EGYPTIAN DENTAL JOURNAL

VOL. 67, 1557:1562, APRIL, 2021

PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360

FIXED PROSTHODONTICS AND DENTAL MATERIALS

www.eda-egypt.org • Codex : 81/21.04 • DOI : 10.21608/edj.2021.60090.1469

MICROBIAL ADHESION TO CO-CR, PEEK AND ACETAL RPDS IN MANDIBULAR KENNEDY CLASS III MOD. 1 (RANDOMIZED SPLIT MOUTH CLINICAL TRIAL)

Nancy N. Elsherbini* *and* Ahmed N. Elsherbini**

ABSTRACT

Aim: Comparing the bacterial adherence and count on denture bases and underlying mucosa when using chrome-cobalt Co-Cr (Metal), Acetal and Polyether ether keton (PEEK) as denture base materials.

Materials and Methods: 20 patients with mandibular Kennedy class III Mod. 1, opposing maxillary fully dentulous ridge were selected. Patients were divided into two groups 10 each. Group I: In a split mouth, patients received removable partial denture with chrome cobalt (Metal) denture base on one side and Acetal denture base on the other side. Group II: In a split mouth patients received chrome cobalt (Metal) denture base on one side and PEEK denture base on the other side. Swabs were taken from the fitting surface of dentures and the mucosa underlying the denture at 1 week, 2 weeks and 3 weeks after insertion. Incubation on blood agar for 24 hours at 37 degrees was done.

Results: On the denture base: Acetal showed 6.93 ± 0.08, Metal 6.48 ± 0.15, and Peek 6.85±0.17. On the mucosa: Acetal showed 6.52 ± 0.13, Metal 6.51 ± 0.18, and PEEK 6.55 ± 0.12. There was insignificant difference between the Acetal and Peek, however metal showed significant difference when compared with other materials.

Conclusion: The bacterial count was low on the mucosal surface for the three materials. For the fitting surface both PEEK and acetal resin showed higher count compared to the metallic denture base through the follow up period.

KEYWORDS: Alloy, Bacterial adhesion, Thermoplastic

* Associate Professor at the Prosthodontics Department, Faculty of Dentistry, Cairo University, Cairo, Egypt

** Lecturer at the Prosthodontics Department, Faculty of Dentistry, Modern Sciences and Arts University, Giza, Egypt

INTRODUCTION

Removable partial dentures are one of the main treatment modalities for the replacement of missing teeth; these may be metallic and/or non-metallic prosthesis. In addition to function, comfort, esthetics and cost. The ability of the denture base material to retain microorganisms on its surface is one of the most important issues to be considered. As it is directly related to the denture hygienic properties and hence its ability to adversely affect the tissue health.[1] The major metals used in denture casting include metallic alloys such as titanium[2], precious and nonprecious metal alloy[3], cobalt–chromium alloy, and platinum-added gold alloy.[4] Titanium is considered to be highly biocompatible, light in weight and superior in anti-corrosion and anti-abrasion properties. On the other hand, because it is difficult to cast and polish, it is not used much despite the above advantages. Regarding the non-metallic partial dentures several materials have been introduced in the market as acrylic denture base, nylon[4], lucitone199, acetal resin and polyetheretherketone (PEEK).[5-7] All of these new types of resins are suited for thermoplastic processing. Acetal resins have fracture strength, wear resistance and flexibility. These characteristics make them usable for preformed clasps, partial denture frameworks, provisional fixed partial dentures, artificial teeth for removable dentures, resin-bonded fixed partial dentures, and orthodontic appliances.[4,7,8] Polyacetal resins are used for the construction of retentive and supportive components of removable partial dentures (RPDs), to improve aesthetics.[10] PEEK is a recently introduced thermoplastic biomaterial that was first used in the medical field in the field of orthopaedics. Yet, nowadays due to its high success rate, it was applied in the dental field in the construction of anatomical bridges, primary crowns, inlays, inlay bridges and Maryland bridges within minutes. PEEK is light in weight with high strength properties, in addition to the CAD-CAM provided digitally designed appliances that fits the patient anatomical structures accurately.[10-12] Regarding its elastic properties are fortunately very close to human bone, it is non corrosive, its water sorption ability is very low, in addition of being radiolucent, so it will not obstruct proper interpretation of radiographs. PEEK has good resistance to chemical degradation and resistance to organic solvents. [12-14] Saliva beside to the properties of the denture base material such as surface roughness, free surface energy, surface tension, wettability, hydrophobicity, hydrophilicity, electrostatic interactions, and micro hardness, will interact with each other.[15] Saliva is composed of many components among which are immuno-defensive components, the ratio of these components may change affected by the change in the oral environment.[16] Saliva and biofilms contains wide range of environmental variances with many species of micro-organisms with different natures.[17]

So this study was conducted to compare the effect of three types of denture base materials of removable partial denture on the microbial environment of the oral cavity.

