Original Article

In Vitro Adhesion of Streptococcus Mutans to Polished IPS e.max and Feldspathic Porcelain

E. Jalalian [1], GH. Mofrad [2✉], M. Rahbar [3], A. Mohseni [2], M. Mohebbi [4].

[1] Associate Professor, Department of Fix Prosthodontics, Member of Dental Material Research Center, Dental Branch, Azad University, Tehran, Iran
[2] Dentist, MPH, University of Nevada, LV, School of Community Health Sciences, Nevada, USA
[3] Associate Professor, Department of Microbiology, School of Dentistry, Dental Branch, Azad University of Tehran, Iran
[4] Dental Student, School of Dentistry, Dental Branch, Azad University of Tehran, Iran

Abstract

Background and Aim: Finding appropriate dental materials with minimal adhesion and colonization of Streptococcus mutans (S. mutans) and other pathogenic bacteria is of great importance. The aim of this study was to compare the level of adhesion of S. mutans to polished IPS e.max and feldspathic porcelain and dental enamel.

Materials and Methods: This in vitro experimental study was conducted on 15 specimens in three groups (five polished IPS e.max Press blocks, five polished feldspathic porcelain blocks and five dental enamel blocks) exposed to S. mutans bacterial suspension (1×10^6 mg/mL). The specimens were then rinsed twice and 0.1 mL of the new suspension was cultured on blood agar. After 48 hours of storage at 37˚C, S. mutans colonies were counted by naked eye. The results were analyzed using one way ANOVA.

Results: The adhesion of S. mutans was 24.4±8.44 colonies/mm^2 to the enamel, 5.6±2.35 colonies/mm^2 to polished IPS e.max Press, and 5.8±1.92 colonies/mm^2 to feldspathic porcelain. The difference between enamel and the other two groups in terms of adhesion of S. mutans was statistically significant (P<0.001); the two groups of ceramics were not significantly different in this regard (P=0.8).

Conclusion: The adhesion of S. mutans to the enamel was higher than that to polished IPS e.max Press and polished feldspathic porcelain.

Key Words: Streptococcus mutans, Bacterial Adhesion, Dental Porcelain

✉ Corresponding author:
GH. Mofrad, Dentist, MPH, University of Nevada, LV, School of Community Health Sciences, Nevada, USA

mofrad@unlv.nevada.edu

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Introduction

Bacterial adhesion plays a substantial role in tooth decay, calculus formation and gingival inflammation [1-4]. Streptococcus mutans, which is the dominant microorganism in dental plaque of patients with active caries, plays a significant role in the onset of dental caries and gingival inflammation [5-8]. Among the bacteria present in dental plaque, streptococci often show great adhesion to oral surfaces such as oral mucosa and dental structures [9].

Crowns are generally classified into four groups: partial veneers, full metals, metal ceramics, and all-ceramics [10]. Selection of appropriate dental materials minimizing colonization of S. mutans is critical in patients at high risk of caries. Several studies have investigated dental materials employed in acrylic dentures [11] and orthodontic brackets [12]; however, only few studies have addressed bacterial adhesion to porcelain restorations [13,14]. A previous study reported that the best results were obtained by glazing, since it provided a surface topography with minimal bacterial affinity [13]. On the other hand, another study proved that polished surfaces showed better results in terms of lower bacterial adhesion than glazed surfaces [14]. Considering the increasing demand for porcelain restorations and the

application of different surface treatments on these materials, and considering the gap of information on S. mutans adhesion to porcelain restorations, this study was conducted to assess the adhesion of S. mutans to polished IPS e.max Press, polished feldspathic porcelain and enamel.

Materials and Methods

In this in vitro experimental study, disc-shaped specimens of feldspathic porcelain (Ivoclar Vivadent, Schaan, Liechtenstein) and IPS e.max Press (Ivoclar Vivadent, Amherst, NY, USA) were fabricated with 5mm diameter and 2mm thickness as follows: Molds made of phosphate-based investment materials were used for the fabrication of five feldspathic discs with the above-mentioned dimensions. Then, they were finished with 400, 600 and 1200-grit carbide discs (3M ESPE, St. Paul, MN, USA). Five disc-shaped samples were carved out of IPS e.max Press blocks (Ivoclar Vivadent, Amherst, NY, USA). The same technician fabricated all the specimens and their dimensions were measured and standardized by a gage. Enamel specimens were carved out of five intact premolars with no caries, restorations, or stains, which had been extracted in 12 to 18 year-old patients due to orthodontic treatment plans. Five disc-shaped enamel samples were prepared using diamond burs and were not polished. Feldspathic and IPS e.max samples were polished using Ultradent diamond polishing paste (Ultradent, South Jordan, UT, USA) using the Jiffy Ultradent brush for 60 seconds (30 seconds with 1 micron diamond paste and 30 seconds with 0.5 micron diamond paste) [15]. The samples were then rinsed with distilled water and autoclave-sterilized. Then, they were exposed to a standard bacterial suspension of S. mutans (RTCC1683) with a concentration of 1×10^6 mg/mL (0.5 McFarland standard). The procedure for each sample of feldspathic porcelain and IPS e.max was as follows: The specimen was immersed in 350 mL of the bacterial suspension in a test tube. The tubes were incubated along with a control for each group (an enamel disc in 350mL of saline) at 37˚C for one hour. Then, they were all rinsed and immersed in normal saline for 20 seconds; subsequently each sample was shaken for one minute in 1mL of fresh normal saline solution; 0.1mL of the obtained saline solution was cultured in blood agar (streaked across the surface with a swab). All culture plates were then incubated at 37˚C for 48 hours. The colonies were counted by naked eye and the results were analyzed using ANOVA followed by a post hoc test.

