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Araştırma/ Research Article

SURFACE ROUGHNESS OF 5 DIFFERENT MATERIALS USED FOR FIXATION OF IMPLANT ATTACHMENT HOUSINGS

İMPLANT DESTEKLİ OVERDENTURE PROTEZLERE TUTUCU PARÇALARIN SABİTLENMESİNDE KULLANILAN BEŞ FARKLI MATERYALİN YÜZEY PÜRÜZLÜLÜĞÜNÜN DEĞERLENDİRİLMESİ

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ABSTRACT

Purpose: Rough intaglio surfaces of overdentures have a great importance since rough surfaces may cause microbial dental plaque accumulation. Thus, the aim of the present study was determination the surface roughness values of 5 different materials that are used to fixation of dental implant attachment housings to overdentures.

Material and Method: 84 specimens with 10X4 mm diameters were prepared from 5 different materials. The surface roughnesses of the materials were analyzed using by a tactile profilometer. The data (*Ra*) was analyzed using one-way ANOVA and Tukey's *post-hoc* comparison. The significance level was set as *α=0.05.*

Results: There was statistically significant difference between the groups. While the roughest surface was observed in the PSC and UGH groups, the least rough surface was observed in the QU GROUP. However, there was statistically no difference between the QU, PHC, QULC, TRF and TRF+RH groups.

Conclusion: In the limitations of the present study, it may be suggested use of QU, PHC, QULC, TRF and TRF+RH instead of PSC and UGH in order to have least rough intaglio surfaces for overdentures. However, this point of views should be approved with clinical studies.

Keywords: Surface roughness, Overdenture, Overdenture attachment housing

ÖZ

Amaç: Overdenture protezlerde, dental implantlara komşu olan iç yüzeylerin pürüzlülüğü, bu bölgelerde mikrobiyal plak tutunmasına yol açtığından büyük önem taşımaktadır. Bu nedenle çalışmamızın amacı, overdenture protezlerde tutucu parçaların proteze sabitlenmesinde kullanılan 5 farklı materyalin yüzey pürüzlülük değerlerini belirlemektir.

Gereç ve Yöntem: Çalışmada, beş farklı materyal kullanılarak 10x3 mm ebatlarında 84 adet örnek hazırlandı. Örneklerin yüzey pürüzlülükleri profilometre cihazı kullanılarak üç farklı noktadan ölçüldü. Elde edilen veriler (*Ra*) tek yönlü ANOVA ve Tukey HSD testleri ile istatiksel olarak değerlendirildi. İstatistiksel analiz anlamlılık düzeyi *α=0.05* olarak belirlendi.

Bulgular: İstatiksel olarak gruplar arasında önemli farklılıklar bulgulandı. En fazla pürüzlülük değeri PSC ve UGH gruplarında gözlenirken, en düşük değer QU grubunda gözlendi. Bununla birlikte, QU, PHC, QULC, TRF ve TRF+RH grupları arasında istatiksel olarak farklılık bulgulanmadı.

Sonuç: Bu çalışmanın sınırları dahilinde, daha az pürüzlü intaglio yüzeyler için overdenture protezlere tutucu ataçmanların sabitlenmesinde UGH ve PSC materyalleri yerine, PHC, QU, QULC, TRF ve TRF+RH kullanılması önerilebilir. Bununla birlikte, konu ile ilgili klinik çalışmalar önerilir.

Anahtar Kelimeler: Yüzey pürüzlülüğü, Overdenture, Overdenture tutucu parçası

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INTRODUCTION

Implant supported overdentures are a common treatment modality currently because of the positive effects of overdentures on the quality of life, chewing ability and increase in maximum bite force of elderly people.[1, 2]

In most cases, implant supported overdentures are made using conventional techniques for full dentures. Despite finishing implant overdenture completely in the dental laboratory is time consuming for both clinicians and patients, some clinicians prefer fixing the implant overdenture attachment housings to the overdenture at the chairside intraorally. Both two methods have some advantages and disadvantages for clinicians and patients.

In the dental market, there are materials for fixation of overdentures to the implant attachment housings.[3, 4] However, according the technique which is used for fixation of housings in the dental laboratory or at chair side; the selection of materials may be limited. For example, the most suitable material may be heat-polymerized acrylic resins in the dental laboratory because of ideal polymerization and less rest monomer. However, the most suitable materials may be chair side relining materials as suggested by some of the manufacturers. Regardless the technique used, the critical point for the selection of fixation materials are the features of them related to microbial plaque accumulation.