MATERIALS AND METHODS

Ethical consideration

The protocol and consent were approved by IRB/ ECs (Institutional review board/ethical committees) with respect to scientific content, compliance with applicable research and human subjects regulations.

Materials under examination and patients selection

A convenient sample size of 20 patients was selected. Two groups of patients, ten patients each, with Kennedy class III mod.1 were selected from the outpatient clinic faculty of oral and dental medicine, Cairo University. Patients were randomly allocated into the groups using the research RANDOMIZER software. Group I patients received removable partial dentures in which one side is acetal resin base and Co-Cr base on the other side as split mouth design, group II patients received removable partial dentures in which one side is PEEK base and Co-Cr base on the other side also as split mouth design. The

patients were selected according to the following criteria: male patients were selected to avoid the hormonal effect on saliva in females, the edentulous spaces had equal length, the opposing arch had full set of natural teeth, and patients had normal salivary viscosity. Patients were free from systemic diseases that would affect the composition of salivary flora as diabetes mellitus or infectious diseases. Patients maintained good oral hygiene, and were free from caries and periodontal diseases. All patients were informed about the nature of the study and were allowed to sign a written consent. The study was approved by the local ethics committee faculty of oral and dental medicine, Cairo University. For both groups primary impressions were made for the patient's upper and lower arches by using irreversible hydrocolloid CAVEX. Then the casts were poured in improved dental stone, primary surveying using Ney's dental surveyor NEY was done on the diagnostic casts, and then they were mounted to the articulator to evaluate the inter arch space and interferences. To eliminate interferences or premature contacts mouth preparation was completed in a logical sequence; sometimes this involved only modification to healthy abutment teeth. Preparation of abutment teeth was performed for all patients involving guiding planes and rest seats preparation. Accurate final impressions were made using medium-bodied elastomeric impression material DENTSPLY, after mouth preparation using acrylic special trays constructed on the diagnostic cast. Impressions were boxed and poured. The master casts were surveyed again and the design was drawn on the cast. The design for both groups was Akers' clasps on all the abutments.

Group I (Acetal) denture construction: The master cast was prepared for duplication, relief areas were done. Only metal side of the edentulous areas was relieved while the other side that received the Acetal was not relieved. The modified master cast was duplicated using duplicating silicon BREDENT, two refractory casts were poured. The design of the metallic framework was traced on the refractory cast. The relieved edentulous space of the cast was covered by a plastic mesh while the other edentulous space was covered by a plane plastic pattern. Then spruing, investing the sprued pattern, burning-out, casting, finishing and polishing were performed.

The unrelieved base saddle of the lower dentures was waxed-up and flasked using Thermopress flask BREDENT. Heated softened Acetal resin was injected into the mold then curing was done at 215°C for 25 minutes. After curing the dentures were deflasked, finished and polished using thermal resin finishing burs, Abraso-Star K 50 BREDENT, with low speed and pumice. Try-in of the cobalt chrome framework and acetal resin denture base was done to check complete seating of the components and proper relation with the opposing dentition. After hand articulation of casts artificial teeth were arranged and the framework was again checked in the patients' mouths.

Group II (PEEK) denture construction: the same procedure was done as for acetal till the step of PEEK injection procedure, the same Thermopress flask was used. Reaching melting temperature was 400°C, then the flask was allowed to cool for 35 minutes. The mould was then placed in a water bath for 10 minutes. After curing the dentures were deflasked, finished and polished using Diagen Turbogrinder BREDENT and Ceragum rubber polishing cylinder BREDENT with light pressure. The frame works were also tried in the patients' mouths, hand articulation of casts and arrangement of artificial teeth was done, reinsertion in the patients' mouths and finally wax was replaced with self-cure resin.

