Cumhuriyet Dental Journal, 28(1): 54-61, 2025
DOI: https://doi.org/10.7126/cumudj.1485029

Cumhuriyet Dental Journal

| cdj.cumhuriyet.edu.tr | Founded: 1998 Available online, ISSN: 1302-5805 Publisher: Sivas Cumhuriyet Üniversitesi

Evaluation of Surface Treatment on The Surface Roughness and Candida Albicans Adhesion of Denture Base Materials in Common Beverages

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Research Article

History

Received: 15/05/2024
Accepted: 22/01/2025

ABSTRACT

Objectives: This study compares the surface roughness and microbial adhesion of the denture base materials(DBMs) on which various surface treatments are applied and immersed in beverages.

Materials and Methods: 240 disc-shaped specimens were prepared from different DBMs; autopolymerized acrylic resin, heat-polymerised acrylic resin and urethan dimethacrylate resin. The samples were divided into two main groups according to applied surface treatment methods; conventional polishing(Cp) and optiglaze (Og) surface sealant agent. Subgroups were created according to the beverage (distilled water, black tea, coffee, and cola) (n=10). After the initial surface roughness measured, and the measurement was repeated on the 14th day. One sample of each group was submitted to bacterial adhesion and scanning electron microscopy(SEM). Data were statistically analysed with Kruskall Wallis and t-test by using SPPS 22.0.

Results: When the Ra0 and Ra1 values were compared, the mean Ra values increased for all groups. Statistically significance was found between the DBMs for Og compared to Cp($p<0.05$). Black tea beverage had been shown to affect all DBMs treated with Og. The highest C.albicans adhesion was found in GroupI-Cp which was kept in cola whereas the lowest adhesion was shown in GroupI-Og, aged in distilled water.

Conclusions: Og surface sealant may be applied as an alternative to Cp. However, the surface roughness of DBMs increase dependent on the consumption habits and microbial adhesion occurs.

Keywords: PMMA, UDMA, Optiglaze, Candida Albicans, Surface roughness.

Protez Kaide Materyallerine Uygulanan Farklı Cilalama İşlemlerinin Yüzey Pürüzlülüğü ve Candida Albicans Tutulumlarının Değerlendirilmesi

Araştırma Makalesi

History

Received: 15/05/2024
Accepted: 22/01/2025

ÖZ

Amaç: Bu çalışmada amaç, farklı yüzey işlemleri uygulanan ve içeceklerde bekletilen protez kaide materyallerinin(DBM) yüzey pürüzlülüklerinin ve mikrobiyal adhezyonunun karşılaştırmaktadır.

Materyal ve Metot: Farklı DBM'lerden 240 disk şekilli numune hazırlandı; otopolimerize akrilik reçine, ısıyla polimerize edilmiş akrilik reçine ve üretan dimetakrilat reçine. Numuneler uygulanan yüzey işleme yöntemlerine göre iki ana gruba ayrıldı; geleneksel polisaj (Cp) ve optiglaze (Og) yüzey kaplama ajanı. Bekletilen içeceğe göre (distile su, siyah çay, kahve ve kola) alt gruplar oluşturuldu (n=10). Başlangıç yüzey pürüzlülüğü ölçüldükten sonra ölçüm 14. günde tekrarlandı. Her gruptan alınan birer örnek, bakteriyel adhezyon ekimine ve taramalı elektron mikroskobuna tabi tutuldu. Veriler Kruskall Wallis ve SPPS 22.0 kullanılarak t-testi ile istatistiksel olarak analiz edildi.

Bulgular: Ra0 ve Ra1 değerleri karşılaştırıldığında tüm gruplarda ortalama Ra değerleri arttı. Cp ile karşılaştırıldığında Og için DBM'ler arasında istatistiksel olarak anlamlılık bulundu ($p<0.05$). Siyah çayda bekletilen Og ile muamele edilen tüm DBM'leri etkilendiği gösterildi. En yüksek C.albicans adezyonunun kolada bekletilen Grup I-Cp'de, en düşük bakteriyel adezyonun ise distile suda bekletilen Grup I-Og'da görüldüğü belirlendi.

Sonuç: Og yüzey kaplama ajanı Cp metoduna alternatif olarak uygulanabilir. Ancak tüketim alışkanlıklarına bağlı olarak DBM'lerin yüzey pürüzlülüğü artmakta ve mikrobiyal yapışma meydana gelmektedir.

Anahtar Kelimeler: PMMA, UDMA, Optiglaze, Candida Albicans, Yüzey Pürüzlülüğü

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How to Cite: Goze Saygın A, Tugut F, Tunc T, Karanfil Okutan E. (2025) Evaluation of Surface Treatment on The Surface Roughness and Candida Albicans Adhesion of Denture Base Materials in Common Beverages, Cumhuriyet Dental Journal, 28(1): 54-61.

