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Abstract:

The relative biomechanical effects of antiresorptive treatment on cortical thickness vs. trabecular bone microarchitecture in the spine are not well understood. To address this, T-10 vertebral bodies were analyzed from skeletally mature female beagle dogs that had been treated with oral saline (n=8 control) or a high dose of oral risedronate (0.5 mg/kg/day, n=9 RIS-suppressed) for 1 year. Two linearly elastic finite element models (36-μm voxel size) were generated for each vertebral body—a whole-vertebra model and a trabecular-compartment model—and subjected to uniform compressive loading. Tissue-level material properties were kept constant to isolate the effects of changes in microstructure alone. Suppression of bone turnover resulted in increased stiffness of the whole vertebra (20.9%, p=0.02) and the trabecular compartment (26.0%, p=0.01), while the computed stiffness of the cortical shell (difference between whole-vertebra and trabecular-compartment stiffnesses, 11.7%, p=0.15) was statistically unaltered. Regression analyses indicated subtle but significant changes in the relative structural roles of the cortical shell and the trabecular compartment. Despite higher average cortical shell thickness in RIS-suppressed vertebrae (23.1%, p=0.002), the maximum load taken by the shell for a given value of shell mass fraction was lower (p=0.005) for the RIS-suppressed group. Taken together, our results suggest that—in this canine model—the overall changes in the compressive stiffness of the vertebral body due to suppression of bone turnover were

attributable more to the changes in the trabecular compartment than in the cortical shell. Such biomechanical studies provide an unique insight into higher-scale effects such as the biomechanical responses of the whole vertebra.

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