ADESÃO DE PATÓGENOS PERIODONTAIS A MATERIAIS UTILIZADOS PARA COROAS TEMPORÁRIAS DE LONGO PRAZO

ADHESION OF PERIODONTAL PATHOGENS TO MATERIALS USED FOR LONG-TERM TEMPORARY CROWNS

АДГЕЗИЯ ПАРАДОНТАЛЬНЫХ ПАТОГЕНОВ К МАТЕРИАЛАМ, ИСПОЛЗУЕМЫХ ДЛЯ ДОЛГОСРОЧНЫХ ВРЕМЕННЫХ КОРОНОК

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RESUMO

As coroas provisórias são amplamente utilizadas no tratamento protético em odontologia e surgiram novos materiais para coroas temporárias, incluindo a poliéterétercetona, que têm requisitos de alta qualidade para uso em próteses temporárias de longo prazo. De particular importância na prótese são as características da adesão da microflora oral patogênica às estruturas ortodônticas. Este estudo avaliou a adesão da flora bacteriana periodontal cariogênica e patogênica das espécies de *Candida* a poliéterétercetona Dentokeep não polida e polida (PEEK), material de polimetilmetacrilato polido (PMMA) polido (Re-Fine Acrylic) e plástico acrílico de cura a quente - um líquido em pó tipo, em que o pó é um copolímero contendo enxofre em suspensão e o líquido é uma mistura de monômeros acrílicos e oligômeros— (Sinma-M) recomendados para a fabricação de coroas temporárias de longo prazo. Estudou-se o efeito de polir ou remover o polimento do material de estudo na adesão de vários microrganismos. O polimento do Dentokeep PEEK influenciou significativamente a adesão primária. A adesão microbiana aos materiais da amostra foi estudada usando cavitação ultrassônica. A adesão de microrganismos a cada material foi classificada como baixa (0-0,27), moderada (0,28-0,69) ou alta (0,70-1). *Streptococcus sanguinis*, *Prevotella intermedia* e *Candida albicans* aderiram moderadamente ao Dentokeep PEEK não polido, enquanto *Porphyromonas gingivalis* e *Candida krusei* foram altamente aderentes. As espécies de *Candida* e a linhagem periodontal patogênica de *P. intermedia* aderiram moderadamente ao Dentokeep PEEK polido, enquanto *S. sanguinis* e *P. gingivalis* foram altamente aderentes. As coroas temporárias requerem medidas higiênicas adicionais para erradicar a microbiota cariogênica (acidogênica), periodontal patogênica e fungica e manter a composição qualitativa e quantitativa normal da microbiocenose oral durante o tratamento protodôntico. Em conclusão, PEEK é um material promissor para a fabricação de coroas temporárias de longo prazo.

Palavras-chave: Odontologia, Poliéterétercetona, Restaurações temporárias, Coroas provisórias, Compatibilidade.

ABSTRACT

Provisional crowns are widely used in prosthodontic treatment in dentistry, and new materials for temporary crowns, including polyetheretherketone, have emerged, which have high-quality requirements for use in long-term temporary prosthetics. Of particular importance in prosthetics are the features of adhesion of pathogenic oral microflora to orthodontic structures. This study evaluated the adhesion of cariogenic and pathogenic periodontal bacterial flora and *Candida* species to unpolished and polished Dentokeep polyetheretherketone (PEEK), polished polymethyl methacrylate (PMMA) material (Re-Fine Acrylic), and hot-curing acrylic plastic — a powder-liquid type, where the powder is a suspension graft fluorine-containing copolymer, and the liquid is a mixture of acrylic monomers, and oligomers—(Sinma-M) recommended for manufacturing long-term temporary crowns. The effect of polishing or un-polishing the study material on the adhesion of various microorganisms was studied. Polishing of Dentokeep PEEK significantly influenced primary

adhesion. Microbial adhesion to sample materials was studied using ultrasonic cavitation. Adhesion of microorganisms to each material was categorized as low (0–0.27), moderate (0.28–0.69), or high (0.70–1). *Streptococcus sanguinis*, *Prevotella intermedia*, and *Candida albicans* adhered moderately to unpolished Dentokeep PEEK, whereas *Porphyromonas gingivalis* and *Candida krusei* were highly adherent. *Candida* species and *P. intermedia* pathogenic periodontal strain moderately adhered to polished Dentokeep PEEK, whereas *S. sanguinis* and *P. gingivalis* were highly adherent. Temporary crowns require additional hygienic measures to eradicate cariogenic (acidogenic), pathogenic periodontal, and fungal microbiota and maintain the normal qualitative and quantitative composition of oral microbiocenosis during prosthodontic treatment. In conclusion, PEEK is a promising material for the manufacture of long-term temporary crowns.

