Thermal and Mechanical Analyses of Dental Composites for Class II Cavity Restoration in a Molar Tooth: A Finite Element Study

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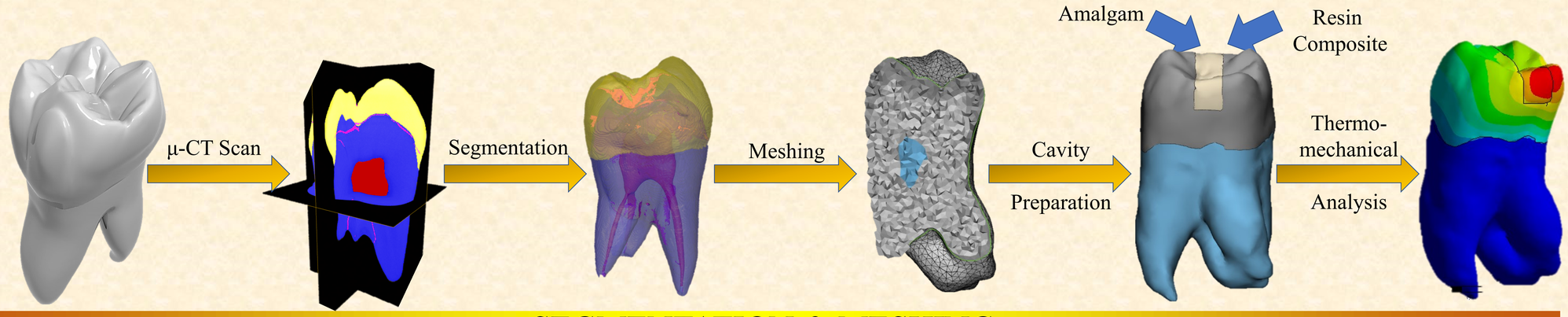
BACKGROUND & INTRODUCTION

- Flowable composites is becoming the material of choice for mercury based amalgam replacement in tooth restoration.
- Resin based dental composites is gaining acceptability due to it's superior mechanical properties with aesthetics, and minimal invasiveness.
- The effect of thermal and mechanical stimuli on resin dental composites is an area of active research.
- The thermo-mechanical properties of a dental whole tooth, a tooth with a cavity and restored tooth cavity with amalgam and dental resin composites are studied.
- The strain and stress distributions in the tooth and tooth restoration, due to thermal and mechanical loading, were studied to optimise the Class II dental cavity restoration.

METHODOLOGY



μ-CT scanning of human molar tooth

Definition of image gradient to create a mask

Implementation of manual masking technique

Creation of pulp cavity

Assembly of multiple 3D bodies through ‘Non-manifold assembly’

