International Poster Journal IPJ of Dentistry and Oral Medicine

Int Poster J Dent Oral Med 2009, Vol 11 No 3, Poster 455

Three-dimensioonal modeling in dentistry using computed tomography

Language: English

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Date/Event/Venue:
24-27 October 2007
FDI Annual World Dental Congress
Dubai

Introduction

Three-dimensional (3D) digitizing and computerization of dental restorations and teeth structures is a trend in dentistry. Therefore multi-slice medical computed tomographies can be used. The method is rapid and can readily be used for different dental applications (1). It can generate detailed and valid three dimensional finite element models. In dentistry, three-dimensional reconstructions after computed tomographies are used in traumatology and implantology. Because the teeth and dental restorations are very complex, their reconstructions require both time and skill using computer aided design applications (2). Establishing a modeling method that is both accurate and practical will be of great benefit in clinical dentistry (2, 3). Sophisticated three-dimensional models are required to better understand the biomechanical behavior in the field of dentistry (4).

Objectives

The aim of the study was to achieve three-dimensional reconstructions after computed tomographies, in order to obtain faithful models which can be used for numerical simulations of the teeth and prosthetic restorations.

Material and Methods

Because of the small dimensions and high complexities used in dentistry, it was necessary to obtain enlarged radioopaque models. Axial slices of 1 mm were made (Fig. 1, 2). Resulted images of teeth and clasps were inverted (Fig. 3, 4), transformed into curves and these in point clouds. The points were used to get a network and than for surfaces and solids, necessary for numerical simulations.

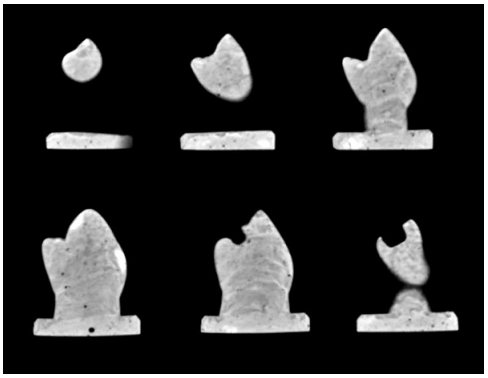
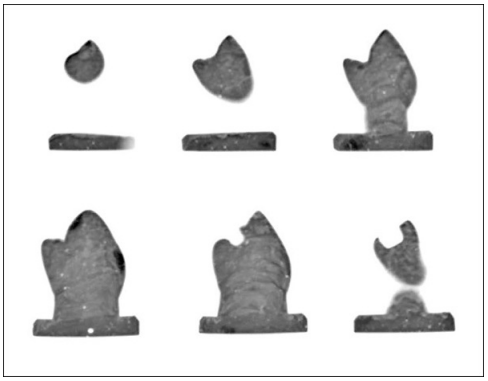


Fig. 1: CT slices of the prepared tooth

Fig. 2: CT slices of the dental clasp



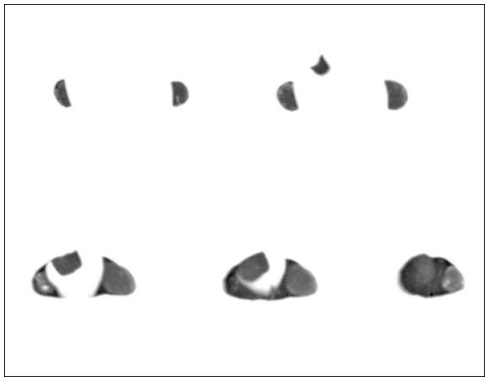


Fig. 3: Inverted CT slices of the prepared tooth

Fig. 4: Inverted CT slices of the dental clasp

Resulted files were imported in LeiosMesh program, where the point clouds from the teeth surfaces were cleaned and assembled. The collected data were used to construct three dimensional models. These points were used to extrapolate the shape of the subject, a process called reconstruction. Because of the complex teeth geometry, a nonparametric program was chose for modeling (Rhinoceros NURBS). Surfaces (Fig. 5, 6) and solids were generated.