Keywords: Dentistry, Polyetheretherketone, Temporary restorations, Provisional crowns, Biocompatibility.

АННОТАЦИЯ

Временные коронки широко используются для протезирования зубов в стоматологии, появились новые материалы для временных коронок, включая полиэфирэфиркетон, которые удовлетворяют высоким требованиям к качеству для долгосрочного временного протезирования. Особое значение в протезировании имеют особенности адгезии патогенной микрофлоры полости рта к ортодонтическим структурам. В этом исследовании оценивали адгезию кариесогенной и патогенной пародонтальной бактериальной флоры и грибов рода *Candida* к неполированному и полированному полиэфирэфиркетону Dentokeep (PEEK), полированному полиметилметакрилату (PMMA) (Re-Fine Acrylic) и акриловой пластмассы горячего отверждения – типа порошок-жидкость, где порошок представляет собой суспензионный привитой фторсодержащий сополимер, а жидкость представляет собой смесь акриловых мономеров и олигомеров (Sinma-M), рекомендованных для изготовления долгосрочных временных коронок. Было изучено влияние полированного или не полированного материала на адгезию различных микроорганизмов. Полировка Dentokeep PEEK значительно повлияла на первичную адгезию. Микробную адгезию к материалам образцов изучали с помощью ультразвуковой кавитации. Адгезия микроорганизмов к каждому материалу была классифицирована как низкая (0–0,27), умеренная (0,28–0,69) или высокая (0,70–1). *Streptococcus sanguinis*, *Prevotella intermedia* и *Candida albicans* обладали умеренной адгезией к нешлифованному Dentokeep PEEK, тогда как *Porphyromonas gingivalis* и *Candida krusei* – высокой адгезивностью. Грибы рода *Candida* и пародонтопатогенный штамм *P. intermedia* обладали умеренной адгезией к полированному Dentokeep PEEK, тогда как *S. sanguinis* и *P. gingivalis* отличались высокой адгезией. Временные коронки требуют дополнительных гигиенических мер для устранения кариесогенной (ацидогенной), пародонтопатогенной и грибковой микробиоты и поддержания нормального качественного и количественного состава микробиоценоза полости рта во время протезирования. В заключение следует отметить, что PEEK является перспективным материалом для изготовления долгосрочных временных коронок.

Ключевые слова: стоматология, полиэфирэфиркетон, временное протезирование, провизорные коронки, биосовместимость.

1. INTRODUCTION

Currently, temporary crowns are manufactured for most patients during prosthodontic treatment (Abdullah *et al.*, 2018; Kasim *et al.*, 2018; Klur *et al.*, 2019). The positive features of temporary restorations are well known to dentists and include protecting the tooth stump from external influences after tooth preparation for prosthodontic structure and providing patients with psychological comfort associated with the ability to communicate fully with family and the society during the prosthodontic treatment (Arutjunov *et al.*, 2012; Afanas'eva *et al.*, 2015; Timoshin *et al.*, 2018). Deadlines for the manufacture of permanent orthodontic structures

(bridge-like prosthetic dentures, single crowns, veneers, and dental inserts) are from 5 to 30 days (Utjuzh *et al.*, 2016), and provisional crowns are retained in patients' oral cavity during this time (Goncharov *et al.*, 2016; Ibragimov *et al.*, 2011; Utjuzh *et al.*, 2017). Recently, numerous polymers have emerged in the market as dental materials for the production of provisional crowns using a direct method (Abdullah *et al.*, 2016; Taylor *et al.*, 2016).

Dentokeep polyetheretherketone (Dentokeep Peek, PEEK) is a new polymeric material for provisional crowns that have not yet been sufficiently characterized and studied in terms of clinical efficacy and influence on oral microbiocenosis (Bathala *et al.*, 2019; Najeeb *et*

al., 2016).

Currently, in dentistry, the materials recommended for the manufacture of provisional crowns are polished polymethyl methacrylate (PMMA) material (Re-Fine Acrylic) and hot-curing acrylic plastic—a powder-liquid type, where the powder is a suspension graft fluorine-containing copolymer, and the liquid is a mixture of acrylic monomers and oligomers—(Sinma-M) (Davydova *et al.*, 2013; Makeeva *et al.*, 2016).