Introduction

In clinical dentistry, to use of polymethylmethacrylate (PMMAs) have been used to treat total or partial edentulousness. PMMAs are preferred due to their smoothed and polished surface, low cost, excellent aesthetics, good compatibility, stability in the oral cavity. However, the materials used to treat edentolusness have expanded with the developments in polymer science.[1] Researchers introduced new materials such as polyvinyl, polyamide, and light-cured urethane dimethacrylate (UDMA) resins because of their mechanical properties.[2,3] Methyl-methacrylate free UDMA was firstly used in early 1980. In this system, high-intensity visible light of 400-500 nm wavelength is used for polymeryzation. Initially, Triad VLC light-cured UDMA (Dentsply Trubyte, York, PA) was used because of acceptable aesthetic, biocompatibility and poor bacterial adhesion. After that, a new base material known as Eclipse (Dentsply Trubyte) was developed, which has better physical properties and advantages of setting time. It was stated that UDMA resin has improved hardness, bending resistance, and bending modulus compared to others.[1,2,4] This material has high polishable property compared to the others.[5]

Surface roughness (SR) is one of the physical properties that directly or indirectly affects plaque accumulation, colour changes, oral health and comfort of the patients.[6-8] The rough surface showed more tendency in terms of plaque accumulation than the smooth surface. It was shown that SR above the threshold Ra value (0.2 µm) causes microbial retention and plaque accumulation.[9,10] PMMAs have some disadvantages, such as poor surface properties that increase bacterial adhesion.[5,11,12] Radford et al. stated that PMMAs as a denture base material are less frequently investigated in surface roughness, bacterial adhesion, and polishing techniques.[13]

DBMs are exposed to many variables of extrinsic or intrinsic factors that can change the mechanical and physical properties of the material. Consumption of beverages as an extrinsic factor is not only a need but also the cultural habits of the society in which it is existed. Depending on the content, solvents can alter the resin materials.[14]

Candida-associated denture stomatitis (DS) is a common disorder seen in removable prosthesis wearers. It was confirmed that adhesion and proliferation of C. Albicans, which is the prime pathogen of DS, are more easily when there are surface cracks and roughness on denture bases (DBs).[15] Microorganisms adhering to the surface can also affect tissues adjacent to intraoral structures by increasing oral stomatitis prevalence in addition to alteration of colours and halitosis.[6,16] Antifungal agents and cleaning methods were developed to enhance denture hygiene, but it was emphasised that these agents affected the DBs' mechanical properties and caused undesirable colour changes.[17,18] For this reason, the retention of C.albicans can be decreased by changing of DBMs surface properties.[19] Some surface modification methods might prevent the formation of microorganisms.

Conventionally, pre-polishing processes with water and fine pumice, silicon abrasives and polishing pastes containing aluminium oxide particles are used before finishing with burs and abrasive stones.

Nevertheless, a light-cured nano-filled composite resin Optiglaze as a new protection method can be applied directly or indirectly. According to the manufacturers of these kits contributed to providing smoothness surface and decreased adhesion of C. albicans. This sealant can obtain a smooth surface on composite restorations, artificial teeth, removable partial and total dentures, temporary crowns and individual acrylic bases.[20] In the presence of occlusal pits and interproximal regions where mechanical polishing is difficult to perform, the sealent can be an effective method.[21] However to the best of our knowledge the long-term performance of Optiglaze as a protetive coating agent for evaluation of the surface roughness and C.albicans adhesion is unknown.[20,22] Thus, this in-vitro study examined the effects of various surface protection methods on DBMs' SR and C.albicans adhesion following immersion in drinks. SR and C.albicans adherence to distinct DBMs was hypothesised to be unaffected by surface protection measures in this work.

Materials and Methods

This study was approved by the Ethics Committee in Sivas Cumhuriyet University (2024-03/23). Heat-polymerized polymethylmethacrylate resin (PMMA), autopolymerized polymethylmethacrylate resin, urethan dimethacrylat resin-based (UDMA) were used in this research. Conventional polishing (Cp) and Optiglaze (Og) surface sealent were used as a surface treatment approach. After being submerged in four different beverages over an extended period.

The overall sample size was found to be n=240, with an effect size of 0.8 (cohen), 80 percent power, and a 0.05 margin of error based on the percentage measurement values of the methodologies to be researched in the literature. Surface roughness measurements were carried out immediately after standard polishing and after 14-day ageing operation using the surface sealant method (Og).

Preparation of the Resin Samples

We used stainless steel molds to obtain 240 disc-shaped specimens, each with a diameter of 10 mm and a thickness of 3 mm. GroupI: Heat-polymerized PMMA specimens (Meliodent, Bayer, UK) were boiled in a 100°C bath for 20 minutes; Group II: autopolymerised PMMA resin (Imicryl, Konya, Turkey) was polymerized under pressure at 40°C for 15 minutes; Group III: UDMA samples were kept in a 55°C conditioning oven for 10 minutes (Conditioning Oven, Dentsply Trubyte, York); Electric spatulas set to 175˚C were used to deposit fluid consistency UDMA resin in the moulds after it had been heated in the heating vessel to 70˚(Eclipse, Dentsply Trubyte, York). Before polymerization could be completed, an oxygen barrier coating was placed to keep the polymer from reacting with the oxygen in the air (Eclipse ABC from Dentsply Trubyte, York).

Manual polishing techniques utilised a tungsten carbide bur (S274 190 060; Horico) and 400-grit silicon abrasive paper to standardise the samples for comparison purposes (English Abrasives). Surface treatments (n=10) separated the resin samples into two subgroups: conventional polishing (Cp) and Optiglaze (Og) surface sealant (GC, Corp, Belgium). Traditionally, polishing was done in a bench vice with a soft brush and a slurry of pumice. In order to create a polished surface, a polishing paste and 1500 rpm lathe flannel wheel

were used for 90 seconds each.[22] Using only one direction to apply the Og agent, we avoided the development of any air bubbles. For 90 seconds, samples polished with Og were polymerised in a light polymerized unit (Dentacolor XS; Heraeus Kulzer GmbH). Using an ultrasonic (Hygosonic; Dürr Dental AG) for 10 minutes and drying with oil-free air after surface treatments, all of the subjects were cleaned and dried. Waxed surfaces of the specimens were implanted in wax plates, and the volunteers sipped on the solutions while they were kept at 37˚C in a dark room to simulate intraoral circumstances.

