

Bacterial Adhesion on Zirconia, Lithium Desilicated and Gold Crowns-*In Vivo* Study

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Abstract

Zirconia crowns have recently been used as an alternative to the common gold crowns and as a competitive to lithium disilicate crowns as well. Many research works demonstrated that zirconia crowns do not adhere bacteria. In an experiment carried out on 17 participants from Ramadi rural areas, Anbar province, Iraq. Participants underwent professional cleaning and instructed not to brush for 72 hours where swabbed were taken by microbiologist from gold, lithium disilicate and zirconia crown surfaces and cultured in two Petri dishes of blood and sabouraud agars and incubated for 48 hours at 37°C. Kruskal-Wallis test showed that median number of *Streptococcus Sanguineus* colonies on zirconia crowns was significantly lower than the other two medians. *Candida albicans* was only found in one case of gold crowns.

Keywords: Zirconia; Gold; Lithium; Biofilm; Adhesion

Introduction

Gold alloys are traditionally used in dental application for many decades. The main use of this material is to build full crowns. The increased price of gold led to decrease demands on this material [1]. The search for new materials to replace gold leads to the introduction of material at reasonable price. Lithium disilicate (IPS e.max, Ivoclar Vivadent) is a glass-ceramic, which claims to combine high flexural strength along with optimum esthetics [2]. Zirconia (zirconium oxide) was introduced by Martin Heinrich Klaproth in 1789 [3]. This material is believed to be a non-cytotoxic metal oxide, insoluble in water and has no potential of bacterial adhesion. In addition, this material has radio-opacity properties and exhibits low corrosion [4,5]. In the last decade of the 20th century, yttrium oxide partially stabilized tetragonal zirconia polycrystals (Y-TZP) was introduced to dentistry as a core material for all-ceramic restorations and has been made available through the CAD/CAM technique [6]. Since then many attempts had been made to improve mechanical properties of zirconia as well as to enhance its biocompatibility. Recently, different types of zirconium have been mentioned in many scientific articles as suitable choice for dental restorations due to their good mechanical properties, tooth-colored and natural appearance and low plaque accumulation [7-9]. According to the potential extension of using zirconia oxide in dental restoration, it is of interest to continue searching the ability of this material

to resist bacterial adhesion. In this context, the main aim of this research work was to investigate whether or not this material is not adhering bacteria accumulated on crown surface. Adhesion of bacteria to the surfaces of both removable and fixed partial dentures can be considered as an important health issue that many authors reported its potential to cause various diseases and illness. Many researchers have studied this problem as to show the types and intensity of bacterial accumulation on the surfaces or bases of dentures [10-12]. Although many articles emphasized the property of zirconia to not adhere bacteria and or fungi, but this is not absolute. Although the number of bacterial colonies on zirconia crown surface were the lowest, but it indicates the possibility of adhering bacteria. From personal observation and daily communication with bacteriologists, it is important to keep in mind that bacterial adhesion does not necessarily relate to the dental materials only, but it is also a matter that relate to different socio-economic factors such as; standard of living, food habits, educational level, residential area, and the general attitude of people on their general health.

The adhesion of bacteria on any surfaces of teeth will form a biofilms which can be a good environment for many microorganisms such as algae, protozoa, and many fungi. The success of dental restoration therefore will be due to the success of avoiding biofilm formation. There are two main points in this context; the first point is the dental material used in restoration, and the

second point is the patient. With regard to the first point, scientific research has to continue in order to find a certain material that is absolutely or at least most likely not adhere bacteria. This is really a very difficult task but it is necessary to save efforts, time, and money. According to the second point, patients must be informed that bad foods habits, bad commercial tooth paste, and improper tooth cleaning may failure of dental restoration.

Patients and Methods

As to investigate how dental materials are differ in their ability to adhere bacteria and or fungi on their surfaces, three main dental materials were considered. These are; gold alloy, lithium-desilicated, and zirconia-based ceramic. A sample of 17 patients were randomly selected from patients living in rural areas of Ramadi city, Anbar province, Iraq. All of them were visiting private dental clinics during the period April-August 2013. The selection criteria were that; all patients must not suffer from any chronic diseases, did not take any type of drugs for the last month, and fixed partial dentures should not be exceeds one year of use. Prosthesis was in the maxillary arch. All of them were instructed in advance how to participate in this research work. Participants had been told about the main aim of this research work. Everyone was scheduled on two occasions; the first occasion when participant undergo a professional tooth cleaning at the clinic, and the second occasion when professional microbiologist is ready to take biofilm swabs. After finishing professional tooth cleaning, participants were instructed to eat as usual and not to brush their teeth 72 hours before the next visit. At this time bacterial formation can be observed. During the next visit, two procedures were adopted. The first procedure was the visual evaluation food residue on the crown surface which was done by the dentist on a scale of four degrees, 0 (no food residue), 1(slight residue), 2 (moderate residue), 3 (intense residue). The second procedure involved swabs taken by the microbiologist. Two swabs were taken from every participant. One was cultured in a standard Petri dish with blood agar and the other one cultured in Petri dish with sabouraud agar, both were incubated for 48 hours at 37°C. The aim of the first agar was to observe growth of *Streptococcus sanguineus* as it is believed that it is the leading cause of dental plaque, whereas the other agar was to observe growth of *Candida albicans* fungus. Identification of the isolates was very important in order to emphasize whether or not *streptococcus sanguine* is the dominant streptococci species or not. Streptococci species were identified with regard to their characteristics colonial morphology colonies in blood agar Gram-stained smears and catalase test. Colony forming unit (CFU) was used to estimate the number of differentiated bacterial colonies. The software SPSS version 17 was used to analyze the collected data analysis of variance (ANOVA).