It was showed that microbial plaque accumulation is directly related to the surface roughness of the dental materials. Plaque accumulation amount and surface roughness of denture materials have also a great importance for implant supported overdentures, since most of the overdenture patients are elders who couldn't performing enough plaque removal.[5] This is of particular importance in old patients who have dexterity or mental problems and who are not able to easily brush their dentures. It was also emphasized that smooth surfaces is essential since therefore preventing plaque formation, so that reducing the incidance of gingival tissue reaction.[6] Therefore, the purpose of the study was evaluation of surface roughness of 5 different materials used for the fixation of implant supported overdenture attachments to the housings.

MATERIALS AND METHODS

Eighty four specimens with 10X3 mm diameters (Figure 1) were fabricated from 5 different materials that used for fixation of implant attachment housings: Paladent heat-cure acrylic denture base resin (Heraeus Kulzer GmbH, Grüner Weg, Hanau, Germany) (PHC), Paladent self-cure acrylic resin (Heraeus Kulzer GmbH, Grüner Weg, Hanau, Germany) (PSC), Quick Up (VOCO Gmbh, Cuxhaven Germany) (QU), Ufi Gel hard (VOCO Gmbh, Cuxhaven, Germany) (UGH) and Tokuyama Rebase II Fast (Tokuyama Dental Corporation, Tokyo, Japan) (TRF). Table 1. shows the manufacturers and Lot numbers of the materials used in the present study. All the specimens were prepared using by a silicon mold. Each of the group specimens were made described below:

Table 1. Implant attachment housings fixation materials used in the present study.

Material	Type	Code		Manifacturer
Paladent Heat-Cure	Heat-cure acrylic resin	PSC	12427	Heraeus Kulzer, GERMANY
Paladent Heat-Cure	Self-cure acrylic resin	PHC	13168	Heraeus Kulzer, GERMANY
Quick-Up	Self-curing luting material for attachments and secondary denture parts	QU	1525058	VOCO Gmbh, Germany
Quick-Up LC	Correction material of Quick UP	QULC	1525058	VOCO Gmbh, Germany
Ufi Gel Hard	Direct hard relining material	UGH	1317338	VOCO Gmbh, Germany
Tokuyama Rebase II Fast	Direct hard relining material	TRF	053EY4	Tokuyama Dental Corporation, Tokyo, Japan
Tokuyama Rebase with resin hardener	Resin hardener solution for Tokuyama Rebase II	TRF+RH	053EY4	Tokuyama Dental Corporation Tokyo, Japan

Figure 1. Specimens evaluated in the present study.

Figure 2. Representation of surface roughness evaluation with the tactile profilometer

PHC: The heat cure acrylic specimens were made with conventional lost wax technique. A silicon matrix with twelve hollows with an internal diameter of 10 mm and thickness of 4.0 mm was used. Heated modeling wax (Dentsply Corporate, York, USA) was laid up in the matrix. The matrix was infused with wax. An isolated glass plate was placed on the wax and waited for the cooling of the wax. After the removal of glass plate, excessive modeling wax was carefully taken from the matrix using by a knife-like sharp instrument. Afterwards, the wax models were displaced from the silicon matrix, 12 wax pattern specimens were obtained. The wax patterns were included in plaster stone using a metal flask with a smooth glass plate. After the flasking, the stone was let completely set and then boiled for 5 minutes. After 5 minutes, the flask removed from the boiling water and opened gently. The entire wax residue was cleaned. The powder and liquid were mixed according to ratios specified in the manufacturers' instructions. The mixture was allowed to reach a doughy stage. Acrylic dough was packed into the molds and then acrylic specimens were polymerized in a controlled water bath. The flask was kept at 72°C water for one and a half hour and then boiled 30 minutes. After deflasking, specimens were checked visually and removed carefully from the molds. No finishing and polishing procedure was performed since all the acrylic specimens were made using by a smooth glass surface in the flask.

PSC: For preparation of specimens, a silicon mold was used above mentioned. The proper powder-liquid ratio was determined with suggestions of the manufacturer. After stirring the powder and liquid, it was waited until a sandy and fibrillar phase of resin and then the plastic phase before placing into the mold. The mold filled with the self curing acrylic resin dough and a smooth glass surface was used at the bottom of the mold. The acrylic resin was processed in a resin polymerizer (Lascounter CD-101, Sun Rostfrei, Istanbul, Turkiye) at 20°C and pressure of 25 psi (1.75 kg/cm^2) for a period of 15 minutes. No finishing and polishing procedure was performed since all the acrylic specimens were made using by a smooth glass surface in the flask.

QU: For preparation of QU specimens, a silicon mold and a smooth glass plate was used at the bottom of the mold. QU has a syringe form to mix and prepare the material. Thus, QU was mixed with Quick Mix syringe according to the manufacturer's instructions. The mixture was applied to the silicon molds with a smoot glass bottom. It was waited for the hardening of the material for 5 minutes. No finishing and polishing procedure was performed since all the QU specimens were made using by a smooth glass surface at the bottom of the silicon molds.

