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Wolff's Law and bone's structural adaptations to mechanical usage: an overview for clinicians

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ABSTRACT

Basic Multicellular Unit-based bone remodeling can lead to the removal or conservation of bone, but cannot add to it. Decreased mechanical usage (MU) and acute disuse result in loss of bone next to marrow; normal and hypervigorous MU result in bone conservation. Bone modeling by resorption and formation drifts can add bone and reshape the trabeculae and cortex to strengthen them but collectively they do not remove bone. Hypervigorous MU turns this modeling on, and its architectural effects then lower typical peak bone strains caused by future loads of the same kind to a threshold range. Decreased and normal MU leave this modeling off.

Where typical peak bone strains stay below a 50 microstrain region (the MESr) the largest disuse effects on remodeling occur. Larger strains depress it and make it conserve existing bone. Strains above a 1500 microstrain region (the MESm) tend to turn lamellar bone modeling drifts on. By adding to, reshaping and strengthening bone, those drifts reduce future strains under the same mechanical loads towards that strain region. Strains above a 3000 microstrain region (the MESp) can turn woven bone drifts on to suppress local lamellar drifts but can strengthen bone faster than lamellar drifts can. Such strains also increase bone microdamage and the remodeling that normally repairs it.

Those values compare to bone's fracture strain of about 25,000 microstrain.

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