additionally, during pregnancy there is profound resorption of the maternal skeleton in order that the foetus may thrive. The condition of the observed bone is consistent with such cyclic events.

Introduction

Bone is a dynamic and living tissue that responds to external factors often with long lasting effects. Pregnancy has huge demands on calcium homeostasis and the maternal skeleton. During the histological investigation of femoral condyle bone samples that were part of the Elliot Smith collection in the Manchester International Mummy Tissue Bank at the University of Manchester it was noted that one of the bones exhibited unusual and severe abnormalities. These abnormalities were evidence of cyclic bone resorption and subsequent healing.

Bone

Bone is a calcified connective tissue that supports and protects the body and allows locomotion through connection to muscles. It is also the major reservoir of calcium that is necessary for biochemical homeostasis. Bone is formed as a non-calcified matrix by osteoblast bone cells, followed by mineralisation with the formation of hydroxyapatite. When sufficient bone has been produced the osteoblast either dies or becomes a non active cell at the surface of bone. In order to maintain bone strength and integrity it is necessary to periodically remove and replace old bone. This removal is achieved by osteoclast bone cells that remove bone from the surface. After removal the equivalent amount of bone is replaced by osteoblasts. This cycle is known as bone remodelling. At the junction of the old bone where the osteoclasts have finished and where the osteoblasts have just begun to repair the bone is a line of protein that stains dark blue with toluidine blue. This line is known as a cement line or reversal line. The reversal line remains at the site of cessation of resorption and slowly becomes buried within bone as apposition continues giving evidence of a period of bone turnover. Normal trabecular (spongy) bone is laid down in a lamellar or layered pattern, however, when the bone needs to be laid down very rapidly such as in a fracture, there is insufficient time for this ordered structure to be made and the bone is then laid down in a disorganised way known as "woven" bone. When certain disease states occur the remodelling cycle and cell function is uncoupled often resulting osteomalacia (poorly mineralised bone) or osteoporosis (well mineralised bone but much less of it).

Bone is the main storage tissue of calcium which is needed for the maintenance of calcium homeostasis. During pregnancy there are increased demands for calcium for foetal growth. In the region of 300mg of calcium are needed per day. The pregnant mother is often unable to maintain sufficient oral intake of calcium to maintain this calcium demand. In order that calcium is available the maternal skeleton is partially resorbed by active osteoclasts resulting in much reduced bone volume and pronounced scalloping of the bone surface. Following delivery of the child and during lactation the demand for calcium is increased to approximately 3g per day, this again resulting in severe osteoclast activity. When the child ceases breast feeding

the maternal skeleton attempts to repair with the rapid apposition of bone, often so rapid that the bone is not the normal lamellar type but the more disorganised woven type. This results in a scalloped reversal line with new bone on its surface. If this cycle of pregnancy, lactation and healing phase occur again, the same pattern of resorption and apposition occur in the bone. The maintenance of normal bone requires that the person is receiving adequate nutrition including protein, calcium and essential vitamins. If this is not the case then skeletal tissue either cannot form or repair normally. Any repair such as that following pregnancy will be affected. Giving rise to either osteoporosis or poor quality new bone.

Materials and Methods

The bone examined was a 6mm diameter lateral femoral condyle "biopsy" which was simultaneously rehydrated and fixed in formal saline containing 1% surfactant. Following fixation the core was decalcified in 20% ethylenediaminetetra acetic acid (EDTA) pH 7.1 for 10 days. The EDTA was washed out for 2 days in water and the bone dehydrated in ethanol with six daily changes. Infiltration of the bone was with London Resin Company LR White Hard Grade acrylic resin. This monomeric infiltration was 5 daily changes which was followed by polymerisation at 60°C in an oven. Sections were cut at 10micron in thickness on a microprocessor controlled microtome with a tungsten carbide tipped knife and stained for 2 minutes in 0.005% toluidine blue at pH4.0. Sections were mounted onto a slide with Loctite Glassbond and UV polymerised.

Results

The bone showed excessive periods of bone resorption and apposition as demonstrated by the pronounced reversal lines followed by new woven bone apposition (Fig. 1). Following the last repair cycle there has been an extensive period of bone resorption through the new woven repair bone and into the old original lamellar bone as can be seen by the hollowing out of the surface. There is no repair of this period of bone resorption indicating that the resorptive process ceased before apposition of new

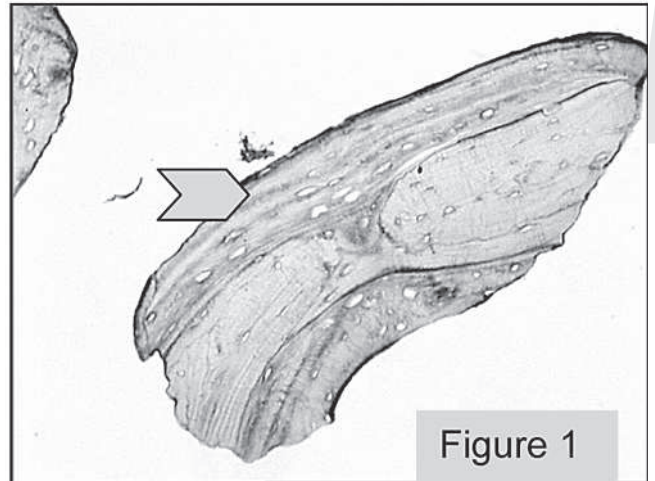


Figure 1

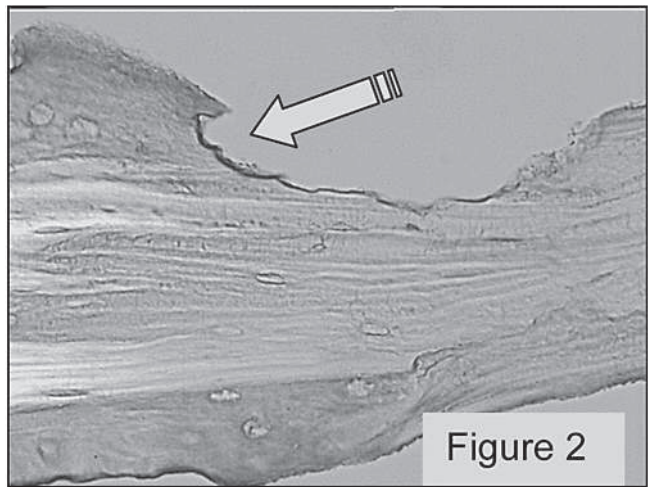


Figure 2

bone. There was marked osteopaenia and trabecular connections much reduced.

Conclusion

The female Nubian bone shows cyclic, severe periods of bone resorption and subsequent rapid repair by woven bone apposition. The cycle has happened at least twice and was ended part way through the last cycle by possibly the death of the woman. Features in bone that are cyclic are seen in bone as a normal maternal response to pregnancy and lactation and more rarely in episodes of poor nutrition.