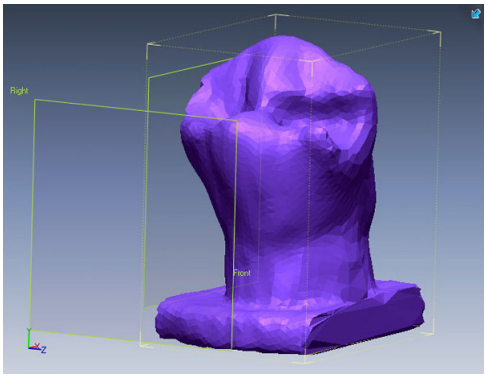


Fig. 5: Meshing the tooth surface

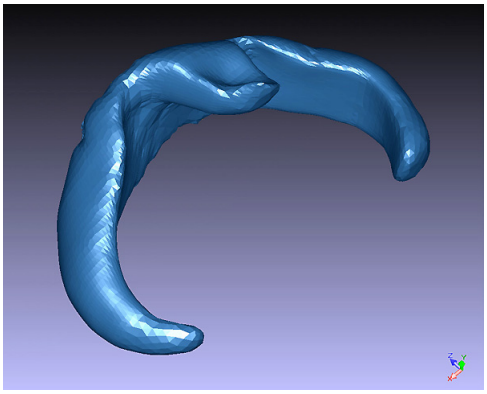


Fig. 6: Meshing the clasp surface

Results

The faithfulness of the solids depends on the structural complexity, the aggrandizement degree and the images processing procedures.
Modeled resulted solids (Fig. 7, 8) have a properly designed morphology and can be used for a wide variety of applications.
The exactness of the models depends on the working procedures, from CT data using to volume generation, and is higher than those obtained using other modeling methods.

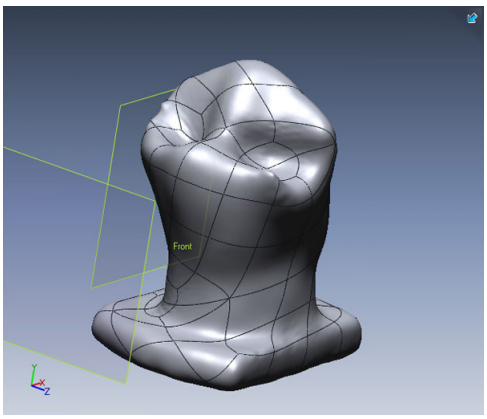


Fig. 7: Resulted solid of the tooth

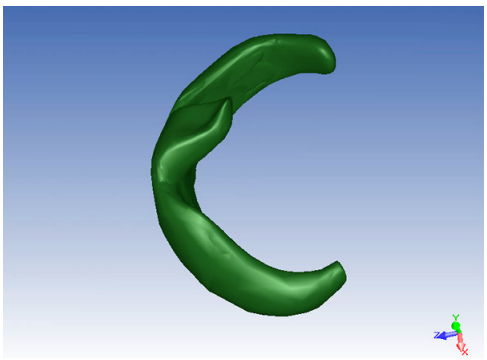


Fig. 8. Resulted solid of the clasp

Conclusions

Three-dimensional reconstructions of complex prosthetic restorations are difficult to obtain using computed tompographies. The method can generate detailed 3D models that can be used to develop applications for didactic and basic research use.

Literature

1. Sohmura, T., Wakabayashi K., Lowmunkong R., Hojo H., Kusumoto N., Okuda H., Kojima T., Nakamura T., Yatani H., Takahashi J.: 3D shape measurement of dental casts using medical X-ray CT, Dent Mater J, 2004, 23(2): 121-8.
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4. Romeed S.A., Fok S.L., Wilson N.H.: A comparison of 2D and 3D finite element analysis of a restored tooth, J Oral Rehabil, 2006, 33(3): 209-15.

This Poster was submitted by Assoc. Prof. Dr. Liliana Sandu.