A variety of microorganisms are present in the oral cavity of an individual, raising concerns regarding the use of temporary recovery materials (Zhimova *et al.*, 2015; Sampaio-Maia, 2016). A specific class of acidogenic streptococci plays the role of stabilizing species that support the normal quantitative and qualitative composition of the microbial flora of the oral cavity (Deo *et al.*, 2019). However, their excessive colonization of the tooth surface and congestion on temporary restorations (crowns) have negative effects as cariogenic factors (Chen *et al.*, 2019; Conrads and About, 2018). A group of periodontal anaerobic bacteria has recently been classified as pathogenic species that can destroy the organic base of the tooth cement, particularly the collagenous periodontal base in root caries, and cause periodontitis. Fungi of the genus *Candida* play a role in the pathology of the oral mucosa and periodontium in individuals with a genetic predisposition and certain immune system defects (Makeeva *et al.*, 2016; Tsarev *et al.*, 2014).

Some clinical situations are known to require longer use of temporary bridge-like prosthetic dentures or individual crowns (up to 12 months). However, along with the performance of certain functions (protective, chewing, aesthetic, and communicative), the presence of temporary restorative devices in the oral cavity could cause complications, leading to the failure of orthopaedic treatment, and contribute to the development or aggravation of chronic periodontitis. This is because the materials from which temporary restorations are made have higher adherence to microbial colonization than the tooth enamel or the materials used to manufacture permanent, fixed orthodontic structures under the conditions of a dental laboratory (Afnas'eva *et al.*, 2015; Tsarev *et al.*, 2014; Yumashev *et al.*, 2016).

The degree of adhesion of microorganisms, in turn, determines the features of subsequent microbial colonization of both temporary structures and permanent prosthetic

dentures, which is subsequently established and affects the entire oral microbiocenosis (Tsarev *et al.*, 2011).

The purpose of this study was to investigate the adhesion of cariogenic (or acidogenic) and pathogenic periodontal bacterial flora and fungi of the *Candida* genus to unpolished and polished PEEK, PMMA, and Sinma-M materials. In clinical dentistry, there is a practice of using polished and unpolished materials for restorations. The choice of material depends on each clinical case, and sometimes, this choice is made by doctors based on their experience. This study comparatively assessed indices of the primary adhesion of representative pathogenic periodontal and acidogenic microbial flora, and *Candida* species to samples of the materials under investigation.

2. MATERIALS AND METHODS

PEEK was the test substance in this study, while the following materials recommended for the manufacture of provisional crowns, Re-Fine Acrylic, and Sinma-M were used for the comparison. All samples were manufactured using the same disc-shaped pattern. The PEEK and Re-fine samples were milled using computer-aided design/computer-aided manufacturing (CAD/CAM) technology, whereas the Sinma M samples were made using a thermal polymerization method. Next, the samples were polished to a mirror shine according to the instructions (Goncharov *et al.*, 2016; Ibragimov *et al.*, 2011). The group included 30 samples each of polished PEEK, unpolished PEEK, polished Re-Fine Acrylic, and unpolished Sinma-M materials, totaling 120 samples. For each group of microorganisms, six samples of each material were prepared. For the experimental studies, the strains of microorganisms used were in accordance with existing recommendations, (Goncharov *et al.*, 2016; Ibragimov *et al.*, 2011) and belonged to the following groups (Goncharov *et al.*, 2016; Ibragimov *et al.*, 2011):

1. **Cariogenic (acidogenic) streptococci:** *Streptococcus sanguinis* – gram-positive, microaerophilic cocci;

2. **Pathogenic periodontal species:** *Porphyromonas gingivalis* and *Prevotella intermedia* – gram-negative, strictly anaerobic rods;

3. **Yeast:** *Candida albicans* and *Candida krusei*.

As control strains of microorganisms, the densities of the bacterial and fungal suspensions were 10^9 CFU/ml and 10^{7-8} CFU/ml, respectively. Samples of materials with test strains were incubated in a thermostat-controlled environment for 2 h at 37°C. To remove the non-adherent bacteria or yeast, the samples were first washed three times with 10 mL sterile isotonic sodium chloride solution.

