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# Stress Distribution in a Dental Prosthesis Subjected to Bruxism Forces Using Finite Element Method

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## Abstract

Bruxism is a condition in which the patient unconsciously grinds or clenches his teeth during day or nighttime. These oblique forces of bruxism differ from ones that are consciously applied for mastication. In this study, we analyzed the impact of bruxism forces on a dental prosthetics using finite element method. particularly, the mean bruxism forces determined by researches was applied in different angles and compared with occlusal forces. This study shows that the effect of the angle of the bruxism oblique force is far more destructive than its magnitude.

***Keyword:*** *Bruxism; Prosthetics; Implants; Different Angles; Finite Element Method*

## Introduction

Bruxism is the habit of grinding teeth overnight or during the day, which can be due to stress (insomnia, stress and anxiety), dental problems (occlusion problems due to improper clenching of the jaws and teeth), unconscious habits, allergies and intestinal parasites. It is the most common sleeping habit occurring in 20% of adults and 18% of children. Studies have shown that bruxism subconsciously creates forces different from the voluntary chewing force. These forces are applied in different directions, which intensifies their destructive impact. The above effects are more damage when the denture replaces the main tooth. At present, dental prosthesis is the best option to replace natural teeth, so extensive research has been done on the amount of stress on it using computational models, especially the finite element method.

To name a few out of many, Akpinar., *et al*. presented a two-dimensional numerical model to investigate the concentration and distribution of stress on implants under occlusal load [1]. Holmgren., *et al*. also used a two-dimensional model to examine parameters such as implant height and diameter [2]. Nagasao., *et al*. Used a three-dimensional model to analyze the finite element of occlusal horizontal forces in different models of the jaw [3]. Huang., *et al*. by modeling 18 different geometries, investigated the stress and slip distribution in implants [4]. The author of this paper investigated the effect of using different metal and ceramic materials as restorations on stress distribution around dental implants [5]. Despite extensive studies on implants with masticatory forces that are mainly perpendicular to the tooth surface, the angular forces exerted by the tooth have been taken for granted.

## Materials and Methods

The studied dental prosthesis is related to mandibular molar teeth and consists of four parts: porcelain, framework, abutment and implant. The mandibular bone in the mandibular molar region is modeled as a bone block 20 mm high and 9 mm wide and the jaw is considered as a nucleus of trabecular bone (spongy) enclosed in a cortical layer 1.5 mm thick.

In this research, R20 Catia software has been used for modeling and Abaqus 6.11-3 computational software has been used for three-dimensional analysis of finite elements to obtain the stresses created in dentures. The tetrahedral element was used to mesh the system. The total number of elements was 129021. All contact surfaces were in full contact with each other and are connected to each other.

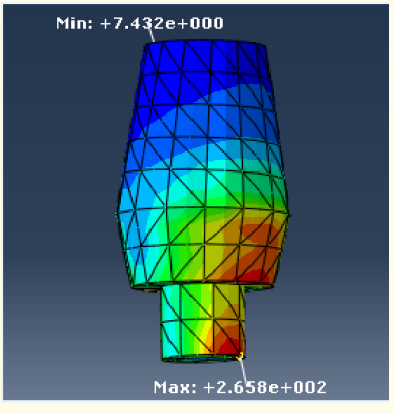
To exert the loads on the model, first the lower part of the bone block was tied and a concentrated force was applied to the buccal direction of the porcelain from different angles. the average bruxism force of 423 N were applied from different angles of 15, 30 and 45 degrees to the line perpendicular to the masticatory surface. Also, for comparison, the effect of applying the average masticatory force (790 N) perpendicular to the masticatory surface of the tooth is analyzed.

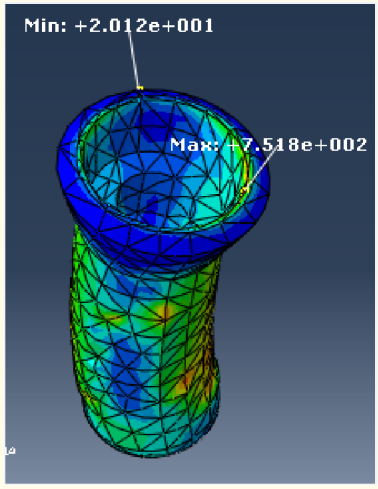
## Results and Conclusion

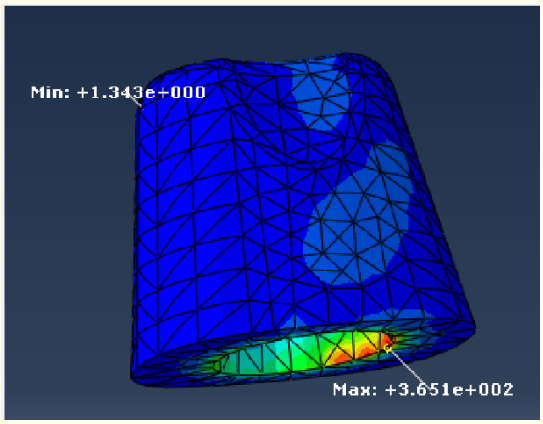
Regardless of the stress concentration on the porcelain, which was due to the application of concentrated force to the porcelain, the von Mises stress in the lower porcelain area was about 20 to 30 MPa, which is approximately 7% of the yield stress. In the framework, a maximum stress of 360 MPa was created in the lower part in contact surface with the abutment, which is 46% of its yield limit (cobalt chromium alloy). The maximum stress value in the abutment was 260 MPa, which is 32% of the yield strength of titanium metal, and as expected, it occurs in the lower part of the abutment in the part where we have cross-sectional changes. To improve this situation, cross-sectional changes can be considered with a gentle slope in the design to prevent implant break.

The results also showed that by increasing the angle, the applied stress on all prosthetic parts increases indicating that the horizontal force is far more destructive than the vertical force. Within the range of 30 to 45 degrees, the implant reached its yield point and other parts also suffered from high stress. It is noteworthy that, despite the fact that the masticatory force is considered to be about twice the force of bruxism, none of the parts has reached the yield point and the stress in the most critical part, namely the implant, was only 70% of the yield stress. This phenomenon indicates that the effect of the load angle on the prosthetic components is greater than the amount of force applied.

In this study, the effect of force from bruxism on a set of mandibular molar dentures was studied using the finite element method. Based on previous studies, the force from bruxism was applied to the masticatory surface of the prosthesis at different angles in the buccal direction. The results showed that with increasing the angle of application of the load, the amount of stress in all parts of the prosthesis increases. The most critical situation is within the implant, leading to failure at an angle of 30 to 45 degrees.



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