

Shape Correspondence for 3D quantification of mandibular asymmetry: validation and application on a 45 patient cohort

Abeer AlHadidi; Lucia H Cevidanes; Richard Cook; Frederic Fest,; Donald Tyndall; Beatriz Paniagua

Objective: Pretreatment diagnosis of mandibular asymmetry in orthognathic surgery patients can be improved by quantitative shape modeling and analysis. The UNC SPHARM-PDM (University of North Carolina Spherical Harmonics - Point Distribution Model) toolbox was applied to a cohort of 45 patients and the results were evaluated.

Methods: Three-dimensional (3D) virtual-surface models are constructed from CBCT scans of each patient in the cohort by segmentation. Mirroring on a sagittal arbitrary plane is used to flip the left and right sides of each image. An automatic voxel-based registration on the cranial base is used to align the volume and its mirror for comparison. SPHARM-PDM is used to compute correspondent models for each hemimandible and the mirror of the contralateral side. Procrustes analysis was used to evaluate discrepancies between each pair of models to assess asymmetry. Mandibular asymmetry was also located and quantified by computing corresponding surface distances between each hemimandible (left and right sides) and the mirror of the contralateral side.

Results: There were no statistically significant differences in surrogates for mandibular asymmetry assessment based on right or the left side mirroring. Those surrogates are the rotational and translational differences between each hemimandible and the mirror of the contralateral side in 3 planes of space (the absolute values of Procrustes registration output in 6 degrees of freedom). Absolute and signed distance maps between each hemimandible and the mirror of the contralateral side located and quantified areas of asymmetry diagnosis for each patient. Even though mandibular condyle asymmetry was observed in 8% of the cases and mandibular asymmetry along areas of the ramus and mandibular corpus was noted in 17.8% of the cases, the remaining 74.2% showed generalized morphological and positional asymmetry at the condyle, the ramus and mandibular corpus.

Conclusion: Three-dimensional diagnosis of mandibular asymmetry revealed the complex involvement of morphological components of the mandible and the heterogeneous nature of this clinical condition. SPHARM-PDM has a promising role in the individual diagnosis and quantification of mandibular asymmetry.