IN VIVO COMPARATIVE STUDY OF BACTERIA AROUND CROWNS MADE FROM DIFFERENT KINDS OF MATERIALS

Dima Jrad[1*]

Abstract

Statement of problem. The oral environment and its bacteria play a major role in the success or failure of dental prosthodontics.

Purpose. This study aims to in vivo compare the bacteria around three types of dental crown materials (metal ceramic – zirconia(monolithic) – E max full ceramic).

Material and Methods. The sample consisted of 60 patients with good general and oral health who have a posterior tooth (premolar or molar) that needs a crown. The sample was divided into three groups; twenty patients each according to the material of the crown (ten patients the tooth was prepared with a supragingival chamfer finish line and the other ten a subgingival chamfer). The first group; zirconia(monolithic), the second metal ceramic, and the third E- max. Bacterial samples were taken for each tooth before preparation, after a week of the crown's application and then after a month. A comparison was made between them.

Results. The results of the study showed a difference in the number of the bacterial colonies between the different materials of the research after a week of the crowns' application and no difference after a month. In addition, there were no difference in the number of bacterial colonies between natural tooth's surface and the crowns' surface after a month of its application.

Conclusions. within the limitation of this study, it can be concluded that there is no difference in the bacterial presence around the crowns of different materials in prosthodontics, and that the adhesion of bacteria to the surfaces of crowns, regardless of the type of material, was not different from the surface of the natural tooth.

[1*]DDS, MMSc, Lecturer, Fixed Prosthodontics Department, Faculty of Dentistry, Manara University, Lattakia, Syria.

***Corresponding authors:** Dima Jrad
*****DDS, MMSc, Lecturer, Fixed Prosthodontics Department, Faculty of Dentistry, Manara University, Lattakia, Syria.

DOI: 10.53555/ecb/2023.12.12.295

CLINICAL IMPLICATION

The research was an attempt to find a substance that causes a small bacterial accumulation and adhesion to be used in order to reduce the incidence of infections of the gums and tissues around the tooth, in addition to the recurrence of caries.

INTODUCTION

The oral cavity is a moist environment that maintains a relatively constant temperature 34- 36° and Ph close to moderate in most locations, despite this it is not considered a uniform environment, as it contains multiple dwellings, each is customized with different chemical and physical factors that support the growth of different groups of microorganisms.[1]

The mouth contains the teeth, where the tooth is described as a hard, unaltered surface, it usually shows several different sites of invasion by the bacterium (Sub gingival and supra gingival), on the other hand, the oral mucosa is characterized by continuous desquamation or alteration of the superficial epithelial cells, which allows rapid removal of adherent germs.[2]

The oral microbiome is very complex and diverse, as it is made up of more than 700 bacterial species, which are coexisting in a balanced state in the natural state.[3]

The dental plaque arises after the surface of the tooth has been cleaned, as a result of the placement of a thin, watery, acellular protein layer, called the acquired pellicle, and its components are derived from saliva and gingival fluid: such as proteins, phosphoproteins, lipids, and bacterial enzyme compounds such as glucosyltransferase. There are also bacteria that Colonize the wall during the first 2-4 hours of cleaning.[4]

These spores grow rapidly, forming tiny colonies that are embedded in an additional cell mass composed of particles from the host and spores. During this process, modification of the environment by the first invading organisms allows colonization by new bacterial populations.[5] Food contributes to increased diversity in the microbial community, and oxygen consumption by aerobic species facilitates colonization by obligate anaerobic microorganisms.[6]

Plaque forms on the surfaces of dental restorations and crowns as well as on the surfaces of teeth, whereas, when placed in the oral cavity, it represents foreign bodies and new sites for bacterial invasion, so the dental plaque forms on its surface as on the surfaces of natural teeth, leading to the formation of secondary caries and infections of the gums and supporting tissues, and thus failure of These treatments.[7]

There are several factors that control bacterial existence and adhesion to the surfaces of natural teeth and the restorations applied to them[7]: general factors related to the general condition of the patient and his general health- local factors such as changing dietary habits- oral care- smoking - alcohol, and factors related to the restored material or the compensation itself (physical and chemical properties).

