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Biomechanical and physicochemical characterization of the rat's osteoporotic bone

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Osteoporosis is a clinical condition characterized by an increased risk of bone fracture. Structural fragility seems to result from a reduction in bone mass due to a decreased mineral content and impaired/altered protein synthesis. Despite the established knowledge on osteoporosis, little is known on how these compositional changes may affect the bone microarchitecture throughout different bones, and how these correlate with the attained increase of the fracture risk.

This work aims to examine the relation between bone material properties and skeletal fragility in the femur, tibia, maxilla, mandible and calvarial structure of an animal model representative of the human osteoporotic condition, i.e., the ovariectomized Wistar rat. Two groups of animals, with 3 and 6 months following the induction of the osteoporotic condition were established, and bone tissue properties were compared to age-matched healthy controls. The biomechanical performance of different bones was tested by three-point bending. Structural (load-bearing capacity and stiffness), geometric (cross-sectional area, cortical sectional area, and moment of inertia) and material (modulus of elasticity and maximum elastic stress) properties were also evaluated, while morphological characterization was performed by FEG-SEM. The organic content was determined by ash measurements and confocal Raman microscopy was used to evaluate compositional differences.

Reported analyses showed that osteoporotic bones presented significant mechanical and morphological differences when compared with those from age-matched controls. Moreover, osteoporotic bones displayed a high ultimate tensile strength and were found to be more brittle than control bones. Attained differences could be related to the reduction in the collagen content, verified in osteoporotic conditions.

These results highlight the role of the collagenous component in the structural and material properties of trabecular bone, and may account for the attained reduced bone mass in osteoporotic conditions.

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