QULC: For preparation of QULC specimens, a silicon mold and a smooth glass plate was used at the bottom of the mold. QULC specimens were prepared as described above mentioned for QU. Then, QULC was prepared according to the manufacturer's instructions and applied on the surface of QU specimens. Quick Up LC was dried with air syringe for 30 seconds. Each of the specimen was light cured for 20 seconds with a curing device (3M Espe Elipar Deep Cure-S LED, 3M Espe Corp. St. Paul, United States) with light wavelength 430-480 nm, light intensity 1,470 mW/cm2 (-10%/+20%).

UGH: For preparation of UGH specimens, a silicon mold and a smooth glass plate was used at the bottom of the mold. The proper powder-liquid ratio was determined according to the recommendations of the manufacturer for UGH. The powder and liquid mixture was stirred with a plastic spatula for 10 seconds. The mixture was vibrated to prevent the air traps. Ninety seconds was waited. After 10 seconds stirring, the silicon molds were filled with the mixture. A resin polymerizer (Lascounter CD-101, Sun Rostfrei, Istanbul, Turkiye) at 40°C and pressure of 25 psi (1.75 kg/cm^2) was used for a period of 15 minutes. No finishing and polishing procedure was performed since all the UGH specimens were made using by a smooth glass surface at the bottom of the silicon molds.

TRF: For preparation of TRF specimens, a silicon mold and a smooth glass plate was used at the bottom of the mold. The proper powder-liquid ratio was determined according to the recommendations of the manufacturer for TRF. The powder and liquid mixture was stirred with a plastic spatula for 10 seconds slowly. The mixture was vibrated to prevent the air traps. Ninety seconds was waited after the end of 10 seconds stirring and then the silicon molds were filled with the mixture. A resin polymerizer (LASCOUNTER CD-101, Sun Rostfrei, Istanbul, Turkiye) at 40°C and pressure of 25 psi (1.75 kg/cm^2)

was used for a period of 15 minutes. No finishing and polishing procedure was performed since all the TRF specimens were made using by a smooth glass surface at the bottom of the silicon molds.

TRF+RH: For preparation of the TRF specimens, the same steps as TRF as suggested by the manufacturer. 1 scoop of resin hardener dissolved per 200 ml of 50°C (104-140°F) water. Material is completely dissolved and TRF samples were immersed in the solution and waited 3 minutes as advised by manufacturer.

Specimens were checked visually, and removed from analysis if any void was identified. All the specimens were immersed in water for 48 hours in an incubator at 37 C°. Surface roughness of the specimens was measured using a tactile profilometer (Figure 3) (Surftest SJ 201, Mitutoyo, Tokyo, Japan) with a 0.25-mm cutoff value. Resolution of the profilometer was 0.01 mm, transverse length was 4.0 mm and the diameter of the diamond recording pin stylus was 5µm. The constant measuring speed was 0.5 mm/sec. to determine an average roughness profile. Six measurements were made with equal distances on the each specimen; the reading direction was always perpendicular to the finished and polished surface of the specimens. The roughness parameters measured and recorded were *Ra* (arithmetical average value of all absolute distances of the roughness profile).

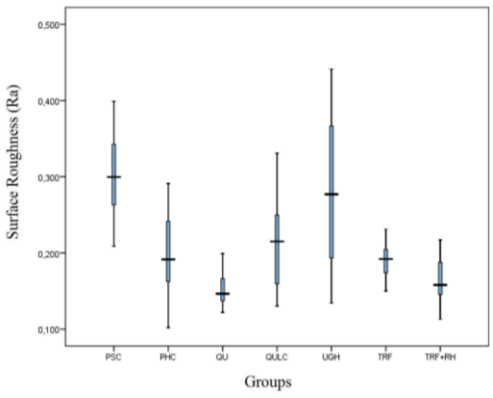

Figure 3. Box-plot representations of surface roughness values among the groups.

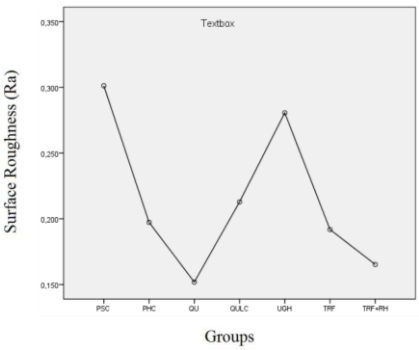

Figure 4. The representatives of surface roughness of tested groups

RESULTS

Table 2., Figure 3 and Figure 4 show the means and standard deviations of surface roughness (*Ra*) of the materials evaluated. The roughest surfaces were observed at the PSC and UGH groups and there was statistically no difference between these two groups ($p>0.05$). Despite the least surface roughness value was determined at QU group; there was statistically no difference between PHC, QU, QULC, TRF and TRF+RH groups. Despite QU and QULC are the same materials basically, the use of LC that was the corrector of QU caused rougher surface than QU alone and there was statistically significant difference between these two groups ($p<0.05$).

