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Bone remodeling rate and remodeling balance: is it the same?

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Bone modeling and remodeling are responsible for the construction of the skeleton during growth and its maintenance during adulthood. Bone remodeling involves the removal of a quantum of bone from a surface followed by the formation of new bone within the cavity created. Remodeling is carried out at spatially discrete foci by teams of cells that form the basic multicellular unit (BMU). The number of BMUs and the relative amounts of bone resorbed and formed within individual BMUs determine bone turnover. Assessment of remodeling balance and rate is achieved using static and dynamic histomorphometry. Estimation of remodeling balance requires measurement of the volume of bone formed (wall width) and resorbed (erosion depth) within individual BMUs. Measurement of erosion depth at completion of the resorptive phase of a remodeling cycle is problematic, imposing limitations on the accurate assessment of BMU balance. Remodeling rate is often expressed as the activation frequency, which represents the probability that a new remodeling cycle will be initiated at any point on the bone surface. Activation frequency represents the bone formation rate at surface level divided by the wall width. The histomorphometric derivation of activation frequency assumes that the remodeling rate is dependent on the duration of the remodeling cycle and the amount of bone formed in individual remodeling units. This implies that remodeling balance and remodeling rate are coregulated. A recent study [1] tested this assumption in normal human adult cancellous bone. Relationships between indices of bone formation at the basic multicellular unit (BMU) level (wall width and mineral apposition rate) and indices of remodeling rate (mineralizing perimeter and osteoid perimeter) were examined in iliac crest biopsies obtained from 57 healthy adults (24 men) 19 to 80 y of age.

Statistical analysis revealed a negative correlation between wall width and osteoid perimeter, but there was no correlation between wall width and mineralizing perimeter or between mineral apposition rate and either mineralizing or osteoid perimeter. After adjustment for age and sex, the association between wall width and osteoid perimeter was no longer observed. Both wall width and mineral apposition rate correlated negatively with age.

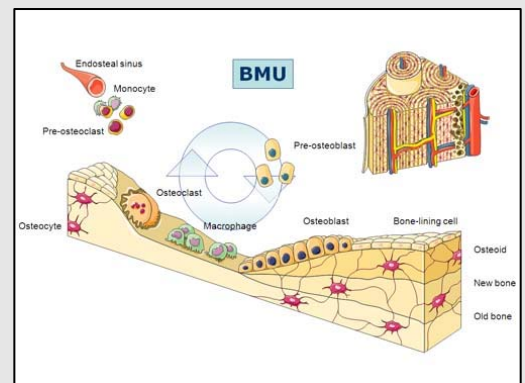
These results indicate that remodeling balance and remodeling rate are not necessarily coregulated in adult human bone. These findings challenge the use of activation frequency, as currently calculated, as an indicator of remodeling rate, and suggest that mineralizing perimeter provides a reliable index.

1. Compston JE et al. *J Bone Miner Res.* 2007;22:1031–1036.

Remodeling balance and remodeling rate

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Remodeling balance (at the BMU level) and remodeling rate are not coregulated in adult human bone. Activation frequency, as currently derived from histomorphometric variables, may not be an optimal indicator of remodeling rate.



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