Surface Roughness Measurements

A contact profilometer (Mitutoyo Surftest-201, USA) was used to assess Ra in the original (Ra0) and 14-day-treated (Ra1) samples, respectively. The profilometer used a 4 mm transverse length and an interval (cut-off length) of 0.8 mm. A reference block was used to calibrate it before each measurement. Each specimen's centre was measured three times, and the arithmetic means Ra values were calculated and recorded in micrometres for each individual. The mean Ra values were used in the statistical evaluation.

Preparation of Different Beverages and Aging Procedure

For each beverage, 40 samples were taken from each group and divided into four equal subgroups of ten samples each, as follows:

Subgroup A: Water purified through distillation

Subgroup B To prepare this solution, 250 ml of boiling distilled water was mixed with 3 gr of tea in (Lipton Black Tea). Before the aging process began, a fresh batch of tea solution was made every day.

Subgroup C: 7.5 g of coffee (Nescafe Classic; Nestle) and 250 ml of boiling distilled water were combined to make a coffee solution, and samples were stored in the 37 °C solutions to test for coffee adsorption.

Subgroup D: The aging and new solutions were created each day with a new bottle using 37°C carbonated cola (Refrescos Ipiranga, Ribeiro Preto, SP Brazil)

The samples were kept in beverages for 18 hours daily for 14 days and in distilled water for 6 hours daily for 6 days.[23] New solutions were often introduced to replace the old. After cleaning with distilled water and drying with drying paper, the samples were ready for the Ra measurement.

C.Albicans Incubation

The samples were ultrasonically cleaned with distilled water for 5 minutes, and then they have disinfected in %70 alcohol. Resin samples were sterilised for 10 minutes using 9W UV light at 253.7nm wavelength to avoid microbiological contamination and not affect the test results. C.albicans was cultured in Sabouraud's dextrose broth (SDB- Acumedica Co., Manufacturers, Inc.) at 37˚C for 48 hours. The infusion was adjusted after the incubation period to obtain bacterial concentrations of $1.5x10^8$ colony forming units per millilitre (CFU/mL) in sterile phosphate-buffered saline solution (PBS, 0.08 M, pH 7.8, Sigma-Aldrich, St. Louis, USA). The bacterial concentration was determined using the 0.5 McFarland standard, which evaluates at 450 nm optical density of the 100 µl of the solution. Five samples from each group were randomly selected to incubate C.albicans.

Scaning Electron Analysis (SEM)

Random samples were selected among each test group according to the surface sealing treatment applied for initial SEM imaging. Samples were coated with gold (Quorum Q150R ES, Quorum Technologies, UK) and evaluated with SEM (Tescan MIRA3 XMU, Brno, Czech Republic). The whole surface scanning was performed, and images were obtained at various magnifications (10x and 250x).

Statistical Analysis

All data were performed using a statistical package (SPSS 22.0). Paired samples t-test was used to check normality and to calculate variance homogenity Kruskall-Wallis H test was used (95%of confidence interval). After Mann Whitney U test was performed to determine of significance of difference between groups ($p < 0.05$).

Results

Surface Roughness Results

Initial surface roughness data are shown in Tables 1 and 2. Upon comparing Ra0 values without a material difference, the average of the Og-treated resins was found statistically significant than Cp-treated resins ($p<0.05$) (Table 1). Upon comparing Ra0 values based on the materials, the difference was not significant between Group I and III, and Group II has also shown significance ($p<0.001$) (Table 2).

The Ra measurements at the initial and 14th days are shown in *Table 2*. The lowest Ra0 value (0.217±0.066) was obtained at Group I-Og. This value was found over the threshold value defined for microbial involvement. The highest Ra0 value (0.696±0.231) was found in Group II-Cp. Ra values increased the of all samples stored in different beverages on the 14th day. The DBMs and surface treatment methods showed statistical significance ($p<0.05$). In contrast, it was seen that the SR values of samples immersed in the coffee solution decreased for Group I and II protected with Cp.

In Group I, heat-polymerized PMMA resin showed statistical significance for surface treatment and different beverages. The SR data is not statistically significant based on different beverages in Group I-Cp samples ($p>0.05$). However, the Og-treated samples' data in B, C, D subgroups in the same group was statistically significant ($p<0.05$), the difference in the samples kept at distilled water was found insignificant ($p>0.05$).

In Group II, Ra values were found as increased in autopolymerized acrylic resin. This increase was found significant in the Cp-treated group kept at cola, and Og-treated group kept in tea ($p<0.05$), any significance was not found in other groups ($p>0.05$).

The increased surface roughness in all samples aged in distilled water for Cp and Og surface sealant applied-UDMA resin was statistically significant ($p<0.05$). Subgroup B was significant only in Group III-Og, while the subgroups were found to be insignificant ($p>0.05$)

Table 1. Initial Ra values of the base materials according to surface treatments

		n	Mean ±Sd	p
Ra0 Values	CP	120	0.515±0.185	
	Og	120	0.457±0.183	**.017***

**Statistically significance*
Sd: Standart Deviation

Table 2. The comparison of SR measurement value of different base material on which applied different surface treatments.

						p
Ra0	Group I	CP	40	.432	.125	.916
		Og	40	.410	.111	
	Group II	CP	40	.649	.179	**.001***
		Og	40	.455	.165	
	Group III	CP	40	.465	.171	.590
		Og	40	.506	.263	

**Statistically significance*

Table3. Ra0 and Ra1 values of denture base materials aged in different beverages.

