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Original article

Surface Treatment of Zirconia Implant, Its Surface Roughness and Its Effect on Osseointegration - A Review

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Abstract

Zirconia implant treatment is currently overriding other prosthetic solutions in replacing anterior teeth in esthetic zone. Surface topography of biomaterial has major impact on osseointegration. Various chemical and physical modifications have been developed to improve osseointegration. This review focuses on different surface treatment of zirconia implant. Surface roughness and its effect on osseointegration.

Keywords: ***Dental Implant, zirconia, Surface treatment, Osseointegration, Surface topography.***

Introduction

Implant treatment is currently overriding other prosthetic solutions especially in case of replacing anterior teeth in esthetic zone. The tremendous increase in patients demands and expectations from dental treatment is progressively, growing which has made clinicians interested in the osseointegration and survival of implant.[1,2] The main reasons for the clinical use of zirconia implants are their biocompatiblity, good chemical and dimensional stability, high flexural strength (900 to 1200 MPa), adequate hardness (1200 Vickers) and Weibull modulus (10 to 12), tooth-like color, low thermal conductivity, machinability, comparable osseointegration to titanium implants, reduced plaque affinity and low corrosion potential.[3-8] As the surface topography of a biomaterial has a major impact on osseointegration, various chemical and physical surface modifications have been developed to improve osseous healing of implants. Increased surface roughness of dental implants resulted in greater bone apposition 4 and reduced healing time 5. Surface modification of zirconia can be achieved by altering the topography and altering the surface chemistry. Different approaches are being used in an effort to improve surface properties of zirconia. For this reason, research has focused on improving the surface bioactivity of zirconia-based materials in order to enhance the bone-to-implant contact, as well as the speed of bone formation, to reach optimal standards. Selective infiltration etching, Low pressure particle abrasion, Fusion sputtering, Laser irradiation, Air bone particle abrasion, Acid etching with hydrochloric and hydrofluoric acid, Plasma spraying, Aggregation of bioactive materials such as hydroxyapatite, Ultraviolet radiation for photo functionalization, Nanotechnology modified zirconia.[10-19]

The aim of this review is to investigate the effect of different surface treatment on the osteoblastic activity of zirconia.

Discussion

Zirconia poses a challenge for surface modifications by surface treatments. Various novels surface treatments have been advocated to improve osseiointegration of zirconia implants. It is well known that the surface characteristics of implants and their alterations play an important role in the establishment of osseointegration.[4-7] Surface roughening procedures that are used for titanium may influence zirconia surface properties negatively.[3-6] In 2009 Hisbergus et al[20] demonstrated that acid etching of zirconia do not provide surface roughness. In a study done by Gahlert et al,[4] 2007 reported that osseintegration capacity of machined zirconia surface can be substantially increased after modification by Al_2O_3 sand blasting. However sand blasting may have a negative effect on the microstructure of zirconia leading to - initial transformation of zirconia surface from the tetragonal to the monoclinic phase and thereby reducing the resistance to low thermal degradation Kohal et al,[5] 2008, Andreotelli et al,[8] 2009 in their report suggested that low thermal degradation will weaker the surface stability of zirconia materials thus possibly leading to promotion failure of sand blasted implant. Selective infiltration etching technique [SIE] employs the coating of zirconia with special infiltration glass and heated above its glass transiton temperature. After cooling to room temperature the glass is dissolved in acidic bath, exposing the newly created nano scale intergrain surface porosities. In this surface treatment is selective as it involves only the surface grains and the architecture and distribution of in 2011 Aboushelib et al[21] found SIE effective way of enhancing the osseointegration. The major component for the clinical success of oral implants is the establishment of an immediate contact between the implant and the adjoining bone. Cap is regarded as a bioactive material having a direct bonding capacity to sourrounding bone. Thomas et al 1987,[22] Geesink et al,[23] Kim et al,[24] 2004 have reported that cap implant coatings accelerate early bone formation and osseointegration. Cap nanotechnology implant coatings have shown to accelerate local bone formation by research conducted by Webster et al[25] in 2000 and Yang et al[26] in 2001. In a study done by Jaebow lee 27, 2009 where they evaluated nano technology modified zirconia oral implant in rabbits and reported that cap nanotechnology does not enhance osteo conductivity. Laser modifications have been used to micro structure zirconia surface. A study done by Stubinger 28 in 2008 reported CO2 laser caused undesirable effects on the surface such as Micro cracks pits and melting of the material. Liu et al[27] in 2005 demonstrated that zirconia posess photo catalytic activity when exposed to UV light by removal of hydrophobic layer of hydrocarbons from the surface of the material. Att et al[19] in 2009 observed that, UV light treatment transformed the zirconia surface from hydrophobic to hydrophilic status. It has been particularly challenging to enhance the osteo conductive capacity of zirconia by its surface topographical modification.

Conclusion

There are many challenges concerning osteo conductive capacity of zirconia dental implants. Also surface roughening procedure that are used for titanium may influence zirconia surface properties negatively. Thus to enhance clinical outcomes, there is a need for specific surface modification techniques. The present review provides insight into bioactive zirconia implants.

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