Validation of a non-invasive model for predicting long bone loading

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Abstract:
Functional interpretation of limb bone cross-sectional geometry depends upon knowledge of the magnitude and direction of habitual loading. Quantification of bone loading has only been possible using invasive, in vivo strain measurement and a non-invasive alternative is highly desirable. This study presents a new biomechanical model that predicts bone loading conditions from non-invasive 3D kinematic and ground reaction force data. The model has been validated using simultaneous strain, ground reaction force and kinematic data obtained in vitro from an aluminum limb model, and in vivo from experiments on sheep metatarsals. Preliminary results suggest that the orientation of the neutral axis of bending, and its position on the bone cross section, can be determined from the non-invasive force and kinematic data. These data can be used to predict the orientation and magnitude of bone bending in distal limb segments suggesting that this model will inform studies relating bone cross-sectional geometry to loading conditions and locomotor behaviors.