Physical properties: The surface structure of these materials (the degree of roughness) plays a role, as the irregular surface structure provides favorable sites for the invasion of germs that protect them from tensile forces upon initial bacterial adhesion responses. The surface energy, whether the surface is hydrophilic or hydrophobic, and the method of surface coating are all factors that play a role in plaque formation.[7-8]

Chemical properties: The chemical composition of the materials plays an essential and important role in the adhesion of bacteria and the formation of plaque on their surface. [9]

Dental crowns and plaque formation: When comparing the position of the tissues around the tooth of crowned teeth with healthy, uncrowned ones, it was found that dental crowns may be related to the appearance of signs of inflammation more.[10]

There are several factors related to the dental crown that may have an effect on the condition of the gums and tissues around the tooth, the most important of which are (the type of crown and the material it is made of, its design and manufacture, its application within the mouth, its edges, the finish line, the adhesive cement used to fix

Crown material: Dental crowns may be made of several types of materials such as metal and alloys, resins, porcelain metal, or all-ceramic materials.[11]

It is known that plaque accumulations are less on the surface of porcelain compared to other restoration materials, except when its surfaces are rough, as it collects plaque more, which increases the possibility of caries and the harmful effect on the tissues around the tooth.[12]

Numerous studies have shown that there is a difference between different types of ceramics in terms of their collection of germs and plaque.

Hence the idea of the study, which compared bacterial adhesion to several types of materials used in making fixed prostheses.

RESEARCH METHODS AND MATERIAL

Study type:
An In Vivo Comparative Study.

The research sample:
The research sample consisted of 60 of our patients who had a posterior tooth (premolar or molar) that need a crown. It was divided as in (Table. 1):

Research methods:
Work steps: The work stages were as follows:
Selection of appropriate patients according to the conditions for selecting the sample, conducting a clinical examination, and filling out the diagnostic information form.

Examination of the teeth selected for preparation clinically and radiologically, to ensure that they are suitable for preparation for the types of crowns selected for the research.

Bacterial culture media were prepared in the laboratory, namely: nutrient agar, which is a general nutrient medium used to study the number of bacterial colonies in general.

Bacterial samples (swabs) were taken from the surfaces of the teeth in three stages: before preparing the tooth, a week after applying the crown, and then a month later. It can be divided into two parts:

When the location of the finish line was above the gum: the swab was taken after good isolation, washing with water and drying to remove any remnants of saliva on the surface of the tooth through a sterile cotton swab passed over the gingival third of the vestibular surface, and then this swab was transferred to the laboratory where the germs were grown on a plate It contained nutrient agar medium, and the dish was placed in the incubator for two days, then it was examined for the number of bacterial colonies.
When the location of the finish line was under the gum: the swab was taken after good isolation, washing and drying through sterile paper points inserted into the gingival sulcus of the tooth and left for 60 seconds. Then the paper points were removed and planted on nutrient agar plates, and the number of bacterial colonies was counted.

Preparing the tooth for the research sample using diamond burs (candle flame - conical round head - separation) with a semi-shoulder finish line located either above the gum level or below the gum level, according to the chosen part of the sample.

Tamping the gingival sutures, drying them well, and taking impressions.
Sending prints to the laboratory so that the crown can be designed, according to the type of material chosen as a sample for research.

After obtaining the crown, it is applied in the patient's mouth, and we verify the compliance of the edges – the occlusion – the contact points, their suitability to the gums and the edges of the preparation, and it is left in the patient's mouth without fixing material, but we rely only on mechanical stability.
We ask the patient to maintain eating habits and oral health procedures, and to review after a week.

The patient returns for the first time a week after applying the crown to take the second swab, where washing, drying and good isolation are done with cotton rolls and we take the swab according to the part of the sample (cotton swabs or paper points) and it is taken to the laboratory to be grown on appropriate media in the appropriate time period and then examined to check the number of bacterial colonies and compare.

The patient is asked to review after a month, with an emphasis on maintaining healthy and nutritional habits. The patient is reviewed for the last time after a month, where the third swab is taken from the surface of the crown and taken to the laboratory to be planted on the appropriate media and the number of bacterial colonies is compared. The status of each case is evaluated and the bacterial adhesion to the tooth is compared before preparation, one week and then one month after the application of the crown, in addition to comparing the number of bacterial colonies between the three types of crown materials over the three measurement periods.