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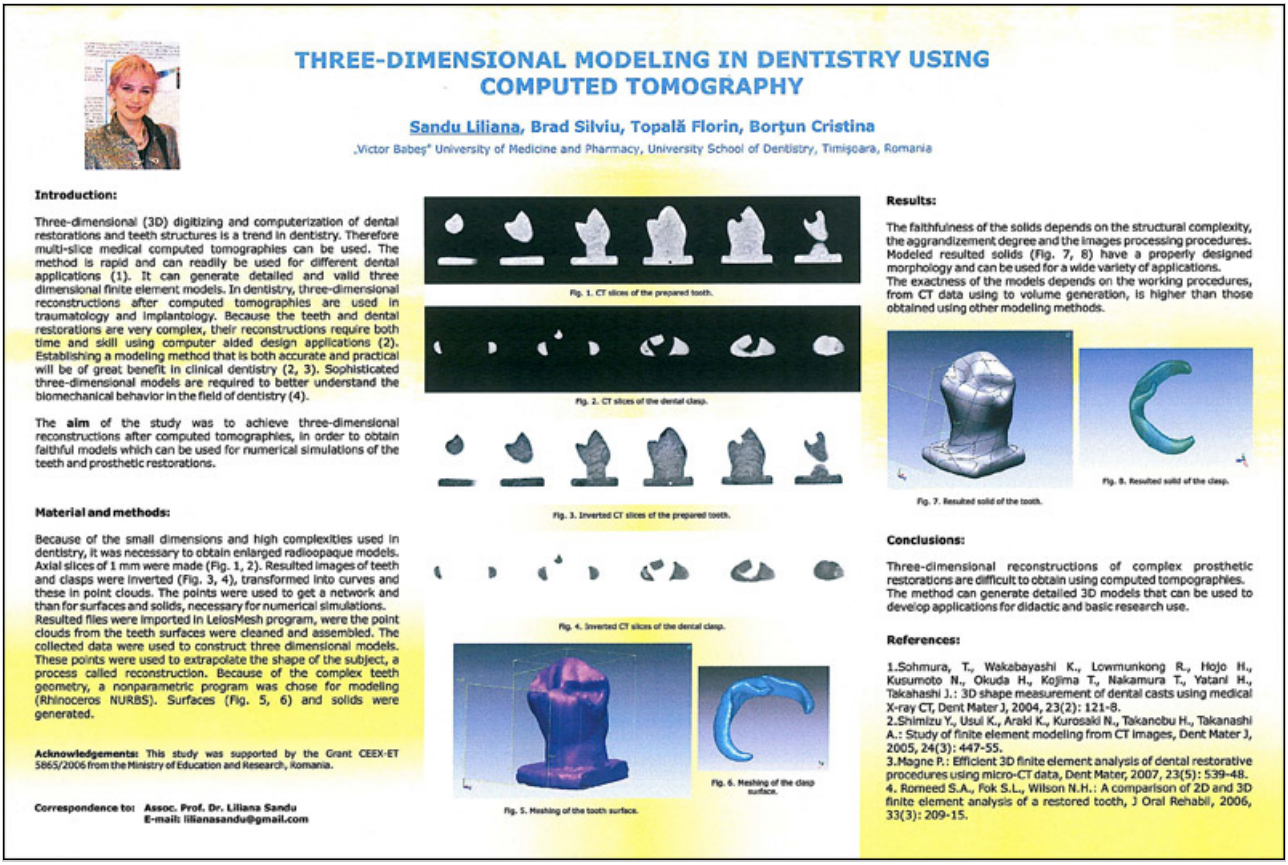
Poster Faksimile:



THREE-DIMENSIONAL MODELING IN DENTISTRY USING COMPUTED TOMOGRAPHY

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Introduction:

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Acknowledgements: This study was supported by the Grant CEEX-ET 5865/2006 from the Ministry of Education and Research, Romania.

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Fig. 5. Meshing of the tooth surface.

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Fig. 7. Resulted solid of the tooth.

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