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Bone Modelling and Remodeling During the Growth and the Attainment of Peak Strength

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DESCRIPTION

Bone modelling is the process by which bone is formed by osteoblasts without prior bone resorption. This process is vigorous during growth and produces changes in bone size and shape. Bone remodeling occurs throughout life. Bone is first resorbed by osteoclasts and then formed in the same location by osteoblasts. These cells form the basic metabolic unit that reconstructs bone in distinct locations on three endocortical, intracortical and trabecular components of its inner or endosteal envelope and to a much lesser extent on the outer or periosteal envelope. Bone modelling and remodeling achieves strength for loading and lightness for mobility in two ways by strategically depositing bone in locations where it is needed to modify bone size and shape and by removing bone from where it is not needed to avoid bulk.

The enormous capacity of this cellular machinery to modify structure during growth is seen in the morphological differences between the playing and non-playing arm of tennis players. Modelling and remodeling modifies bone size, shape and mass distribution if the humerous of the playing arm without changing its mass. However, this ability to adapt structure to its loading circumstances after the completion of longitudinal growth is limited because periosteal apposition decreases and the age related changes in remodeling occur that produce structural decay. Bones becomes strong with more mass and mass takes time to grow and maintain the mobility limit. Bone also must serve a second need lightness to facilitate mobility. Longer tubular bones need more mass to construct their length than shorter bones do, but wider and narrower cross sections do not necessarily differ in the absolute amount of material needed for reformation.

Although it seems obvious that the total cross sectional area of a wider femoral neck or femoral shaft must be assembled with more mass, this is not the case. The total cross sectional area of a tubular bone and its bone mass are independent wider and narrower bone cross sections are assembled using a similar amount of material. Thus, larger cross sections are assembled with less material relative to their size, producing a lower apparent volumetric bone mineral density and so avoiding bulk. Smaller cross sections are assembled with more material relative to their size, producing a higher bone mass density while avoiding the fragility of slenderness. Bulk is avoided in larger cross sections by greater endocortical resorption, which excavates a correspondingly larger marrow cavity so that the endocortical envelope approximates the periosteal envelope wider tubular bones are assembled with a relatively thinner cortex which produces the same cortical bone area because the thinner ribbon of cortex is distributed around a larger perimeter. Thus, the bone size, shape and mass distribution is the result of differing degrees of focal bone formation at each point around the periosteal perimeter and resorption at the corresponding point on the endocortical surface during growth. Bone strength is optimized not by using a greater net amount of mass but by strategically modifying bone size shape and the distribution of mass using the minimum net amount of bone needed.