			Subgroup I Distilled Water (mean±Sd)	Subgroup II Tea (mean±Sd)	Subgroup III Coffee (mean±Sd)	Subgroup IV Cola (mean±Sd)
Group I (Heat-polymerized acrylic resin)	**Cp**	Ra0	0.399±0.131	0.328±0.154	0.423±0.167	0.324±0.117
		Ra1	0.463±0.132	0.478±0.144	0.393±0.104	0.393±0.110
		p	0.121	0.082	0.636	0.054
	Og	Ra0	0.308 ±0.073	0.217±0.066^{a}	0.350±0.103^{b}	0.304±0.057^{c}
		Ra1	0.377±0.102	0.382±0.99^{a}	0.463±0.103^{b}	0.420±0.129^{c}
		p	0.069	**0.02***	**0.011***	**0.026***
Group II (Auto-polymerized acrylic resin)	**Cp**	Ra0	0.579±0.178	0.587±0.187	0.696±0.231	0.565±0.146^{e}
		Ra1	0.605±0.179	0.656±0.132	0.604±0.167	0.733±0.221^{e}
		p	0.693	0.183	0.173	**0.003***
	Og	Ra0	0.368±0.446	0.345±0.129^{d}	0.454±0.186	0.424±0.120
		Ra1	0.446±0.161	0.454±0.107^{d}	0.447±0.150	0.472±0.098
		p	0.078	**0.008***	0.909	0.189
Group III (Urethan Dimethacrylate)	**Cp**	Ra0	0.332±0.088^{f}	0.391±0.139	0.415±0.161	0.398±0.085
		Ra1	0.509±0.207^{f}	0.505±0.169	0.447±0.197	0.426±0.209
		p	**0.041***	0.122	0.618	0.707
	Og	Ra1	0.322±0.113^{e}	0.237±0.108^{g}	0.344±0.180	0.435±0.123
		Ra2	0.509±0.207^{e}	0.526±0.464^{g}	0.492±0.158	0.499±0.130
			0.002*	**0.013***	0.061	0.308

Sd: Standart deviation
Same letters indicate statistical differences between groups.
**p < .05 was accepted as significance level.*

***Table 4**. Average Candida albicans involvement to the materials stored in different beverages.*
Capital same letters determine differences on the same row.
The different lowercase letters represent the statistical difference between on the same column.

	Beverages	Group I (Mean±Sd)	Group II (Mean±Sd)	Group III (Mean±Sd)	
CP	Distilled Water	24.420±1.436^{a}	28.100±1.529^{A,a}	16.440±2.864^{A,a,b}	**0.01***
	Tea	26.060±2.436^{b}	27.700±1.456^{A,b}	17.600±3.847^{A,c,d}	**0.02***
	Coffee	19.660±4.364^{c}	31.360±1.773^{c}	27.240±3.982^{a,c}	0.172
	Cola	62.580±3.164^{A,a,b,c}	16.900±3.075^{A,B,a,b,c}	38.800±3.489^{B,a,b,d}	**0.01***
p		**0.01***	**0.02***	**0.01***	
OG	Distilled Water	14.960±4.149^{A}	28120±14215^{A,a,b}	17.100±9633^{a}	**0.02***
	Tea	19.340±2.278	17500±10223^{a,c,d}	26.740±6.806	0,09
	Coffee	16.540±2.250^{A}	28740±15344^{d,e}	35.200±2.327^{A,a,b}	**0.02***
	Cola	18.520±3.998^{A}	44500±21095^{A,B,b,c,e}	20.200±2.736^{B,b}	**0.01***
p		0.315	**0.03***	**0.01***	