Results and discussion

Patients' age ranged between 38-48 years, with mean age of 43.23 years and standard deviation of 2.73 years. The sample in-

involved 10 women (58.82%) and 7 men (41.18%). The one-way analysis of variance showed that there is no significant difference between groups' mean age (Table 1), which is an evidence to discard age effects on the process of bacterial accumulation. It is very clear from personal observation that as age increased people become more careless about their own dental health status as a common behavior in most Arabic countries. Such a behavior will leave a print of its bad impact on many real dental problems like plaque and caries which probably lead to loss natural teeth. Figure 1 shows the visual evaluation of the food residue as observed clinically by the dentist. The figure showed clear accumulation of food residue on gold material in comparison to the other two materials which reflect the ability of this material to adhere such particles. The Kruskal-Wallis' test showed that there is no significant differences ($p>0.05$) when comparing groups median of the evaluation degree for the three materials. Nevertheless, when considering lithium disilicate and zirconia as a one group and comparing them to gold by the use of Mann-Whitney' test a significant difference ($p<0.05$) between median visual evaluation degree was obtained. Lithium disilicate and zirconia crowns are less susceptible to adhere bacteria than gold. This is of course indicated that appearance of zirconia and lithium silicate surfaces are much better than that of gold. It is a good advantage that these materials help wearer to have good teeth looking. Table 2 shows the number of *streptococcus sanguineus* species as determined from cultured swabs. The Kruskal-Wallis test showed that median *streptococcus sanguineus* colonies are significantly different ($p<0.05$) between groups of crown materials. Gold crowns found to adhere the highest number of bacterial colonies followed by lithium disilicate. Zirconia crowns appear to adhere the minimum number of bacterial colonies. It may be possible that with daily tooth brushing zirconia crowns may not be susceptible to adhere any bacteria for short time. However, bio film may be accumulated on zirconia surfaces in longer time than it does on other material surfaces. *Candida albicans* fungi are found only in one case of gold crown participants. This is may be because gold crowns surfaces are not smooth enough like surfaces of the other two materials, and that explained how the roughness of materials can construct an environment for bacteria and fungi.

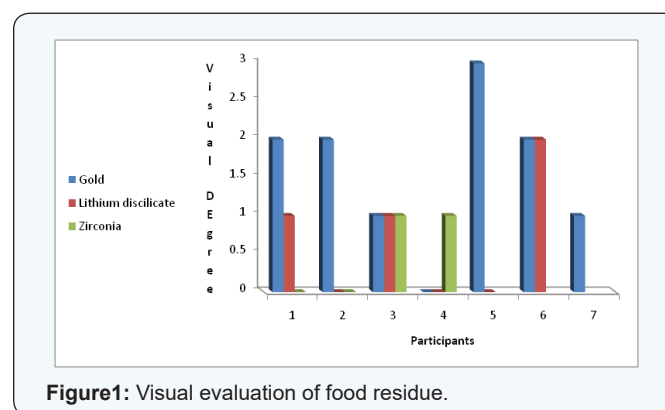


Figure1: Visual evaluation of food residue.

Table 1: Results of the one-way analysis of variance for age means of participants.

Source of Variation	Df	SS	MSS	F-test	p-value
Between groups	2	9.95	4.98	0.64	0.543
Error	14	109.11	7.79		
Total	16	119.06			

Table 2: Number of Streptococcus Sanguineous colonies.

Crowns					
Gold		Lithium disilicate		Zirconia	
Partici-pant	Number	Partici-pant	Number	Partici-pant	Number
1	11	1	9	1	4
2	14	2	2	2	1
3	11	3	7	3	2
4	7	4	1	4	6
5	26	5	4		
6	18	6	14		
7	17				

Conclusion

From the results we can conclude that zirconia crowns adhere less *Streptococcus Sanguineous* colonies compared to lithium disilicate and gold crowns. The participants from rural areas are considered at the lower level of people who are caring about oral hygiene. In this context, any material could be exposed to the risk of biofilm formation which lead by time to number of dental diseases in addition to the potential corrosion of the dental restoration. Zirconia crowns is still not common due to its expensive price in comparison to other materials. Moreover, the slight potentiality of bacterial adhesion may not make it as a competitive material to the other available counter parts materi-

als. Effort and research must be continued to achieve zirconium alloys which provide both, cheap and higher biocompatibility that ensure the lowest potentiality of adhering bacteria.

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