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SIMULATION OF SURGERY AND RADIOTHERAPY USING FINITE ELEMENT MODELS OF THE TONGUE

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Summary: Introduction: Tongue cancer is notorious for its effect on swallowing and speech after treatment. Therefore, shared decision making and evidence based patient counselling is important when considering treatment options. However, because of the complex structures and systems involved in oral and oropharyngeal functions, it is challenging for a physician to predict the functional consequences of treatment by experience and reasoning alone.
We therefore developed a tool to simulate surgery and radiotherapy on a finite element (FE) model of the tongue. This includes the simulation of closure of the resected volume with suturing, scar formation and post radiotherapy fibrosis.
Methods: Using the 3D modelling platform ArtiSynth (Lloyd J.E. et al. 2012), a tool was created to remove parts of a (segmented) tongue mesh and its muscle fiber locations defined by vector fields. A FE mesh using only cubic hexahedral elements is automatically generated to approach the shape of the edited surface mesh, and facilitates the mesh and muscle deformation during closure of the created defect. In the post-surgery and post-radiotherapy model, elements are stiffened at the location of respectively the defect and the radiated area to simulate scar tissue.
Results: A generic model of the tongue based on the model of Buchaillard S. et al.(2007) was created with our new approach and showed comparable movements upon activation. Tissue removal at the right lateral side of the model showed an impaired motion to the left in accordance with the literature and one of our case studies. Also an impaired downwards motion was visible in both our model and the patient of our case study.
Conclusion & Future Perspective:
A tool was developed to simulate surgery and radiotherapy on a finite element (FE) model of the tongue. Our generic model showed an impaired motion to the left in accordance with the literature and one of our case studies upon tissue removal. A prospective study is started to gather data to create and validate personalized models of patients receiving surgery or radiotherapy.