Then, each sample was placed in a separate plastic chamber containing 1 mL sterile isotonic sodium chloride solution and sonicated in an Ultra-Est-M ultrasound bath (GeoSoft Research and Production Company, Russia) at a frequency of 60 kHz for 10 min to collect microbial cells that adhered primarily to the surface of the dental material. To assess the primary adhesiveness of the organisms, identical disc-shaped samples were prepared (0.5 cm in diameter). These were UV-sterilized and then placed in a Petri dish. Then, 100 µL each of 1-day-old bacterial culture suspensions of the test strains was applied to the surface (Table/Fig 1). The technique of setting the primary adhesion test was consistent with the protocol described in the manual by Tsarev (Tsarev *et al.*, 2014). The resulting flushing from the samples was inoculated at the amount of 100 µL on 5% Columbia blood agar using an automatic micropipette. The material was distributed on the nutrient medium surface using a sterile plastic loop.

A dense Saburo medium was used to study the yeast adhesion. The obtained colonies were counted and examined using a research stereomicroscope (Nikon, Japan). Based on the determined decimal logarithm, the primary adhesion index was calculated for each sample of the material/test strains using the Equation 1 proposed by Tsarev (Tsarev *et al.*, 2014):

$$I_a = \lg A / \lg N \quad (\text{Eq. 1})$$

where I_a is the index of primary adhesion; A is the number of bacteria deposited on the sample; N is the number of bacteria in the washout from the sample (Tsarev *et al.*, 2014). All samples were tested once.

3. STATISTICAL ANALYSIS

All the experimental data were processed using the Statistica 6.0 statistical software package for Windows. The statistical significance of differences between the compared groups was

determined using the Kruskal-Wallis statistical test. Differences between the groups were considered statistically significant at $p < 0.05$. The average values are expressed as the means $\pm$ the standard deviation (SEM).

4. RESULTS AND DISCUSSION:

Based on the obtained values of the primary adhesion index, the degree of adhesion of the representative oral microbiota was evaluated (Table/Fig 2) as low (< 0.27), moderate (0.28–0.69), and high (> 0.70) (Timoshin *et al.*, 2018). The *S. sanguinis* acidogenic species was characterized by a high adhesion index for Re-Fine Acrylic (0.74 ± 0.64) and polished PEEK (0.70 ± 1.10) and moderate adhesion indices for Sinma M (0.58 ± 0.70) and unpolished PEEK (0.60 ± 0.68) (Table 1). The analysis of the representative bacterial pathogenic periodontal flora showed the following results. *P. gingivalis* showed the highest adhesion to all materials studied, including both polished and unpolished PEEK (0.77 ± 0.80) (Table 2). Another pathogenic periodontal species *P. intermedia* was characterized by moderate adhesion to the investigated materials, while the polished and unpolished PEEK did not differ in adhesion indices (0.51 ± 1.04) (Table 3).

The adhesion index of *C. albicans* for the investigated materials was moderate for all the materials studied and did not depend on the PEEK polishing degree (0.61 ± 0.70 and 0.59 ± 1.10 , for polished and unpolished, respectively) (Table/Fig 3D). In contrast, the less common *C. krusei* strain was highly adherent to Re-Fine Acrylic (0.75 ± 1.10) and unpolished PEEK (0.80 ± 1.12), while polished PEEK showed a moderate level of adhesion (0.63 ± 0.70) (Table 3 and 5). The results of primary adhesion index determination of the microorganisms on the investigated sample materials are given in Table 4, Figure 3.

The representative pathogenic periodontal species of bacteria differed in their degree of adhesion to the studied materials – the most unfavorable indicators (with an extremely high degree of adhesion) were characteristic for the *P. gingivalis* strain, while the other frequently encountered periodontal pathogen, *P. intermedia*, showed moderate adhesion. The adhesion of *C. albicans* could be defined as moderate for all the investigated materials, and it did not depend on PEEK polishing. Contrastingly, the less common *C. krusei* strain was highly adherent to Re-Fine

Acrylic and unpolished PEEK.