Clinical case:
The patient came to the clinic for the purpose of crowning the upper left first molar, and it was decided, according to the research plan, to prepare it with a supragingival chamfer finish line and crown it with a zirconia crown (Fig. 1A, B).

Swabs were taken from the surface of the tooth using cotton swabs, and the culture medium was nutrient agar. The first swab was taken from the

tooth's surface before preparation (Fig. 2). And then after a week and after a month of the crown's application (Fig. 3A, B).

RESULTS AND STATICAL STUDY

To achieve the objectives of the research, the Statistical Package for Social Sciences (SPSS V20) program was used, in order to carry out the analysis at the level of significance (5), and the following tests were applied:

Testing the normal distribution using (Kolmogorov-Smirnov, K-S), in order to see if the distribution of the data is a normal distribution or not, Arithmetic means, standard deviations as well as confidence intervals and t-test for independent samples.

Comparison between the averages of the number of colonies according to the group during the three periods to be measured:

The test for comparison of averages for correlated samples was used to compare the averages, and the following table represents the values of the arithmetic averages and the result of the test (Table. 2).

We note from the previous table that differences appeared between the averages of the number of bacterial colonies when comparing smears (before preparation - after a week) as well as between the averages (after a week - after a month), while no differences appeared between the averages for the comparison between (before preparation - after month) for the three groups, where the level of significance was greater than (0.05).

Comparison between group averages according to each stage separately:

First: Before preparation: In order to compare the means, the ANOVA test was used. We found that the value of the significance level of the Fisher's F test is greater than 0.05, and therefore there are no differences between the averages of the three groups in the pre-preparation measurements.

Second: After a week: In order to compare the averages, the one-way

ANOVA test was used. We found that the value of the significance level of the Fisher F test is less than 0.05, and therefore there are differences between the averages of the three groups in measurements after one week.

Third: After a month: In order to compare the averages, the one-way

ANOVA test was used. We found that the value of the function level of the Fisher's F test is greater than 0.05, and therefore there are no differences between the group averages in the pre-preparation measurements.

DISCUSSION

The results of the study showed that there was no difference in the number of bacterial colonies between the three groups at the stage before preparation, and one month after applying the crowns, while there was a difference a week after applying the crowns. The reason for this is the presence of saliva that covers the surface of the crowns and reduces the effect of the composition of the material with bacterial adhesion, the longer the period of the crowns being in the mouth. Whereas, in the first days of applying crowns within the mouth, saliva proteins are attached to its surface in a small percentage, and germs are able to stick to the surface of the crown.

The results of the study agreed with the study of Martin Rosentritt and colleagues in 2009, which compared the bacterial adhesion of Streptococcus mutans to several types of ceramics (three types of zirconia and three types of vitreous porcelain) that were designed in the form of rectangular models that were smoothed and polished so that the degree of surface roughness and wettability was reduced to the minimum limits. The samples were incubated in artificial saliva for 2 hours at 37˚C, then in suspensions of cocci bacteria. [17]

The results of the study differed from the results of Bremer and colleagues in 2011, who conducted a clinical study to compare plaque formation on five types of ceramic materials (a veneering glass-ceramic- a lithium disilicate glass-ceramic, a yttrium-stabilized zirconia (Y-TZP)- a hot isostatically pressed (HIP) Y-TZP ceramic, and an HIP Y-TZP ceramic with 25% alumina).

This study focused on plaque formation in general and not on bacteria as in the current study. It also used a special dye and confocal microscopy to investigate the results, while we used swabs and bacterial culture. [15]

The results of the study agreed with the study of Jalalian and colleagues in 2015, which compared the level of bacterial adhesion of Streptococcus mutans on the surface of IPS e.max, feldspathic and enamel ceramics.. the bacterial colonies of S. mutans bacteria were counted with the naked eye, and the result was that bacterial adhesion was higher on the surface of the enamel than on the surface of the polished feldspar or IPS e.max Press without a significant difference between them.[16]

