

Abstract

Background:

In the last decade, dental implants have been successfully used to support fixed partial dentures. In spite of the proven clinical success of metal-ceramic restorations, there has been an increase in the use of metal-free ceramic systems because of their superior esthetics, chemical durability and biocompatibility. The use of fiber composite technology for FPDs is a lowcost alternative to metal-alloy, metal-ceramic, or all-ceramic restorations. The transfer of functional loads and stress distribution on a dental implant overdenture depends on the physical properties and geometric design model of each component.

Aim:

The aim of this study was to compare the stress distribution on adhesive fixed dental prosthesis made up of conventional metal or fiber reinforced composite frameworks and two different veneering materials (porcelain and particulate composite).

Methods:

A 3- dimensional finite element analysis was conducted to evaluate the stress distribution in bone, implant-abutment complex and prosthetic structures. Mandibula premolar-molar region of bone, a standard dental implant and abutment complex was modelled in this study. Overdentures were made up of conventional metal or fiber reinforced composite frameworks and two different veneering materials (porcelain and particulate composite). Axial and lateral loads were considered and the stress distribution was evaluated.

Results:

According to the results of this study we observed that implant supported fiber reinforced composite frameworks could eliminate the excessive stresses in the bone-implant interface and maintain normal physiological loading of the surrounding bone, therefore minimizing the risk of peri-implant bone loss due to stressshielding. Fiber reinforced composite frameworks provide a better stress distribution than metal ones.

Conclusions and clinical implications:

In our study according to the comparison of the models it was found that all investigated stress values in the metal framework model were higher than the values in the fiber reinforced framework model except for the stress values in the implant-abutment complex.

In the first model (M1) cobalte chromium (Bego, Bremen, Germany) was used for the framework and feldspathic porcelain was used for the veneer material. The thickness of the metal framework was 0.5 mm, and the veneering material varied 0.8- 1.5 mm in thickness from the cervical to the occlusal surface. The cement thickness was ignored.

In the second model (M2), an anisotropic, continuous, unidirectional fiber was selected to construct the framework of the FPD. A combination fiber and hybrid composite coping was made to fit over the metal abutment. The veneer was made of an isotropic veneering hybrid composite. The thickness of the coping used in this study was 0.5 mm, and the thickness of the luting composite was ignored. The hybrid composite veneering material varied 0.8-1.5 mm in thickness from the cervical to the occlusal area and was placed over the framework to cover the entire contour of the crown.

All materials used in the models were considered to be isotropic, homogeneous and linearly elastic.

Materials	Elastic Modulus (MPa)	Poisson Ratio	Density (kg/m ³)
Cr-Co Metal Framework	230,000	0.3	0.085
Porcelain	65,000	0.3	0.024
FRC Framework	965	0.3	0.0025
Composite	9,000	0.3	0.002

Table 1: Material properties.

In the present study, a total vertical force of 300 N was distributed over the entire occlusal surface of the superstructure. To simulate an oblique loading condition, a total static load of 100 N was applied horizontally from the vertical. Maximum von Mises stresses in the system were calculated and evaluated.