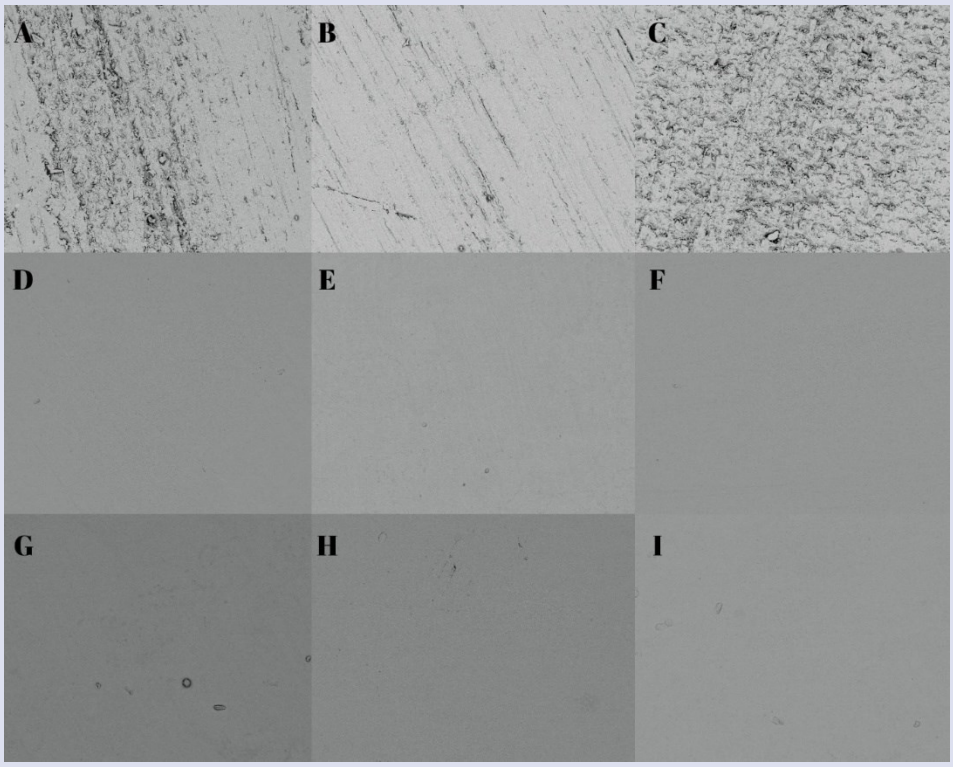

Figure. 1. Untreated surfaces of the specimens of Group I(A), Group II(B) and Group III(C). SEM image treated using Conventional Polishing of the materials (D,E,F). SEM images of the specimens polished using Optiglaze (G,H,I)

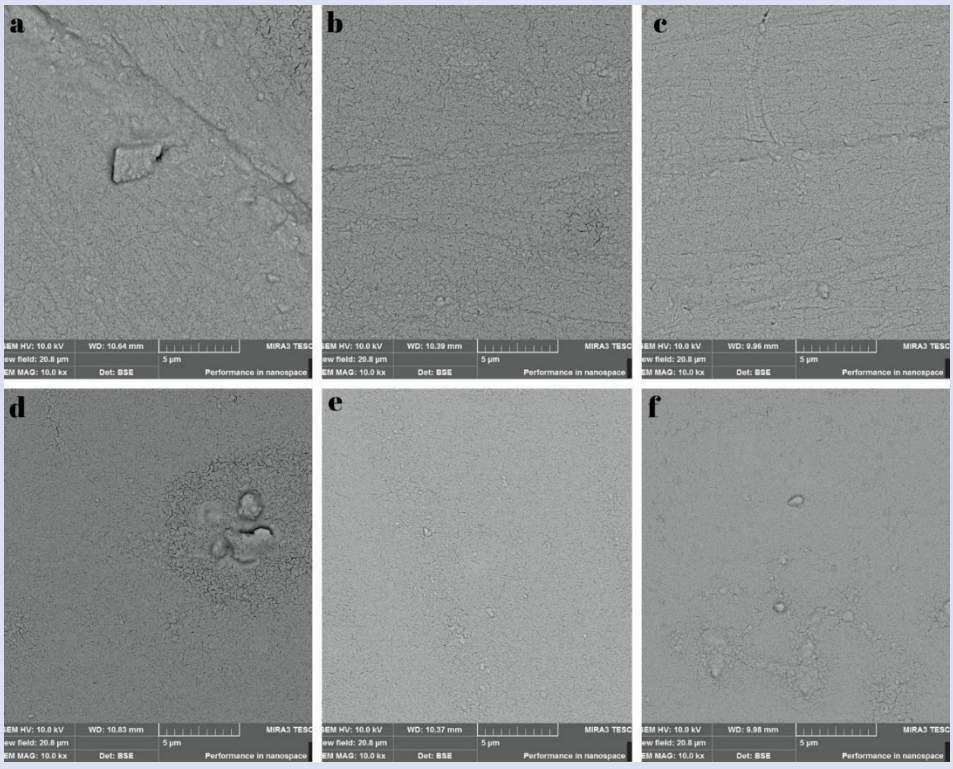

Figure. 2. Heat-polymerized acrylic resin treated with Conventional polishing and Optiglaze (a,d). SEM image of cracked surface of autopolymerized acrylic resin treated with Conventional polishing(b). Autopolymerized resin polishing with Optiglaze(e). UDMA base material treated with Conventional polishing and Optiglaze(c,f).

** Images in the same column belong to the same material (250x)*

C.Albicans Adhesion

The difference seen between the materials regarding Candida adhesion was found statistically significant ($p< 0.05$). The difference between Group I - Group II and Group II- Group III was found significant. The average number of Candida yeasts in Group II is statistically significant when compared to the other groups ($p < 0.05$).

There was statistically significance in Cp-treated samples in Group I whereas Og-treated samples was not significant ($p <0.05$). The lowest C.albicans adhesion was seen in Group-I-Og-Subgroup A, while the highest adhesion was seen in Group I-Og-Subgroup D.

Cp treated samples in the different base materials were found statistically significance in Subgroup I, II and IV. It was significance in the Og-treated samples for Subgroup I, III and IV.

SEM Evaluation

The SEM images were shown in Figure 1 and 2. When the images of the unpolished surfaces samples were examined (Fig.1A, B, C), the surfaces were observed as smooth in all groups. More regular surfaces were observed for all groups to which Cp and Og surface treatment was applied (Fig1). Og all applied materials were showed more smooth surfaces (Fig.2). While microcracks were seen on the surface in Group I and II resins, these cracks were more intense for autopolymerized acrylic (Fig2). Both Cp-treated surface and Op-treated surfaces were observed regularly in Group III samples, brush traces were observed in Og samples (Fig.1C, E)

Discussion

Based on the results of this study, the Ra measurements of different DBMs immersed in different beverages and C.albicans adhesion to these materials were investigated. The null hypothesis was rejected, which states that the surface treatment methods would not affect the Ra values and C.albicans adhesion on DBMs.