The results of the study differed from the study of Hussein and his colleagues in 2016, which clinically compared zirconia crowns, lithium

disilicate ceramics and gold in terms of bacterial adhesion to them. The sample of this study consisted of patients previously treated with dental crowns (a period that may be different between patients) and a comparison was made between the subjects (a different type of material for each patient). While in our study, the period of applying crowns and taking swabs is standardized for all patients, and the comparison was between other types of materials different from the study of Hussein and colleagues.[13]

The results of the study differed from the study of Viitaniemi and colleagues in 2017, which compared in vitro bacterial adhesion of Streptococcus aureus on four types of materials. (Lithium disilicate glass-ceramics, Fully stabilized zirconia, Partially stabilized zirconia, and Dual curing cement. This study was conducted in the laboratory and focused on a specific type of bacteria, unlike our study, which was conducted clinically and compared bacterial adhesion in general between subjects. In our study, it was found that there was a difference between subjects in the first period of plaque formation (after a week), unlike this study.[18]

The results of the study differed from the study of BOLAT and her colleagues in 2019, which clinically compared the formation of plaque on the surfaces of three types of materials used to make dental bridges (BioHpp, a material modified from PEEK by adding 20% of ceramic fillers - zirconia – Porcelain). This study evaluated plaque formation in general and not bacteria as in our study, and its sample was bridges of different materials while in our study it was crowns. The comparison was after the final cementation, after a week, then 6 months, using the system SURE II device that determines the level of ATP, while in our study, the mechanical fixation of the crowns was relied on without the use of cement, and the sampling period was shorter (after a week - after a month) and the comparison was Through swabs and bacterial culture.[14]

CONCLUSIONS

Through the results of this research, and within the limits and conditions of the experiment, the following can be concluded: There is no difference in bacterial adhesion and the number of bacterial colonies between the three types of materials used in the research (porcelain fused to metal - zirconia - full porcelain E-max) after a month of applying crowns in the mouth of patients, although there is a difference in the first period (after a week). And there was no difference between the number of bacterial colonies between the surfaces of the natural teeth before preparation and one week after applying the crowns.

PATIENT CONSENT

the following ten points were really considered throughtout the research:

1. Research participants were not subjected to harm in any ways whatsoever.
2. Respect for the dignity of research participants was prioritised.
3. Full consent was obtained from the participants prior to the study.
4. participants have rights to withdraw from the study at any stage if they wish to do so.
5. The protection of the privacy of research participants was ensured.
6. Adequate level of confidentiality of the research data was ensured.
7. Anonymity of individuals and organisations participating in the research was ensured.
8. Any deception or exaggeration about the aims and objectives of the research was avoided.
9. Any type of communication in relation to the research should was done with honesty and transparency.
10. Any type of misleading information, as well as representation of primary data findings in a biased way was avoided.

REFERENCES

1. Kilian M, Chapple LC, Hannig M, Marsh PD, Meuric V, Pedersen AML, et al. The oral microbiome- an update for oral healthcare professionals. Br Dent J 2016; 221: 657-666.
2. Bruce J, Olsen I, Aas J, Dewhirst F. The breadth of bacterial diversity in the human periodontal pocket and the other oral sites. Periodontology 2000; 42: 80-87.
3. J Li, EJ Helmerholst, Leone CW, Troxler RF, Yaskell T, Haffaajee AD, et al. Identification of early microbial colonizers in human dental biofilm. J Appl Microbiol 2004; 97: 1311-1318.
4. Teughels W, Assche NV, Sliepen I, Quirynen M. Effect of material characteristics and\or surface topography on biofilm development. Clin Oral Implants Res 2006; 2: 68- 81.
5. Wallman C, Krasse B. Mutans streptococci in margins of fillings and crowns. J Dent 1992; 20: 163-166.
6. Perng –Ru Liu, Milton E Essig. A Panorama of Dental CAD\CAM Restorative Systems. Compend Contin Educ Dent 2008; 26: 507-513.
7. Oilo M and Bakken V. Biofilm and Dental Biomaterials. Materials (Basel) 2015; 8: 2887-2900.

