Computational Bite Force Estimation from a Human Mandible Density Profile

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Introduction Occlusal overload of dental implants produces complications which may result in its failure. While bite force information is essential to properly design and position dental implants, it is not routinely available. According to Julius Wolff bone morphology is a product of its loading history [1], we investigate the possibility of extracting bite force information from a human mandible geometry and its corresponding density map (CBCT images).

Methods We first build a forward model by adopting and expanding on the theory which treats bone as a self optimizing material and remodels till reaching a fixed value of natural strain energy density introduced by Huiskes [2]. The computer model is based on the finite element method (FEM), we assume the bone domain is occupied by a linear elastic continuum where it's mechanical properties are dependent on it's apparent density. Given an initial state, we apply bite forces on a human mandible geometry producing a strain energy signal. We assume the signal diffuses to the surrounding tissue and decays at a constant rate described by the diffusion equation. We assume this process to be fast and therefore to be in a stationary state. Secondly, we use the developed model to generate pairs of bite forces and density profiles, the problem is solved in an inverse setting using a least squares FE approximation.

Results The proposed forward bone remodeling sensory model doesn't suffer from stiffness localization while being suitable for large meshes and 3D applications.

Conclusion Here, we propose an extended forward model for bone remodeling. Undergoing work is focused on identifying bite forces from the generated density. Future work will include validating the model.

References:

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