Clinically, various materials (PMMA, UDMA, polyamide etc.) and protective methods (conventional, chairside silicone polishing, surface coating etc.) have been used for prosthetic dentistry. Autopolymerized acrylic repair broken DBMs or to produce interim prosthesis has more surface roughness than heat-polymerised acrylic resin that is widely used because of its mechanical and physical properties.[8] In the preparation process, hand-mixed resins can have surface porosities, irregularities and defects. Bubble formation or unreacted monomer in the polymerisation process can cause surface roughness and water absorption.[24] Due to the mixing process, acrylic resins have different surface characteristics based on the difference between polymerisation initiators and uncomplete polymerisation. They were suggested to be at 3 mm thickness to have a homogenous structure as in our study. UDMA which could be used as an alternative base material instead of PMMA, was chosen because of its mechanical properties and non-allergic nature.[4,25] The highest Ra values were obtained in the autopolymerized acrylic resin group in the findings of our study in parallel to the literature data.

Ra, which is roughness data, is the most frequently used parameter used in defining the roughness. No definitive information is available in the literature regarding Ra; it is known that resin material with a Ra value larger than 0.2 µm for removable dentures is more suitable for bacterial colonisation.[26,27] According to the results of our study, Ra values showed a difference between 0.217 to 0.733 µm. These measurements confirmed that Cp and Og surface protective procedures are suitable for DBMs because of below the value, which is clinically detectable 10 µm limit.[28]

Various rubber polishers, abrasives, polish pastes, and pumices used to polish acrylic resin cause to exceed the threshold value of 0.2 mm, although it is recommended that different surface treatments prevent bacterial adhesion.[29,30] Surface protective agents are used for obtaining a smooth surface by filling micro-cracks and microdefects in restorations due to their high viscosities. However, it has disadvantages such as low abrasion resistance and its resistance characteristics, poor connection to the material, poor surface quality arising from its high viscosity characteristics.[31-34] Surface protection agents decrease the surface roughness by increasing the molecular weight of the methacrylate components of the resins, stated by Borchers *et al.*[31] Şahin et al. found the mean Ra value between the range of 0.17 µm (±0.01) to 0.24 µm (±0.02) in the study in which they compared Ra values of PMMA samples which they optiglazed. The highness of this data in our study can be explained as it can arise from the hand precision requirement of the surface treatments and the contact profilometer characteristics.

Surface protective methods have the importance to obtain a smooth surface. SR values of the samples applied with Og were found lowest than Cp surface treatment. Kuhar et al. found conventional polishing more effective in their study in which they compared the surface roughness of different base materials to which they applied chairside polishing and conventional polishing method and emphasised in SEM images that autopolymerized acrylic had wide porosities.[22] The surface roughness mean values of the conventional polishing-applied samples were found higher than the samples to which Og surface-protection treatment was applied in our study without any material difference. The difference in the obtained data suggests that it may be due to the difference between the base materials and surface protection methods. Obtaining the most irregular surface in Cp-applied autopolimerized acrylic in SEM images in our study coincides with the study conducted by Kuhar *et al.*

Three different fluids (tea, coffee and cola) were chosen for this study because of their common consumption. In literature, different immersing times ranging from or 1 day to 1 year have been performed by researchers.[35-37] It was reported that artificial ageing by

immersing in a beverage for 336-hr (14 days) corresponded to a period of approximately 13 years by Von Fraunhofer *et al.*[36] when the survival rate of removable prothesis which commonly fabricated from PMMA was thought between 10 and 20 years an acceptable period to investigate of wearer's to fluids.[38]

The specimens kept in distilled water as a control group showed the most minor changes on SR except for UDMA resin. The increased Ra values were most outstanding in the UDMA material for samples held in distilled water. Tea is described as a superfood due to the antioxidant content that may cause tooth erosion.[23] However, it has a low acid composition, and its consumption leads to only small and short-term decreases in pH at the tooth surface.[39] Tea can be considered to cause a difference in Og surface due to its antioxidant structure and content. According to the average Ra values of the current study, the coffee solution was found to be a lower effect than the other groups. This can be explained as the penetration of coffee particles into microporosities in the materials.[40] The resin containing materials are affected carbonated beverages. This result may be explained that cola beverages that cause hydrolysis of PMMA can cause the surface deterioration of resin matrix and erosion of surface.[41] Low ph acts as a catalyst for esther groups present in the UDMA resin matrix and may distort polymer network.[42]

Contrary to this data, the unaffected condition of UDMA material from cola and tea with low ph value in terms of surface roughness suggests that it may be due to the design of the studies. The surface roughness may be affected by the beverages with different characteristics based on the structure of the monomers (Bis-GMA, UDMA, TEGDMA etc.) in dental composites. However, the studies in the literature concerning UDMA (Eclipse) used as a base material are limited in our study, and they have not been used together with Og surface protective agent so far. Our study is the first study in the literature in this sense, and therefore it is impossible to compare them with the previous studies.

