Finite Element Approach on Human Teeth- A Case Study on Molar and Premolar Teeth

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I] Abstract

This paper focused on fatigue problem in human teeth and restored teeth. This problem can be solved by computational modeling i.e. Finite Element Analysis. There are two types of teeth mainly used for cutting and chewing food is molar and premolar teeth. This are mounted at the back of the mouth. Due to the cyclic loading during mastication, they may cause to break. When natural teeth are lost at that time dental implant or restoration are used as replacement of natural tooth. Most of the time there is only dental caries which can remove by filling material.

II] Introduction

The molar teeth are large, flat at the back of the mouth. The human tooth faces different stresses under environment of different loading condition; also the cyclic loading produces major factors in weakness of tooth and bone structure. Although the teeth consist of most resistant and hardest material in the human body, it can still damaged by mechanical, chemical and biological processes. The most common damage is dental caries, which can be removed by dental instrument and vacant place is ready for the application of filling material. This procedure is called tooth restoration. A well executed restoration of tooth helps to prevent the spread of further caries and maintains the basic function of teeth like separating and crushing food.

III] Literature Review

[A] A three dimensional analysis of enamel distribution pattern in permanent first molar [1]

This paper study on enamel cap and thickness of the enamel of human molars are related to function. A distinctive pattern of enamel thickness common to all the individuals examined was found, regardless of variation in absolute enamel thickness among individuals.

The lingual faces of upper molars and buccal faces of lower molars have thicker enamel than the other faces. In lower molar, hypoconid significantly thicker than protoconid. Distinctly thin enamel at and near the tip of messiobuccal cusps in both lower and upper molars. The relative enamel thickness will be different at lingual side and buccal side of molars.

[B] Fracture behavior of human molars [2]

This focused on the longitudinal fracture in molar teeth- channel like cracks that run along the enamel sidewall of the tooth between the gum line and occlusal surface.

The loading conditions that govern fracture behavior in enamel are reported and observations made of the evaluation of the fracture as the load is increased. The relatively low loads required to cause both radial median and margin crack growth under compression suggest that such cracks may occur under normal conditions of mastication, highlighting the vulnerability of teeth to the formation of longitudinal cracks. Damage may occur relatively low loads as small as 100-200N. The presence of this cracks reduce the load carrying capacity of tooth and increase load

transfer from the enamel to the internal components, potentially resulting in physical pain. The presence of longitudinal cracks in a tooth, the structure remains relatively intact until the load reaches 600-1000N. Complete destruction of tooth results from the interaction between multiple cracks to cause spelling of sections of the enamel.

[C] Stress strain analysis of restored first molar tooth with cavity of class-II [3]

The presented paper focused on the stress-strain analysis of restored tooth. For this problem finite element method is used. The tooth is modeled from dentine and dental enamel with a class-II cavity. The size of cavity is considered in three shape and three sizes. For this cavity sizes are minimal middle and maximum cavity size. For restoration two types of filling materials were used they are amalgam and composite resin. A physiological model of tooth was created force was applied on the ooclusal surface of the tooth. The analysis of results shows that from the different filling materials and their interaction with dental tissue amalgam is from a mechanical aspect the best material for the restored tooth in the molar segment.

[D] Experimental and numerical stress distribution of molar teeth with different types of fillings. [4]

In this study, both the experimental method as well as the numerical finite element method has been used to analyze the stress within human teeth under forces similar to those that usually occur during chewing process with different types of food in experiment work. Models of natural first lower molar teeth were collected. The teeth were randomly divided into two experimental groups according to treated cavity shape class I and class II. Each class restored with two types of dental filling material Nanohybrid composite and Microhybrid composite and then strain gauge bonded at the buccal surface of tooth used. The stresses level are higher in molar tooth filled with Nanohybrid then it with Microhybrid at class I and class I. In tooth model for both composite filling materials the stress at class I higher than from it at class II.

[E] Fatigue analysis of dental prosthesis by finite element method [5]

The dental prosthesis is typical biomechanical structure because they have the objective to restore the mastication functions are responsible for replacing the original tooth that was damaged. The cyclic nature of loading that components are exposed means that fatigue failures are the type of failure which needs more attention in these kinds of structure.

Therefore this project aims to develop a tridimensional finite element model of dental prosthesis in order to evaluate the fatigue problem. The results from fatigue simulations and analysis demonstrated that abutment screw will have a finite life in most of the analyzed cases and the fixation screw will be an infinite life. In this study, the fatigue conditions were explored and analyzed. Finally, the knowledge about this problem could be improved.

[F] Fatigue life of Dental Implant – A review. [6]

In general fatigue life depends on many factor such as implant itself, physical properties of bone as well as other morphological characteristics that are patient dependent. This review study the fatigue behavior of dental implants made of commercially pure titanium alloy Ti-6Al-4V. The success or failure of an implant is determined by how the stresses at the bone implant interfaces are transferred to the surrounding bones. Maximum stress concentration was presented in the connection of abutment screw implant as well as the first threads of implant where the failure of implant occurs. The prediction of fatigue life of dental implant in finite element stress analysis with computer code of ANSYS was used. Implant design parameter such as pitch diameter and length is important to ensure long term fatigue performance for dental implant. The combination of sharp notches and narrow metal cross section might be harmful for fatigue resistance. The fatigue failure of dental implant depends on factors such as cyclic stress state, geometry, implant material, surface quality, residual stress, direction of loading, Goodman and SWT methods give the most conservative estimates of failure life of dental implant.

[G] Tubule orientation and fatigue strength of human dentin. [7]

In this study the influence of tubule orientation on the strength of human dentin under static and cyclic loads was examined. Rectangular beams were sectioned from the coronal dentine of virgin

extracted molars and then loaded in quasistatic 4 point flexure or 4 point flexural fatigue to failure. The flexure strength, energy to fracture and fatigue strength were evaluated for specimens with the dentin tubules aligned parallel (0^o) and Perpendicular (90^o) to the plane of maximum normal stress. The result from the monotic loading showed that both the flexural strength and energy to fracture of dentin specimen with 0^o were significantly greater than those of 90^o. Furthermore, the apparent endurance strength of dentin with 0^o was significantly greater than that of the dentin with 90^o.

IV] Conclusion

From the study of various papers it is found that the teeth are get damage by the various stresses but in day to day life it may be damage by fatigue during mastication. For that if any damages occur in teeth there will be a solution of filling material to recover. So the study of natural tooth and restorative tooth will be done further.

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