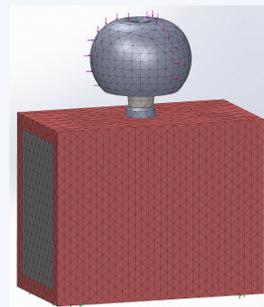


Figure 1: The main mesh form of the system

Background and Aim

Superstructures on dental implants commonly consist of a metal-framework veneered with ceramic facing. In spite of the proven clinical success of metal-ceramic restorations, there has been an increase in the use of metal-free ceramic systems because of their superior esthetics, chemical durability and biocompatibility. A novel alternative to metal-ceramic and full ceramic restorations in implant-supported FPDs is fiber reinforced composite (FRC) designs. FRC materials, which had been successfully used in a variety of commercial applications, have been more widely used in dentistry. The use of fiber composite technology for FPDs is a lowcost alternative to metal-alloy, metal-ceramic, or all-ceramic restorations. Moreover, FRC has been suggested to absorb energy from the masticatory cycle due to the lower flexural modulus of the material. Composite veneer materials have distinct advantages over porcelain veneers; the former are less brittle, do not wear the opposing dentition, and chemically bond to the FRC framework. Recently FRC was found to have better stress distribution than other materials, such as glass ceramic, gold, alumina and zirconia. The clinical success of osseointegrated implants is largely influenced by the manner in which mechanical stresses are transferred from the implant to the surrounding bone. The selection of prosthesis designs and materials is critical for the longevity and stability of implant prostheses. The aim of the present study was to evaluate and compare the effects of the framework and veneering materials on stress distribution of implant retained FPDs in the bone around the implants as well as in the fixture-abutment complex, in the framework and in the veneering part of the prostheses.

Methods and Materials

To evaluate the stress distribution in and around the bone, the model of the implant-abutment complex and 1 unit crown supported by an implant was designed by the software SOLIDWORKS (Yenasoft,Ataşehir,Istanbul) and postprocessing of the system with the same program. A main 3-D model of a box shaped mandibula premolar region was designed for testing and analysis. The model consisted of 2 mm cortical bone with cancellous bone inside.

Two different models were designed as follows. Model 1 (M1) consisted of an implant supporting a conventionally formed of a metal framework and porcelain veneer. Model 2 (M2) consisted of an implant supporting a crown composed of an FRC framework and particulate composite veneer. In the present study, a model of a 10 mm long and 4.1 mm diameter Dental Implant KA and abutment H2 were selected.

Results

In this study parallel to the literature it was found that higher stress values arises with the conventionally formed metal framework and porcelain veneering.

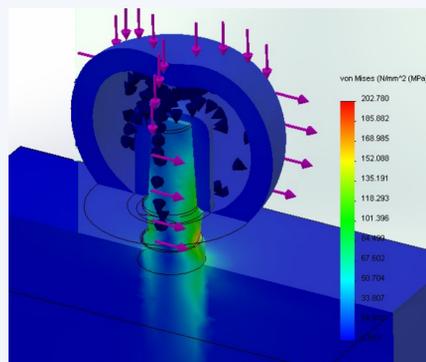


Figure 2: M1: Metal framework and porcelain veneering

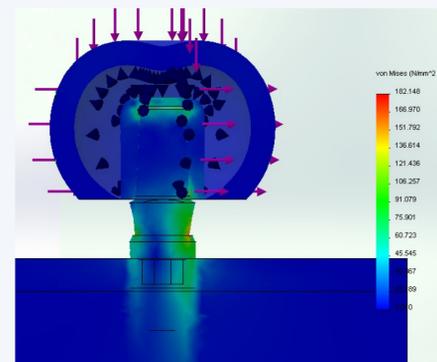


Figure 2: FRC framework and composite veneering

Maximum von misses stresses focused on the abutment surface where the horizontal forces applied. Also frameworks as seen in the figure 2 and 3 are the important areas where stresses major on.

Conclusions

In contrast with the metal framework, FRC framework had a better stress distribution which allows lesser stress values to the whole implant- crown system. With the results of this study we can figure out that fiber reinforced composite frameworks provide a better stress distribution than metal ones. As we know the selection of prosthesis designs and materials is critical for the longevity and stability of implant prostheses. So these results may have a high importance especially for the cases with prosthesis which faces non physiological loads like in bruxists.

References

1. Erkan Erkmen et. Al., Biomechanical comparison of implant retained fixed partial dentures with fiber reinforced composite versus conventional metal frameworks: A 3D FEA study Journal of the mechanical behaviour of biomedical materials 4, 2011, 107-116.
2. Martin A. Freilich, Ajit C. Karmaker, Charles J. Burstone, A. Jon Goldberg, Development and clinical applications of a light-polymerized fiber-reinforced composite, J Prosthet Dent 1998;80:311-8.