Candida yeasts can quickly increase when micro porosities are on the DB surface and during the repair process between the base material and autopolymerized acrylic resin.[43] Jackson *et al.* examined C.albicans and S.oralis adhesion to acrylic surfaces with different roughness values and found higher microorganism presence in rough surfaces.[44] TiO_2 and SiO_2, which are available in Og surface protective agents different from the other protective agents on the market, provide antibacterial characteristics to the material.[45] It was found at the lowest level, and the Og-conditioned heat-polymerized resin in our study in which C.albicans adhesion, which is accepted as the fundamental reason for denture stomatitis, was examined. Kulak et al. stated that autopolymerized acrylic resins show more tendency to C.albicans adhesion than the others.[46] The presence of more C.albicans adhesion than the other base materials in autopolimerized acrylic resin is supportive of the previous studies.

This in-vitro study has some limitations, and total in-vitro conditions were not provided. The conventional polishing treatment was performed with hand precision as in the previous studies. Considering the intraoral conditions, clinical studies in which factors such as the variables of the patient, nutritional and hygiene habits, smoking are assessed are required.

Conclusions

As an alternative to the conventional methods, smoother surfaces may be obtained by applying the Optiglaze surface protective agents to base materials. However, this surface protective treatment is affected by the beverages with different characteristics. Considering increased surface roughness and the affinity to C.albicans of DBMs, nutritional and hygiene habits of the patient are essential criteria that should be considered.

Acknowledgement

Authors do not have any financal interest.

References

1. Ali IL, Yunus N, Abu-Hassan MI. Hardness, flexural strength, and flexural modulus comparisons of three differently cured denture base systems. J Prosthodont 2008;17:545-549.
2. Pfeiffer P, An N, Schmage P. Repair strength of hypoallergenic denture base materials. J Prosthet Dent 2008;100:292-301.
3. Rodriguez LS, Paleari AG, Giro G, de Oliveira Junior NM, Pero AC, Compagnoni MA. Chemical characterization and flexural strength of a denture base acrylic resin with monomer 2-tert-butylaminoethyl methacrylate. J Prosthodont 2013;22:292-297.
4. Akin H, Tugut F, Guney U, Akar T. Shear bond strength of denture teeth to two chemically different denture base resins after various surface treatments. J Prosthodont. 2014;23:152-156.
5. Machado C, Sanchez E, Azer SS, Uribe JM. Comparative study of the transverse strength of three denture base materials. J Dent. 2007;35:930-933.
6. Patil SS, Dhakshaini MR, Kumar Gujjari A. Effect of cigarette smoke on acrylic resin teeth. J Clin Diagnostic Res. 2013;7:2056-2059.
7. Mahross HZ, Mohamed MD, Hassan AM, Baroudi K. Effect of cigarette smoke on surface roughness of different denture base materials. J Clin Diagnostic Res. 2015;9: ZC39-ZC42.
8. Berger JC, Driscoll CF, Romberg E, Luo Q, Thompson G. Surface roughness of denture base acrylic resins after processing and after polishing. J Prosthodont. 2006;15:180-186.
9. Sahin O, Koroglu A, Dede DÖ, Yilmaz B. Effect of surface sealant agents on the surface roughness and color stability of denture base materials. J Prosthet Dent. 2016;116:610-616.
10. Köroğlu A, Şahin O, Dede DÖ, Deniz ŞT, Karacan Sever N, Özkan S. Efficacy of denture cleaners on the surface roughness and Candida albicans adherence of sealant agent coupled denture base materials. Dent Mater J. 2016;35: 810-816.
11. Gungor H, Gundogdu M, Yesil Duymus Z. Investigation of the effect of different polishing techniques on the surface roughness of denture base and repair materials. J Prosthet Dent 2014;112:1271-1277.

