Finite element modeling of lumbar spine biomechanics under oblique loading conditions

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As aircraft passenger seating continues to evolve, safety guidelines and regulations must be updated or developed to accommodate new seating configurations. One such configuration incorporates seats oriented obliquely with respect to the aircraft centerline. However, current transportation safety guidelines have been developed for forward- or side-facing seats, and the loads experienced when seated obliquely are likely different than those when forward or side facing. There exists a need to understand the different biomechanics associated with oblique loading in order to develop new safety criteria. Finite element modeling has often been used to investigate complex biomechanics of the musculoskeletal system. A hierarchically validated, probabilistic model of the lumbar spine was developed to investigate the effect of oblique loading. The model encompasses the T12-L5 vertebrae and was validated at successively more complex hierarchical levels. The model also incorporates soft tissue variability using probabilistic methods. Controlled loading based on port-mortem human subject experimental testing was utilized with the model placed at varying oblique angles. The load consisted of a bending moment and a tensile component. The model showed that increased obliqueness leads to higher level soft tissue stresses. Probabilistic methods will be used to quantify the relationship between the oblique angle and the probability of risk of injury. The model can further be used to develop injury criteria for obliquely mounted passenger aircraft seats.