A variable Finite Element Model of the Overall Human Masticatory System for Evaluation of Stress Distributions during Biting and Bruxism

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ABSTRACT

Simulating the masticatory system during chewing, clenching and bruxism, requires a model that captures the dynamical behavior of its different components: the mandibula and maxilla, the temporomandibular joint (TMJ), the teeth, the periodontal ligaments (PDL), and the muscles. A considerable amount of literature has been published on individual components separately [1, 2, 3]. This contribution incorporates these elements into a single FE model under more realistic conditions. Hereby the simulation is a transient analysis where the dynamic behavior of the jaw is considered and the reaction forces in the teeth and the joints arise from contact instead of nodal forces or constraints. The TMJ has been modeled with geometrical structures and material properties as found in the literature [2], with ensuing additional adjustments. The material properties of the PDL are calibrated to obtain a realistic force-displacement behavior. Geometries for the jaw and teeth were obtained through a segmentation process. Jaw motion is governed by forces from the jaw opening and closing muscles which have been positioned following proposals in the literature and are represented by Hill type muscle models. Activation levels of the muscles where employed based on previous work of the authors [3]. Analyses are executed with the FE program LS-DYNA [4]. The model currently reproduces realistic motions of the jaw during opening and closing. Reaction forces for a variety of biting tasks show good agreement with the literature. The model provides insight into the significance, or lack thereof, of particular structures such as the posterior attachments of the disc and the suprahyoid muscles during various situations. The current and future goals are to determine the stress distributions in the mandible, teeth and PDL during clenching, grinding and chewing with different sized boluses, also when dental implants are incorporated at different positions of the mandible.

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