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RESEARCH AND EDUCATION

Surface roughness and adaptation of different materials to secure implant attachment housings

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ABSTRACT

Statement of problem. Various materials are available to secure implant attachment housings in overdentures. Surface roughness and the adaptation of these materials to the denture base and the housings may increase the microcracks and bacterial adhesion at the interfaces in the long term. The surface characteristics of the interface between the denture base orientation material and the attachment housing have not been extensively studied.

Purpose. The purpose of this in vitro study was to evaluate the surface roughness and the adaptation of 5 different housing orientation materials to the housings and the denture base.

Material and methods. Fifty-five poly(methyl methacrylate) (PMMA) specimens (15 mm in diameter and 4 mm in height) were prepared with a clearance inside to allow the insertion of overdenture housings. Five different materials were used for housing orientation (Quick Up, Ufi Gel Hard, Tokuyama Rebase II Fast, Meliodent, and Paladent). The specimens were thermocycled 5000 times between 5°C and 55°C. The surface roughness (Ra values) of the specimens was measured with a noncontact profilometer. Scanning electron images were made in order to inspect the PMMA-orientation material-housing interfaces. The Kruskal-Wallis test was used to investigate the differences between the surface roughness values of the orientation materials, and the Iman-Conover test was used for pairwise comparisons (α=.05).

Results. The surface roughness values significantly differed between Quick up and Ufi Gel orientation materials only, and Quick up had smaller surface roughness values than Ufi Gel (P=.009). Microcracks were observed among the groups only at the junction of the orientation material and the housing after thermocycling.

Conclusions. Ufi Gel Hard showed the roughest surfaces around the overdenture attachment housings. The adaptation between the orientation material and the housing may deteriorate, and increased surface roughness and microcrack formation may be seen around the housings. (J Prosthet Dent 2016;■:■-■)

Implant-supported overdenture prostheses have advantages such as providing improved mastication, adaptation, and retention of the prostheses and lead to improved quality of life compared with conventional complete dentures.[1-3] Unlike conventional dentures, overdentures have an additional component inside the denture, the female part of the attachment system. The housings can be secured inside the denture base by using either direct or indirect methods.[2,3-5] The indirect method reduces the time spent chairside and avoids the contact of monomer with the tissues; however, laboratory procedures lengthen the treatment time and may require additional patient visits. The direct method is usually simpler, less expensive, and quicker than the indirect method. However, there is a risk of locking the prosthesis in the mouth with the direct method if the undercuts around the overdenture abutments are not blocked out properly.[3,5,6]

The most common material for overdenture fabrication is poly(methyl methacrylate) (PMMA), which has been used since 1937. Ease of manipulation, satisfactory esthetics, and low cost have made PMMA a popular

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Clinical Implications

All the tested orientation materials, except for Ufi Gel Hard, appear suitable for overdenture orientation. They produced smooth surfaces around the overdenture attachment housings and should minimize any soft tissue complications that may occur because of surface roughness and microcracks.

option.[7,8] However, the denture base may be thin around the implant attachment housings, and PMMA base fractures have been reported.[8]

Generally, autopolymerized PMMA resin is used to secure the attachment housings in the overdenture base.[5] Autopolymerized resin is also used for denture repairs and bonds well with the denture base resin, as both of them are PMMA resins.[2] In addition, different kinds of hard relining materials and attachment orientation materials are commonly used for housing orientation in overdentures.

The bond between the orientation resin and the denture base and orientation resin and the housing is important for the success and longevity of an overdenture.[2] Some authors have reported that no true chemical bonding occurs between different acrylic resins.[9] To improve the mechanical properties of the hard denture relining materials, cross-linking agents have been added. A low penetration of the monomers with greater molecular weight has been reported; thus, bond strength of the reline materials cannot be high.[10]

The lack of bonding between overdenture components and acrylic resin may weaken the prosthesis. In addition, gaps that form as a result of adhesion failure can lead to microleakage between the orientation material and the housing. These gaps may serve as a passage of fluids and microorganisms and can increase staining and accelerate discoloration.[10-15] The unpolymerized surface of the autopolymerized resin could be another reason for staining, and the color stability of the relining materials are inferior to the heat-polymerized PMMA.[12,15] Another factor that effects plaque accumulation, staining, and discoloration is the surface roughness. The surfaces of the dentures should be as smooth as possible in order to achieve optimum oral hygiene, reduced plaque accumulation, and favorable esthetics. The surface roughness values of the repair materials have been reported to be greater than that of PMMA.[3,15,16] To the authors' knowledge, no studies have assessed the surface roughness at the interface between the denture base-orientation material and the attachment housing and their adaptation in detail after thermal changes have been applied.

The purpose of this in vitro study was to evaluate the surface roughness of 5 different orientation materials (Quick Up, Ufi Gel Hard, Tokuyama Rebase II Fast, Meliodent, and Paladent) and the denture base-orientation material attachment housing adaptation using scanning electron microscopy (SEM) after thermocycling. The null hypothesis was that the surface roughness and adaptation of different housing orientation materials would be similar to those of the denture base and housings.

Table 1. Resins used for housing orientation

Brand	Manufacturer	Lot No.	Type
Ufi Gel Hard	Voco GmbH	1537441	Acrylic-based hard relining resin
Tokuyama Rebase II Fast	Tokuyama Dental Corp	077E85	Acrylic-based hard relining resin
Quick Up	Voco GmbH	1539091	Composite resin
Meliodent Heat Cure	Heraeus Kulzer		Heat-polymerized acrylic resin
Paladur	Heraeus Kulzer		Autopolymerizing acrylic resin

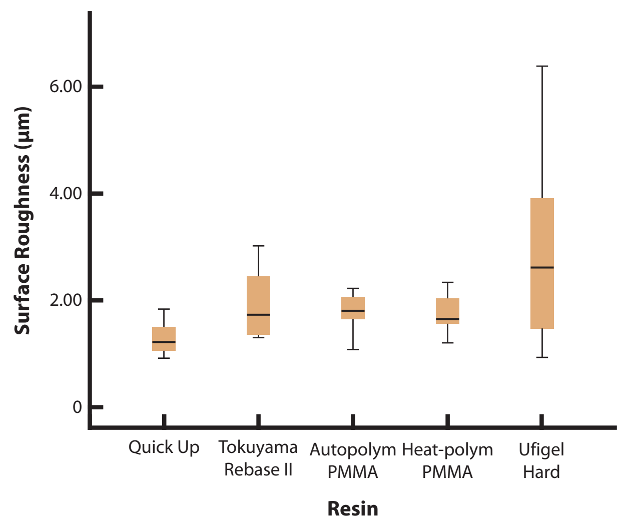

Figure 1. Surface roughness of resins. Error bars show standard deviations.

MATERIAL AND METHODS

Fifty specimens were prepared to evaluate the adaptation characteristics and surface roughness of 5 orientation materials. The sample size was calculated using the equation

$$n=\frac{\alpha^2\times\sigma^2}{d^2},$$

where n is the number of specimens, α is a Type I error, σ is variance, and d is effect size; a minimum of 50 specimens was needed to achieve a 94% power.

Denture base replica specimens were prepared from PMMA (15 mm in diameter, 5 mm in height). The housings used in the study were titanium-aluminum