Surface (2D) mesh refinement and adaptive meshing

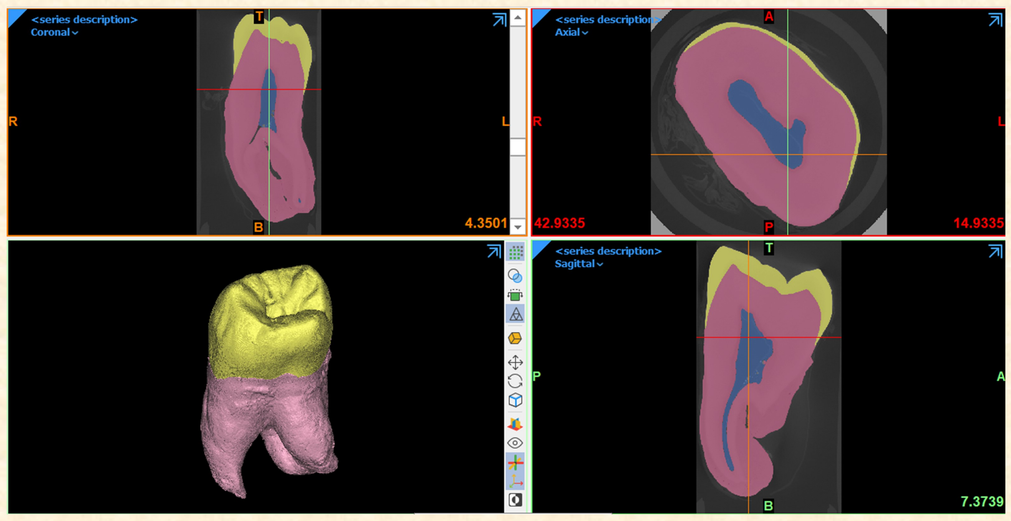
Creation of 3D mesh for whole body

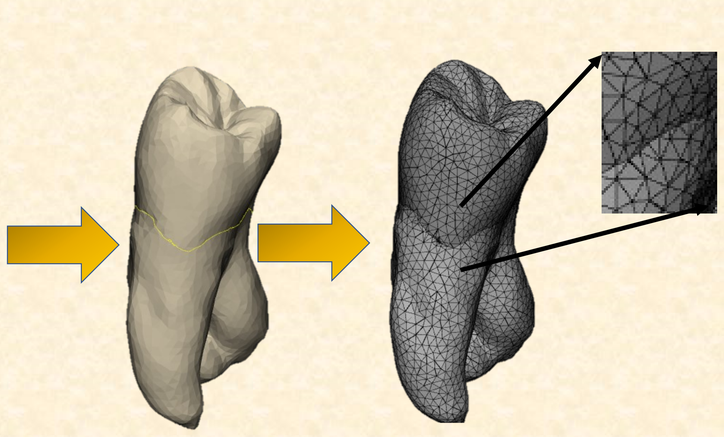
Manual fixing of meshing inaccuracies

Generation of final meshed body for analysis

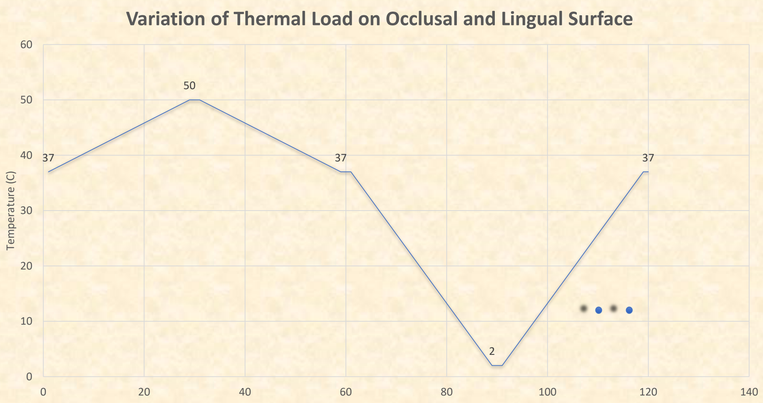
Transient Thermal and Structural analysis