Sample obtaining for both groups: samples were obtained using gamma sterilized disposable swabs, from the mucosa extending from the ginigival margins of the abutments in length and bucco-lingual width in width of the edentulous spaces. Samples for the fitting surface of the RPDS were taken from the same opposing area of the

mucosa. Samples were taken before denture insertion from the fitting surfaces of the acetal resin denture base, PEEK denture base and metallic denture base, as well as from mucosa beneath them. Also, samples were taken at 1 week, 2 weeks, and 3 weeks after denture insertion.

Sample preparation: Samples were obtained with gamma sterilized disposable swabs (Beta Lab., Cairo, Egypt) the samples were diluted in saline solution to concentrations of 1:10, 1:100, and 1:1000 and spread onto the surface of blood agar OXOID LTD. Then incubated for 24 hours in an incubator at 37˚C. The counting was done by counting the number of colonies that appeared on the Petri dish (Colonies Forming Units per Sample) (CFU/sample).

Statistical analysis

Data were collected statistically analyzed using SPSS 19 version (Statistical Package for Scientific Studies 'SPSS').

Analysis of variance (ANOVA) was conducted first to detect the presence of any significance between the three groups. Benferoni test was consequently executed. This test was conducted to determine which of the groups showed significant differences. P-value less than 0.05 was considered as the level at which statistical significance exists.

RESULTS

The bacterial count of the mucosal surface and denture fitting surface within the three groups increased along the follow up period, with non-significant difference. However, when the bacterial count was compared between groups metal showed significant difference <0.001 when compared with the Acetal and PEEK groups. Table 1 showing the values of bacterial count within and between the three groups.

TABLE (1) Effect of time on the bacterial count in the three materials

Follow- up period	Site	Acetal	SD	Metal	SD	PEEK	SD	P value
1w	D	6.71[a]	0.12	6.32[b]	0.13	6.63[a]	0.18	<0.001
	M	6.41[a]	0.19	6.35[a]	0.14	6.43[a]	0.11	0.2245
2w	D	6.82[a]	0.15	6.41[b]	0.11	6.71[a]	0.14	<0.0001
	M	6.45[a]	0.13	6.46[a]	0.13	6.48[a]	0.14	0.7703
3w	D	6.93[a]	0.08	6.48[b]	0.15	6.85[a]	0.17	<0.0001
	M	6.52[a]	0.13	6.51[a]	0.18	6.55[a]	0.12	0.6668

D: Denture base M: Mucosa

Mean values with the same letters are statistically non significant according to POST HOC test

Mean values with the different letters are statistically significant according to POST HOC test

DISCUSSION

According to the available literature bacterial adhesion to various denture base materials is a complicated process; due to the variable conditions associated with the environment in which the base is present in. Properties which affects adhesion of micro-organisms, such as the coarseness of those materials, and the ability to attract water and proteins in saliva.[17]

Regarding the fitting surface of the dentures both PEEK and acetal both materials showed higher bacterial count compared to the metal fitting surface. This was suggested to be due to the irregular surface topography with micro pits and micro porosities, which in turn increases the surface area and results in an increase in the number of adhering microorganisms.[18-20]

Also the thermal properties of metallic and non-metallic materials may have had an effect as the adhesive behaviour of bacterial strains subjected to temperature changes was observed. We concluded that the period of 4h was sufficient to induce alterations in the bacterial surface properties.[21]

Regarding the mucosal surface, the microbial adhesion in the three materials PEEK, acetal resin, and metal denture bases showed lower counts of bacteria compared to fitting surface of the three denture bases. This may be attributed to that the mucosa is a smooth surface that will not favour bacterial adhesion. On the other hand saliva has an important role, acting as a line of defence for the mucosal surface. Immunoglobulin A (IgA) presence prevents the adhesion of bacteria to the surface and neutralizes their inflammatory products. [22]

CONCLUSION

Within the limits of this study it was concluded that effect of the three materials on the count of microorganisms was as follows:

The bacterial count was less in the mucosal surface for the three materials through the follow up period compared to the fitting surface of the dentures.

Also the fitting surface of both PEEK and acetal resin showed higher count compared to the metallic denture base through the follow up period.

ACKNOWLEDGEMENT

I would like to acknowledge Microbiology lab, Clinical pathology department, Faculty of medicine, Cairo University. Also many thanks for Dr. Mohamed MN for his effort in the statistical analysis of the study.

