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INVESTIGATION OF EFFICIENT COMPUTATIONAL TECHNICS FOR FOOD BREAKDOWN MODELING, WITH APPLICATIONS IN MAXILLOFACIAL RECONSTRUCTIVE SURGERY

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Summary: Background: Maxillofacial reconstructive surgery is on the list of the top 5 common reconstructive surgeries in the US, with 202,000 procedures performed in 2016 [1]. The quality of mandibular reconstruction surgery depends on the fulfillment of cosmetic objectives as well as the restoration of mandibular functions: phonation, swallowing, and mastication [2]. However, the unknown state of force distribution on the mandible during mastication [3] leads to suboptimal surgical outcomes, preventing patients to retrieve their natural masticatory performance.
Objective: Computational modeling of food breakdown is an important component missing
from biomechanical simulation of mastication to accurately predict post-operative masticatory efficacy
of a given treatment plan. Such a predictive tool can enhance the performance and success rate of jaw reconstructive surgeries by providing accurate insight on the force distribution on the subject's dentition.
Methods: Modeling food breakdown can be represented using a fracture mechanics model. Typical approaches used for fracture mechanics modeling include: finite-element method, boundary-element method, and smoothed-particle hydrodynamics. In order to represent the most realistic model of food breakdown, we compare different computational methods available for fracture mechanics modeling. Finally, we validate results against experimental data. In our case, we base our experiments on the clinical "almond test" method [4] as a measurement for masticatory performance; the computational methods then are rated based on their accuracy in evaluating the relevant masticatory performance.
Conclusion: By finding the method that best matches all the physical restrictions and computational challenges for modeling mastication, we can make an effective virtual mastication set-up for a patient to enable clinicians to plan surgical procedures to optimize functional outcomes.

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