12. De Visschere LM, Grooten L, Theuniers G, Vanobbergen JN. Oral hygiene of elderly people in long-term care institutions--a cross-sectional study. Gerodontology. 2006;23:195-204.
13. Radford DR, Challacombe SJ, Walter JD. Denture plaque and adherence of Candida albicans to denture-base materials in vivo and in vitro. Critical Reviews in Oral Biology and Medicine. 1999;10:99-116.
14. Shahdad SA, McCabe JF, Wassell RW. Developments in denture teeth to prevent softening by food solvents. J Mater Sci Mater Med. 2007(18):1599-1603.
15. JA von F, ZG L. Factors involved in microbial colonization of oral prostheses. Gen Dent 2009;57: 136-143.
16. Casemiro LA, Martins CHG, Pires-De-Souza FDCP, Panzeri H. Antimicrobial and mechanical properties of acrylic resins with incorporated silver-zinc zeolite - Part I. Gerodontology. 2008;25:187-194.
17. Nawasrah A, Gad MM, El Zayat M. Effect of henna addition on the surface roughness and hardness of polymethylmethacrylate denture base material: An in vitro study. J Contemp Dent Pract. 2018;19:732-738.
18. Gad MM, Al-Thobity AM, Fouda SM, Näpänkangas R, Raustia A. Flexural and Surface Properties of PMMA Denture Base Material Modified with Thymoquinone as an Antifungal Agent. J Prosthodont. 2020;29:243-250.
19. Wady AF, Machado AL, Zucolotto V, Zamperini CA, Berni E, Vergani CE. Evaluation of Candida albicans adhesion and biofilm formation on a denture base acrylic resin containing silver nanoparticles. J Appl Microbiol. 2012;112:1163-1172.
20. AlBin-Ameer MA, Alsrheed MY, Aldukhi IA, Matin A, Khan SQ, Abualsaud R et al. Effect of Protective Coating on Surface Properties and Candida albicans Adhesion to Denture Base Materials. J Prosthodont. 2020;29:80-86.
21. Tekçe N, Fidan S, Tuncer S, Kara D, Demirci M. The effect of glazing and aging on the surface properties of CAD/CAM resin blocks. J Adv Prosthodont 2018;10:50-57.
22. Kuhar M, Funduk N. Effects of polishing techniques on the surface roughness of acrylic denture base resins. J Prosthet Dent. 2005(93):76-85.
23. Guler S, Unal M. The Evaluation of Color and Surface Roughness Changes in Resin based Restorative Materials with Different Contents After Waiting in Various Liquids: An SEM and AFM study. Microsc Res Tech. 2018;81:1422-1433.
24. Nomoto R, McCabe JF. Effect of mixing methods on the compressive strength of glass ionomer cements. J Dent. 2001;29:205-210.
25. Alkurt M, Yeşil Duymuş Z, Gundogdu M. Effect of repair resin type and surface treatment on the repair strength of heat-polymerized denture base resin. J Prosthet Dent. 2014;111:71-78.
26. Heintze SD, Forjanic M, Ohmiti K, Rousson V. Surface deterioration of dental materials after simulated toothbrushing in relation to brushing time and load. Dent Mater. 2010;26:306-319.
27. Schwindling F, Rammelsberg P, Stober T. Effect of Chemical Disinfection on the Surface Roughness of Hard Denture Base Materials: A Systematic Literature Review. Int J Prosthodont. 2014;27:215-225.
28. Kaplan BA, Goldstein GR, Vijayaraghavan TV., Nelson IK. The effect of three polishing systems on the surface roughness of four hybrid composites: A profilometric and scanning electron microscopy study. J Prosthet Dent. 1996;76:34-38.
29. Loney RW, Brent Moulding M, Hacker CH, Ritsco RG. Finishing and polishing of a poly (fluoroalkoxyphosphazene) resilient denture liner. Int J Prosthodont 1994;7:362-367.
30. Nawasrah A, Al Nimr A, Ali AA. Antifungal effect of henna against Candida albicans adhered to acrylic resin as a possible method for prevention of denture stomatitis. Int J Environ Res Public Health. 2016;23:520-526.
31. Borchers L, Tavassol F, Tschernitschek H. Surface quality achieved by polishing and by varnishing of temporary crown and fixed partial denture resins. J Prosthet Dent. 1999(82):550-556.
32. Bertrand MF, Leforestier E, Muller M, Lupi-Pégurier L, Bolla M. Effect of surface penetrating sealant on surface texture and microhardness of composite resins. J Biomed Mater Res. 2000;53:658-663.
33. Sarac D, Sarac YS, Kulunk S, Ural C, Kulunk T. The effect of polishing techniques on the surface roughness and color change of composite resins. J Prosthet Dent. 2006;96:33-40.
34. Şahin O, Dede DÖ, Köroğlu A, Yilmaz B. Influence of surface sealant agents on the surface roughness and color stability of artificial teeth. J Prosthet Dent. 2015;114:130-137.
35. Bayrak S, Ozalp N, Okte Z. Effects of drinks on solubility of different restorative materials. Mater Res Innov. 2011;15:83-86.
36. Von Fraunhofer JA, Rogers MM. Dissolution of dental enamel in soft drinks. Gen Dent. 2004;52:308-312.
37. Dos Santos PA, Garcia PPNS, De Oliveira ALBM, Chinelatti MA, Palma-Dibb RG. Chemical and morphological features of dental composite resin: Influence of light curing units and immersion media. Microsc Res Tech. 2010;73:176-181.
38. Heintze SD, Monreal D, Rousson V. Fatigue resistance of denture teeth. J Mech Behav Biomed Mater. 2016;53:373-383.
39. Rugg-Gunn A. Is black tea better for your teeth than acidic soft drinks? Br Dent J .2001;190:374-376.
40. Imirzalioglu P, Karacaer O, Yilmaz B, Ozmen I. Color stability of denture acrylic resins and a soft lining material against tea, coffee, and nicotine. J Prosthodont. 2010;19:118-124.
41. Reddy PS, Tejaswi KLS, Shetty S, Annapoorna BM, Pujari SC, Thippeswamy HM. Effects of commonly consumed beverages on surface roughness and color stability of the nano, microhybrid and hybrid composite resins: An in vitro study. J Contemp Dent Pract 2013;14:718-723.
42. Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater. 2006;22:211-222.
43. Gad MM, Al-Thobity AM, Shahin SY, Alsaqer BT, Ali AA. Inhibitory effect of zirconium oxide nanoparticles on Candida albicans adhesion to repaired polymethyl methacrylate denture bases and interim removable prostheses: A new approach for denture stomatitis prevention. Int J Nanomedicine. 2017;28:5409-5419.
44. Jackson S, Coulthwaite L, Loewy Z, Scallan A, Verran J. Biofilm development by blastospores and hyphae of Candida albicans on abraded denture acrylic resin surfaces. J Prosthet Dent. 2014;112:988-993.
45. Sodagar A, Bahador A, Khalil S, Saffar Shahroudi A, Zaman Kassaee M. The effect of TiO_2 and SiO_2 nanoparticles on flexural strength of poly (methyl methacrylate) acrylic resins. J Prosthodont Res 2013;57:15-19.
46. Kulak Y, Arikan A, Kazazoglu E. Existence of Candida albicans and microorganisms in denture stomatitis patients. J Oral Rehabil. 1997;24:788-790.