Polishing the PEEK material had a significant effect on the mechanisms of primary adhesion, and, in bacteria and fungi, this effect was manifested in different ways. A study of polished and unpolished materials, which was conducted using PEEK, showed that with regard to cariogenic microflora, polishing did not significantly affect the degree of adhesion, whereas, in *C. krusei*, it was significantly reduced. Evaluation of the primary adhesion of the acidogenic *S. sanguinis* strain to the material samples revealed that the polished PEEK was characterized by a higher adhesion index than the unpolished sample. Thus, the findings showed that the adhesion of the test microorganisms *S. sanguinis*, *P. intermedia*, and *Candida albicans* to the new material for manufacturing temporary crowns, i.e., unpolished PEEK, was moderate, whereas that of *P. gingivalis* and *C. krusei* was high. Furthermore, the fungal *Candida* species and pathogenic periodontal strain *P. intermedia* showed moderate adhesion to polished PEEK, whereas *S. sanguinis* and *P. gingivalis* showed a high adhesion. We proved that there are statistically significant differences between the materials in the context of the adhesion of the microorganisms. In this context, unpolished PEEK was better than PMMA in preventing the adhesion of *S. sanguinis*, and polished PEEK was better than PMMA in preventing the adhesion of *C. krusei*. PEEK had no advantage over Sinma M.

The obtained results also suggested that the mechanisms of adhesion to polished and unpolished materials differed in streptococci and fungi. The streptococci seemed to interact through receptors and material molecules, which were not affected or may have been strengthened by polishing, whereas fungi, particularly *C. krusei*, likely had the main mechanism of attachment associated with surface roughness. Therefore, the polishing process likely reduced the degree of adhesion, which corresponds to the literature data based on scanning electron and atomic force microscopy (Kasim *et al.*, 2018; Utjuzh *et al.*, 2017; Abdullah *et al.*, 2016).

According to studies by Tsarev *et al.* (2014), who previously investigated various materials for the manufacture of temporary restorative, prosthetic dentures, representative pathogenic periodontal flora showed the highest degree of adhesion to composite photopolymerizable materials (Filtek, 3M ESPE);

the degree of adhesion of *S. sanguinis* was 0.63-0.90, and that of *C. albicans* was 0.75-0.85. Similar data were obtained by Goncharov *et al.* (2016) who studied newly imported materials for provisional crowns—acrylic self-hardening plastic (Tempron, GC Corporation) and bis-acrylic composite with a new generation of fillers (Protemp, 3M ESP)—and domestic material—polymeric composite material based on multifunctional methacrylates (Tempocor, VladMiVa)—in polished, lacquered, and uncoated states. It was found that the domestic material showed a lower level of adhesion for pathogenic periodontal microbes than other organisms, but streptococci and *Porphyromonas* differed significantly in the level of adhesion on lacquer, which raises concerns of the need to improve the antiadhesive characteristics of the lacquers used (Goncharov *et al.*, 2016). For the Tempocor material without and with lacquers, the degree of adhesion of *S. sanguinis* was 0.45 and 0.88, that of *P. gingivalis* was 0.60 and 0.60, that of *C. albicans* was 0.50 and 0.50, and that of *C. krusei* was 0.75 and 0.78, respectively. For the Tempron material, the degree of adhesion of *S. sanguinis* was 0.67, *P. gingivalis* was 0.80, *C. albicans* was 0.58, and *C. krusei* was 0.71, which are significantly worse than the PEEK values. PEEK also had the advantage of being used to assess the degree of adhesion over the Protemp material with respect to *C. albicans* and *C. krusei*, for which the adhesion indices were 0.60 and 0.75, respectively (Goncharov *et al.*, 2016). In conclusion, the results of this study indicate that PEEK is a promising material for the manufacture of long-term temporary crowns. The disadvantages of temporary acrylic crowns have long been known, which further underscores the potential benefits and justifies undertaking clinical studies on the effectiveness of PEEK-based long-term temporary crowns.

5. CONCLUSIONS:

In the study had assessed indices of the primary adhesion of representative pathogenic periodontal and acidogenic microbial flora and *Candida* species to samples of the materials under investigation.

The study concluded that the primary adhesion depends on the type and polishing of the material. To establish this fact, the degree of adhesion of microorganisms to PEEK, Re-Fine Acrylic and Sinma-M were determined.

Installed features indices of the primary

adhesion of mouth microflora allowed us to conclude about the most preferred materials for use in restorative dentistry. With the best side of themselves showed PEEK, while other materials had a higher degree of adhesion.

The results of the study can help dentists to choose the most optimal material for the patient in prosthodontic treatment in dentistry.

It is rational to continue the study of the adhesion of microorganisms to other materials for prosthetics in order to expand knowledge about their pro-adhesiveness.