8. Song F, Koo H and Ren D. Effects of Material Properties On Bacterial Adhesion and Biofilm Formation. J Dent Res 2015; 94: 1027- 1034.
9. Gharechahi M, Moosavi H and Forghani M. Effect of surface roughness and materials composition on biofilm formation. J Biomater Nanobiotechnol 2012; 3: 541-464.
10. Giollo MD, Valle PM and Rosing CK. A retrospective clinical ,radiographic and microbiological study of periodontal conditions of teeth with and without crowns. Braz Oral Res 2007; 21: 348-354.
11. Shilingburg HT, Sather D, Wilson E, Cain J, Mitchell D L, Blanco LJ, et al. Fundemental of Fixed Prosthodontics. 4th ed. Hanover Park IL: Quintessence Pup; 2012. p. 761.
12. Shenoy A and Shenoy N. Dental ceramics An Update. J Conserv Dent 2010; 13: 195-203.
13. Hussein A, Hajwal S, AB-ghani Z. Bacterial Adhesion on Zirconia, Lithium Desilicated and Gold Crowns-In Vivo Study, ADOH 2016; 1: 1-3.
14. Bolat M, Bosincianu DG, Sandu IG, Bosincianu DN. Comparative Study on The Degree of Bacterial Biofilm Formation of Dental Bridges Made From Three Types of Materials. Mater Plast 2019; 56: 144-147.
15. Bremer F, Grade S, Kohorst Ph, Stiesch M. In vivo biofilm formation on different dental ceramics. Quintessence Int 2012; 42: 565-574.
16. Jalalian E, Mofrad GH, Rahbar M, Mohseni A, Mohebbi M. In Vitro Adhesion of Streptococcus Mutans to Polished IPSe.max and Feldespathic Porcelain, JIDAI 2015; 27: 182-185.
17. Rosentritt M, Behr M, Burgers R, Feilzer A, Hahnel S . In Vitro Adherence of Oral Streptococci to Zirconia Core and Veneering Glass-Ceramics. J Biomed Mater Res B Appl Biomater 2009; 91: 257-263.
18. Viitaneimi L, Abdulmajeed A, Sulaiman T, Soderling E, Narhi T. Adhesion and Early Colonization of S. Mutans on Lithium Disilicate Reinforced Glass-Ceramics, Monolithic Zirconia and Dual Cure Resin Cement. Eur J Prosthodont Restor Dent 2017; 25: 1-7.

TABLES

Table 1. Research's sample.

20 patients	**20 patients**	**20 patients**
The tooth was crowned with zirconia	The tooth was crowned with metal ceramic	The tooth was crowned with E max
10 patients with supragingival finish line 10 patients with subgingival finish line	10 patients with supragingival finish line 10 patients with subgingival finish line	10 patients with supragingival finish line 10 patients with subgingival finish line

Table 2. Shows comparison of colony counts by group over three measurement periods.

			Paired Samples Statistics					
decision	Sig	T value	standard deviation	number	average	measurement period	comparison	group
There's a difference	0.001	4.136	809.64	20	1223.05	Before preparation	Pair 1	First group (zirconia crown)
			201.44	20	497.50	After a week		
No difference	0.635	0.483	809.64	20	1223.05	Before preparation	Pair 2	
			565.30	20	1152.95	After a month		
difference	0.000	-5.153	201.44	20	497.50	After a week	Pair 3	
			565.30	20	1152.95	After a month		
difference	0.000	4.454	759.01	20	1373.50	Before preparation	Pair 1	Second group (porcelain fused to
			213.50	20	702.20	After a week		
no difference		-0.280	759.01	20	1373.50	Before preparation	Pair 2	

	0.783		486.61	20	1422.65	After a month		metal)
difference	0.000	-6.527	213.50	20	702.20	After a week	Pair 3	
			486.61	20	1422.65	After a month		
difference	0.000	4.246	628.51	20	1275.35	Before preparation	Pair 1	Third group full ceramic crown (Emax
			210.80	20	643.80	After a week		
No difference	0.736	-0.343	628.51	20	1275.35	Before preparation	Pair 2	
			745.92	20	1345.65	After a month		
difference	0.000	-4.374	210.80	20	643.80	after a week	Pair 3	
			745.92	20	1345.65	After a month		

FIGURES

Figure 1. clinical case. A, before preparation. B. after crown's application.

A **B**

Figure 2. swab before preparation.

Figure 3. bacterial swabs. A, after a week. B, after a month.