SEGMENTATION & MESHING





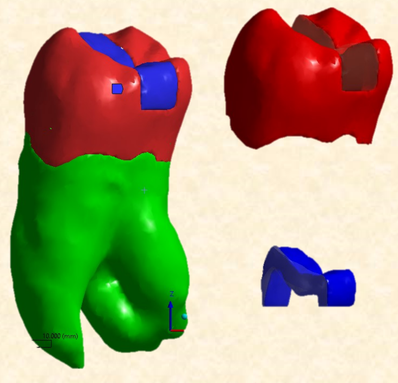
NUMERICAL SIMULATION



Thermal Load: Occlusal and Lingual Surface Temperature and Convection Loading

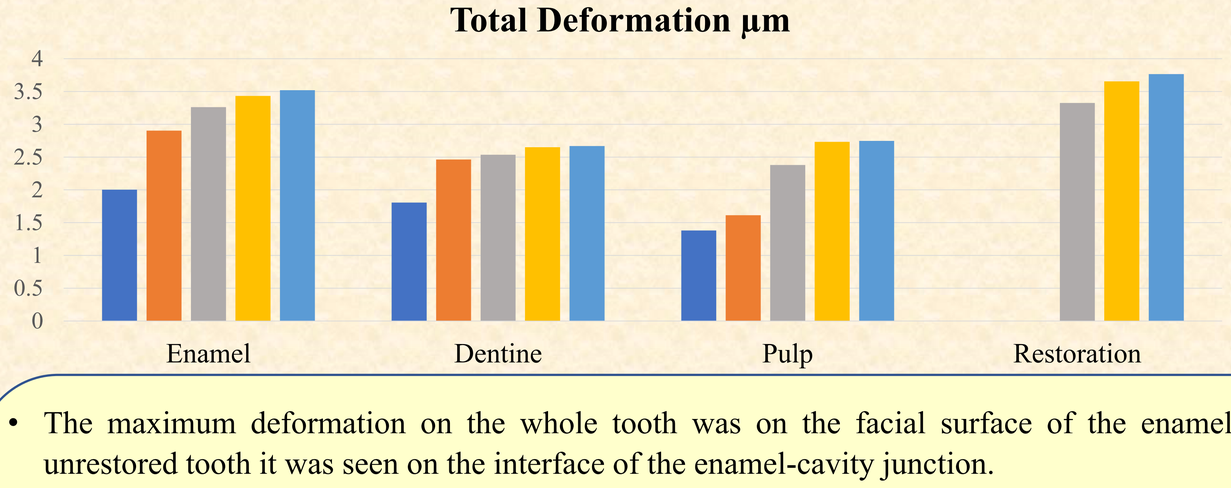
Static Load: Occlusal Surface (400N)

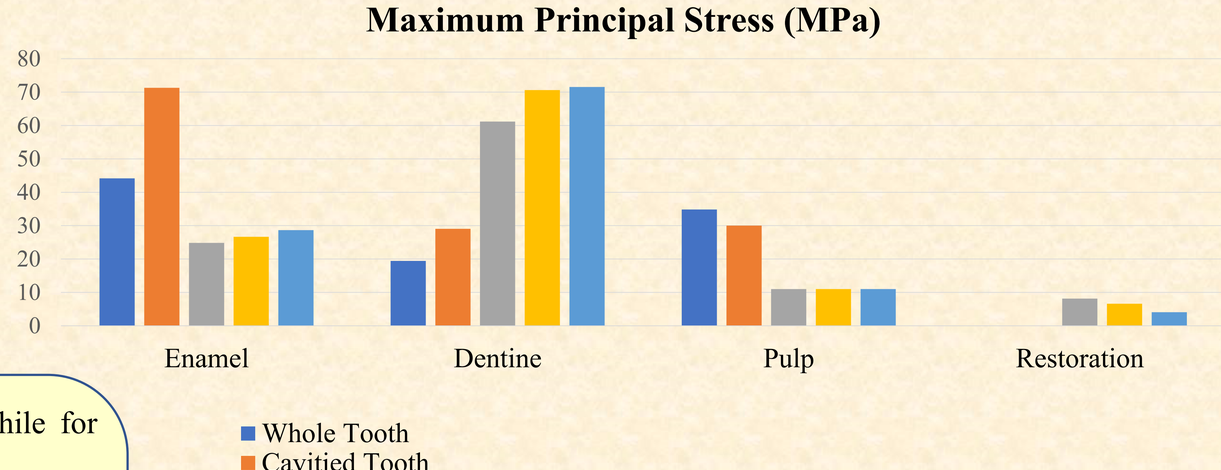
Fixed Support: Dentine



Fully Bonded Contacts

RESULTS & DISCUSSION





- The maximum deformation on the whole tooth was on the facial surface of the enamel, while for unrestored tooth it was seen on the interface of the enamel-cavity junction.
- High stress is observed on the occlusal-surface of the cavity-enamel junction which can lead to possible failure of restoration at the junction due to fatigue.
- Stresses induced on the enamel by dental amalgam and commercial particulate composites (Filtek Z250 and Adaptic II) decreases by 40%, 36% and 31% respectively.
- The stresses transfers onto the dentine for dental amalgam, Filtek Z250 and Adaptic II increasing it by 265%, 321% and 327% % respectively.
- The finite element simulations shows that restorative filling materials with higher Young’s modulus and coefficient of thermal expansion results in higher stress levels.

ACKNOWLEDGEMENT

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