Manufacturers' Details

Dentokeep Peek material: HT-Trading GmbH & Co. KG, Germany

Re-Fine Acrylic: Yamahachi Dental MFG, Co, Japan

Sinma M: Stoma JSC, Ukraine

Ultra-Est-M ultrasound bath: GeoSoft Research and Production Company, Russia

Research stereomicroscope: Nikon, Japan

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Figure 1. Application of the test strain suspension on samples of dental polymers used to manufacture provisional crowns

A

B

Figure 2. The evaluation results of *Prevotella intermedia* strain adhesion to the Dentokeep polyetheretherketone (PEEK) material used to manufacture provisional crowns (A – low index, B – high index)

Figure 3. The results of in vitro adhesion of oral microbiota representatives to materials used for provisional crowns

Table 1. Comparative evaluation results of in vitro adhesion of oral *Streptococcus sanguinis* to materials used for provisional crowns, (mean $\pm$ SEM, n = 6)

	Material	CFU count	CFU Lg	Adhesion index
1	Re-Fine Acrylic	5×10^6	6.7	$0.74 \pm 0.64^{**}$
2	Sinma M	2×10^5	5.3	$0.58 \pm 0.70^*$
3	PEEK polished	10^6	6	$0.70 \pm 1.10^{*/**}$
4	PEEK unpolished	4×10^5	5.6	$0.60 \pm 0.68^{*/**}$
	control	10^9	9	1

Note: * $p < 0.05$ compared to Re-Fine Acrylic

** $p < 0.05$ compared to Sinma M

Table 2. Comparative evaluation results of in vitro adhesion of oral *Porphyromonas gingivalis* to materials used for provisional crowns, (mean $\pm$ SEM, n = 6)

	Material	CFU count	CFU Lg	Adhesion index
1	Re-Fine Acrylic	10^7	7	$0.77 \pm 1.35^{**}$
2	Sinma M	4×10^6	6.6	$0.73 \pm 1.15^*$
3	PEEK polished	10^7	7	$0.77 \pm 0.50^{**}$
4	PEEK unpolished	10^7	7	$0.77 \pm 0.80^{**}$
	control	10^9	9	1

Note: * $p < 0.05$ compared to Re-Fine Acrylic

** $p < 0.05$ compared to Sinma M

Table 3. Comparative evaluation results of *in vitro* adhesion of oral *Prevotella intermedia* to materials used for provisional crowns (mean $\pm$ SEM, $n = 6$)

	Material	CFU count	CFU Lg	Adhesion index
1	Re-Fine Acrylic	10^3	3	$0.33 \pm 1.21^{**}$
2	Sinma M	4×10^4	4.6	$0.51 \pm 0.70^*$
3	PEEK polished	4×10^4	4.6	$0.51 \pm 0.70^*$
4	PEEK unpolished	4×10^4	4.6	$0.51 \pm 1.04^*$
	control	10^9	9	1

Note: $^*p < 0.05$ compared to Re-Fine Acrylic

$^{**}p < 0.05$ compared to Sinma M

Table 4. Comparative evaluation results of *in vitro* adhesion of oral *Candida albicans* to materials used for provisional crowns (mean $\pm$ SEM, $n = 6$)

	Material	CFU count	CFU Lg	Adhesion index
1	Re-Fine Acrylic	8×10^4	4.90	0.61 ± 1.04
2	Sinma M	6×10^4	4.78	0.59 ± 1.10
3	PEEK polished	8×10^4	4.90	0.61 ± 0.70
4	PEEK unpolished	6×10^4	4.78	0.59 ± 1.10
	Control	10^8	8	1

Note: $^*p < 0.05$ compared to Re-Fine Acrylic

$^{**}p < 0.05$ compared to Sinma M

Table 5. Comparative evaluation results of *in vitro* adhesion of oral *Candida krusei* to materials used for provisional crowns, (mean $\pm$ SEM, $n = 6$)

	Material	CFU count	CFU Lg	Adhesion index
1	Re-Fine Acrylic	10^6	6	$0.75 \pm 1.10^{**}$
2	Sinma M	6×10^4	4.78	$0.59 \pm 1.06^*$
3	PEEK polished	10^5	5	$0.63 \pm 0.70^{*/**}$
4	PEEK unpolished	3×10^6	6.4	$0.80 \pm 1.12^{*/**}$
	Control	10^8	8	1

Note: $^*p < 0.05$ compared to Re-Fine Acrylic

$^{**}p < 0.05$ compared to Sinma M