REFERENCES

1. Sadig WM and Idowu AT. 2002. Removable partial denture design: a study of a selected population in Saudi Arabia. J Contemp Dent Pract.; 3: 40-53.
2. Ohkubo C, Hanatani S, Hosoi T. (2008).Present status of titanium removable dentures-a review of the literature. J Oral Rehabil;35:706-14.
3. Bezzon OL, Pedrazzi H, Zaniquelli O, da Silva TB. (2004) Effect of casting technique on surface roughness and consequent mass loss after polishing of NiCr and CoCr base metal alloys: a comparative study with titanium. J Prosthet Dent;92:274-277.
4. Takayama Y, Takishin N, Tsuchida F and Hosoi T. (2009). Survey on use of titanium dentures in Tsurumi University Dental Hospital for 11 years. J Prosthodont Res.;53: 53-59.
5. Machado C, Sanchez E, Azer SS, Uribe JM. (2007). Comparative study of the transverse strength of three denture base materials. J Dent;35:930-933.
6. Arikan A, Ozkan YK, Arda T, Akalin B. (2010). Effect of 180 days of water storage on the transverse strength of acetal resin denture base material.J Prosthodont;19:47-51.
7. Ata SO, Yavuzyilmaz H. (2009).In vitro comparison of the cytotoxicity of acetal resin, heat-polymerized resin, and auto-polymerized resin as denture base materials. J Biomed Mater Res B Appl Biomater;91:905-909.
8. Turner JW, Radford DR, Sherriff M. (1999) Flexural properties and surface finishing of acetal resin denture clasps. J Prosthodont;8:188-195.

9. Kutsch VK, Whitehouse JW, Schermerhorn K, et al. (2003) The evolution and advancement of dental thermoplastics. DentalTown;4:52-56.

10. Janda R. 1997. Prothesenkunststoffe aus werkstoffkundlicher Sicht. Quintessenz Zahntech;23:665-672.

11. Phoenix RD, Mansueto MA, Ackerman NA (2004). Jones RE. Evaluation of mechanical and thermal properties of commonly used denture base resin. J Prosthodont; 13:17-27.

12. Toth JM, Wang M, Estes BT, Scifert JL, Seim HB, Turner AS. (2006) Polyetheretherketone as a biomaterial for spinal applications. Biomaterials.; 27:324-34.

13. Stawarczyk B, Beuer F, Wimmer T, Jahn D, Sener B, Roos M, Schmidlin PR. (2013) Polyetheretherketone a suitable material for fixed dental prostheses? Journal of Biomedical Materials Research Part B: Applied Biomaterials.; 101:1209-1216.

14. Costa-Palau S, Torrents-Nicolas J, Brufau-de Barberà M, Cabratosa-Termes J. (2014) Use of polyetheretherketone in the fabrication of a maxillary obturator prosthesis: a clinical report. The Journal of prosthetic dentistry; 112:680-682.

15. Pereira-Cenci T, Del Bel Cury AA, Crielaard W, Ten Cate JM. (2008) Development of Candida-associated denture stomatitis: new insights. J Appl Oral Sci;16:86-94.

16. Gocke R, Gerath F, von Schwanewede H. (2002) Quantitative determination of salivary components in the pellicle on PMMA denture base material. Clin Oral Investig; 6:227-35.

17. Toole GO, Kaplan HB, Koller R (2000) Biofilm formation as Microbial development. Annual Review of Microbiology 49-79.

18. Katsikogianni M, Missirlis YF (2004). Concise review of mechanisms of bacterial adhesion to biomaterials and of techniques used in estimating bacteria-material interactions. Eur Cell Mater;8:37-57.

19. Pereira-Cenci T, Del Bel Cury AA, Crielaard W, Ten Cate JM. (2008).Development of Candida-associated denture stomatitis: new insights. J Appl Oral Sci;16:86-94.

20. Diebel LN, Liberati DM, Diglio CA, and Brown WJ (2005): Immunoglobulin A modulates inflammatory responses in an in vitro model of pneumonia. J. Trauma.59:1006-1009.

21. Zeraik A. and Nitschke M. (2012): Influence of Growth Media and Temperature on Bacterial Adhesion to Polystyrene Surfaces. Brazilian archives of biology and technology. 55:569-576

22. Samaranayake LP, Leung K, Jin L. (2009): Oral mucosal fungal infections. Periodontology 2000.49:39-59