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# Strain rate dependency of bovine trabecular bone under impact loading at sideways fall velocity

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## Abstract

There is currently a knowledge gap in scientific literature concerning the strain rate dependent properties of trabecular bone at intermediate strain rates. Meanwhile, strain rates between 10 and 200 /s have been observed in previous dynamic finite element models of the proximal femur loaded at realistic sideways fall speeds. This study aimed to quantify the effect of strain rate ( $\dot{\epsilon}$ ) on modulus of elasticity ( $E$ ), ultimate stress ( $\sigma_u$ ), failure energy ( $U_f$ ), and minimum stress ( $\sigma_m$ ) of trabecular bone in order to improve the biofidelity of material properties used in dynamic simulations of sideways fall loading on the hip. Cylindrical cores of trabecular bone ( $D=8\text{mm}$ ,  $L_{\text{gauge}}=16\text{mm}$ ,  $n=34$ ) from bovine proximal tibias and distal femurs were scanned in  $\mu\text{CT}$  ( $10\mu\text{m}$ ), quantifying apparent density ( $\rho_{\text{app}}$ ) and degree of anisotropy ( $DA$ ), and subsequently impacted within a miniature drop tower. Force of impact was measured using a piezo-electric load cell (400kHz), while displacement during compression was measured from high speed video (50,000 frames/s). Four groups, with similar density distributions, were loaded at different impact velocities (0.84, 1.33, 1.75, and 2.16 m/s) with constant kinetic energy (0.4J)

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