DESIGNING A NUMERICAL MODEL OF TOOTH FROM CT WITH VOLUMETRIC MESH

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Abstract

The content of this paper highlights step by step procedure of building numerical model of intact and endodontic treated tooth. A model of this kind can help in performing analysis for accurate calculation of the load on the teeth (one, more or all teeth), prediction of the outcome of the implant and/or implant-prosthetic dental treatment. The proposed procedure can be applied for designing a numerical model of whole jaw which can be used to find answers of whether the complex dental construction will withstand the chewing forces and hence can help by proposing a precise solution if the predicted outcome is unfavorable.

Introduction

Today's dental praxis is strongly based on assumptions and experience; hence it often leads to unwanted complications and failure in the therapy. Complex dental treatments, such as crowns, bridges, prostheses, implant constructions, can cost a lot of time, money and effort to be created. In order to decrease the number of failures, the dentistry is striving for digital solutions capable to plan and predict treatments.

Geometry

One of the most demanding processes in the design of the numerical models is definition of the geometry, especially in cases with nonlinear and nonregular shapes. Since we are analyzing dental problems, one of the easiest ways to digitalized the geometry is with computer tomography. We recommend to use software for visualization, processing, segmentation 3D images that can make a 3d finite element model from the spatial image. For purpose of this paper we are using 3D Slicer, a free and open source software.

In addition, by digitalization of the geometry, one can use software for editing the mesh of the finite elements which will help in choice of appropriate density, smoothing the areas, eliminating errors, creating cuts....

We are using MeshMixer for editing the mesh of finite element triangular elements
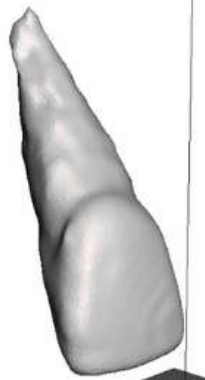
Volumetric mesh

The output of the MeshMixer is an ASCII file which can be used as input file in software for finite element analysis (FEA). It is STL format, so one can easily edit and adjust to the ASCII form required by the FEA software. There are many software solutions for conversion of ASCII files, we are using the one from Center of Artificial Intelligence which converts into Sofistik's ASCII file.

Since the STL format contains information about planar triangular elements, which are forming closed spatial areas, and 3D FEA requires a volumetrically discretized it is necessary to create mesh of volumetric elements from the closed bond surfaces.

Conclusions

We proposed step by step procedure for transforming a geometry which originates from a three dimensional imaging technique (CT, MRI...) to to a computational surface mesh or grid. The tooth model that we are creating for the purpose of this paper is confirmation that this procedure is applicable not only for solid bodies, but for complex bodies with different composites and hence can be used for prediction of complex dental treatments.