A statistical shape model of the human second cervical vertebra

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Purpose
Statistical shape and appearance models play an important role in reducing the segmentation processing time
of a vertebra and in improving results for 3D model development. Here, we describe the different steps in generating a
statistical shape model (SSM) of the second cervical vertebra (C2) and provide the shape model for general use by the scientific community. The main difficulties in its construction are the morphological complexity of the C2 and its variability in the population.

Methods
The input dataset is composed of manually segmented anonymized patient computerized tomography (CT)
scans. The alignment of the different datasets is done with the procrustes alignment on surface models, and then, the registration is cast as a model-fitting problem using a Gaussian process. A principal component analysis (PCA)-based model
is generated which includes the variability of the C2.

Results
The SSM was generated using 92 CT scans. The resulting SSM was evaluated for specificity, compactness and
generalization ability. The SSM of the C2 is freely available to the scientific community in Slicer (an open source software for image analysis and scientific visualization) with a module created to visualize the SSM using Statismo, a framework for statistical shape modeling.

Conclusion
The SSM of the vertebra allows the shape variability of the C2 to be represented. Moreover, the SSM

will
enable semi-automatic segmentation and 3D model generation of the vertebra, which would greatly benefit surgery
planning.

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