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Automated Finite Element Modeling of the Lumbar Spine:

Using a Statistical Shape Model to Generate a Virtual Population of Models

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Abstract

Population-based modeling of the lumbar spine has the potential to be a powerful clinical tool. However, developing a fully parameterized model of the lumbar spine with accurate geometry has remained a challenge. The current study used automated methods for landmark identification to create a statistical shape model of the lumbar spine. The shape model was evaluated using compactness, generalization ability, and specificity. The primary shape modes were analyzed visually, quantitatively, and biomechanically. The biomechanical analysis was performed by using the statistical shape model with an automated method for finite element model generation to create a fully parameterized finite element model of the lumbar spine. Functional finite element models of the mean shape and the extreme shapes (±3 standard deviations) of all 17 shape modes were created demonstrating the robust nature of the methods. This study represents an advancement in finite element modeling of the lumbar spine and will allow population-based modeling in the future.