Results

Two groups of feldspathic porcelain and IPS e.max samples (n=5) along with enamel samples as controls were prepared in order to assess S. mutans adhesion. All specimens in the test groups were exposed to bacteria and one enamel sample was considered as the control for each of these groups. The mean S. mutans adhesion level to enamel samples was 24.4 ± 8.44 colonies/mm^2, which was significantly higher than that in the two test groups according to ANOVA ($P< 0.001$). The post hoc test results revealed that the difference between the mean S. mutans adhesion to feldspathic porcelain samples (5.8 ± 1.92 colonies/mm^2) and to IPS e.max samples (5.6 ± 2.35 colonies/mm^2) was not significant ($P=0.8$). However, the difference between these two groups and enamel samples was significant ($P< 0.001$). Also, S. mutans adhesion to enamel samples exhibited more homogeneity than to specimens in the two test groups, with similar homogenous adhesion (Table 1).

Discussion

Replacement of extracted teeth and restoration of carious teeth have always been a priority. Today, one way to achieve this goal is via the use of ceramic restorations. As a result of the lack of sufficient data regarding the S. mutans affinity to porcelain restorations, and due to the inconsistency in the results of previous studies, it is a priority to find materials minimizing the adhesion and colonization of S. mutans [2-4]. This study assessed the level of adhesion of S. mutans to polished IPS e.max Press and feldspathic porcelain, and to dental enamel as well. According to the fact that a smoother surface will be achieved by polishing procedures compared to glazing, the samples of the present study were polished after they were fabricated [16]. The present study revealed that bacterial adhesion to the enamel surface was significantly higher that to polished IPS e.max Press and feldspathic porcela

Table 1. Comparison of the adhesion level of S. mutans to polished feldspathic porcelain, polished IPS e.max Press and enamel

Materials used	Mean adhesion level	Coefficient of variation
Polished feldspathic porcelain	5.8±1.92 colonies/mm^2	36.33
Polished IPS e.max Press	5.6±2.35 colonies/mm^2	45.28
Enamel	24.4±8.44 colonies/mm^2	34.59
P value	P<0.001	--

(P< 0.001), while the two groups of polished IPS e.max Press and feldspathic porcelain were not significantly different from each other in terms of bacterial affinity (P= 0.8). The surface topography of the enamel and the polished porcelain surfaces can justify these results as well as the existence of hydrophobic antigens on the cell wall of streptococci that explain the affinity of mutans streptococci to the enamel surface [17]. Accordingly, if other factors affecting bacterial adhesion such as marginal integrity, the emergence profile, gingival contour, and the finishing line are acceptable, healthy periodontal tissues adjacent to polished feldspathic porcelain and IPS e.max Press restorations will be expected. Karayazgan et al, in 2010 reported that the level of adhesion of Candida albicans to the polished surface of feldspathic porcelain was 3.4 ± 0.25 colonies/mm^2 , which was in contrast to the findings of the present study declaring higher affinity of S. mutans to these materials (5.8 ± 1.92 colonies/mm^2) [18]. This can be attributed to the different types of microorganisms assessed, distinct surface treatment procedures, or different measurement methods employed. Four surface treatment techniques were compared in the afore-mentioned study among which polishing and glazing caused the highest affinity of Candida albicans [18]. Kantorski et al, in 2008 used enamel as the control for assessment of the adhesion of S. mutans to uncoated and saliva-coated glass ceramics and composites [19]. Their results were consistent with the findings of the current study (the enamel exhibited higher bacterial adhesion which was ascribed to its topographical properties) [19].

Moreover, Wang et al, in 2003 stated that the adhesion level of S. mutans to polished porcelain surfaces was 2.9±1.3 colonies/mm^2 [20]. The current study showed that this level was 5.6 ± 2.35 colonies/mm^2, and 5.8 ± 1.92 colonies/mm^2 to IPS e.max and feldspathic porcelain, respectively, with no significant difference between the two groups.

Hahnel et al. investigated bacterial adhesion to dental materials and enamel surfaces in 2008 with results in line with those of the current study. They argued that the higher bacterial affinity to the enamel was attributable to its higher surface energy [21]. The results reported by Kawai et al, in 2001 were also consistent with ours [14]. They measured the adhesion level to different dental materials (ceramics, composites, and amalgam) and concluded that the bacterial affinity was equal in all groups of ceramics assessed in their study and that it was lower than other materials they tested [14].

One limitation of the current study was its in vitro design, since oral environment cannot be well simulated in vitro. A strength of this study was that the results (number of colonies) were quantifiable and that the enamel was considered as the control for each group.

Conclusion

According to the findings of the present study, polished IPS e.max Press and polished feldspathic porcelain exhibit similar characteristics in terms of bacterial adhesion and either one can be the choice material for crowns in parallel conditions (marginal integrity, emergence profile, gingival contour and finishing line).

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