Table 2. Surface roughness (Ra) values (means±SD) of the implant attachment housings fixation materials used in the present study.

Groups	N	Means (±SD)
PSC	12	0.30 (±0.06)^{c}
PHC	12	0.20 (±0.05)^{a}
QU	12	0.15 (±0.02)^{a}
QULC	12	0.21 (±0.06)^{a,b}
UGH	12	0.28 (±0.11)^{b,c}
TRF	12	0.19 (±0.02)^{a}
TRF+RH	12	0.16 (±0.03)^{a}

DISCUSSION

Surface roughnesses of the dental materials are investigated widely in dental literature since, surface roughness effects surface free energy.[7-10] It means that rough surfaces of dental materials has a high surface free energy which causes more microbial plaque formation.[5] Thus, surface roughness of materials used for implant attachment housings have a special importance because these materials are in

contact with the most critical area which is the gingiva of the overdenture supporting dental implants. Also, the soft tissues of the overdenture supporting implants are completely covered by the materials that used for fixation of implant attachment housings. This situation also makes a suitable media for microbial bacteria accumulation.

In the dental literature, it was showed that denture plaque control has a great importance for long term oral tissue health.[10-16] It was showed that rough denture surfaces cause thicker dental biofilms than smooth.[17] It is also important that the tested materials in the present study are the materials that used in the intaglio surfaces of the prosthesis. It was suggested that the intaglio surfaces of the dentures shouldn't be polished. Thus, in the present study the tested materials were not polished. Instead of polishing, all the test surfaces were prepared on a smooth glass surface that are representing oral mucosa.

Surface roughness of dental materials such as composites, acrylic resins and other restorative materials were investigated in the dental literature. However, the authors of the present study couldn't find any literature comparing both acrylic resins and relining materials suggested for implant attachment housings. Charman *et al.*[17] showed that there was increased coverage of the denture with Streptococcus bacteria as the surface roughness increased. It was also showed that cold-cure acrylic resin tends to more plaque accumulation than heat-cure acrylic resin.[17] According to the results, self cure acrylic resin (PSC group) had also a rougher surface than the other tested groups except UGH.

It is necessary that the intaglio surfaces of the overdentures neighbor to the dental implants must be as smooth as possible for easy cleaning and hygiene measurements. The results of the present study was showed that QU group had the least rough surface comparing to the other tested groups. However, there was statistically no difference between the PHC, QU, QULC, TRF and TRF+RH. It means that use of these mate- rials for implant attachment housings fixation may cause similar bacterial formation considering to their surface roughness values. The roughest surface was observed at PSC and UGH groups and there was statistically no difference between these two groups. The use of LC, the correcting material of QU, caused a rougher surface comparing to use of QU only. However, the use of TRF with resin hardener caused a decrease in surface roughness. PHC group had rougher surface than QU, TRF and TRF+RH. In the present study correcting agent of the clinical hard relining materials were also investigated. Mostly, the correcting agents are used after intraoral denture relining. However, overdenture surfaces neighbor to the gingiva of implants may cause more plaque formation and peri-implantitis. According to results of the present study, hardening material for TRF (+RH) may be suggested to have lesser surface roughness. However, correcting material for QU (LC) caused rougher surface. The roughest surface was observed in self cure acrylic resin and the smoothest surface was observed in QU group in the present study.

It was showed that peri-implant mucositis and peri-implantitis do occur in totally edentulous patients and incidence numbers are high.[18] In the same study it was emphasized that strict oral hygiene measurements throughout life are mandatory to prevent peri-implantitis and mucositis to a minimum.[18] Smooth surface of dental materials may also cause easy surface cleaning of the surface of the overdentures. In the limitations of the present study, among the tested groups all the materials except self cure (PSC) and permanent hard relining (UGH) materials should be used for fixation of implant housings to the overdenture to insure the oral hygiene applications for patients causing less microbial plaque formation. However, it is necessary that the present study's results feasibility must be investigated in clinical conditions or in vivo.

CONCLUSION

According the results and in the restrictions of the present study,

1. It may be suggested that the fixation of the overdenture implant housings with PHC, QU, QULC, TRF and TRF+RH for less rough intaglio surfaces.
2. In the tested groups, the roughest surface was observed in the self-cure acrylic resin group.
3. There is a need for new studies that investigates the same materials in vivo.

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