ORIGINAL ARTICLE

Surface roughness changes of two composite resin restorative materials after thermocycling

Taanya Imtiaz, S. Balaji Ganesh[1], S. Jayalakshmi[1]

Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, [1]White Lab - Materials Research Center, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

J. Adv. Pharm. Technol. Res.

ABSTRACT

Composite is usually a mixture of two phases. The composites used in dentistry have high durability. The individual properties of each phase are important to increase the mechanical property of the composite. This study aimed to determine the surface roughness changes of two composite resin restorative materials after thermocycling. Two of the commercially available composites were chosen (RestoFill and SwissTEC). The composite disks of dimension 10 mm diameter and 3 mm height were prepared using silicone molds, and every increment was light cured for 30 s. A stylus profilometer was used to assess the surface roughness prethermocycling, and then, the disks were subjected to an integrated thermocycler (T.S-4.4) for 1000 cycles. The postsurface roughness was obtained after the thermocycling process using the same stylus profilometer. The surface parameter values before and after thermocycling of the SwissTEC sample is less than that of RestoFill. There was a significant difference between the Rz and Rq values of the two different commercially available composite materials. Thus, the present study concludes that thermocycling influenced the surface roughness of composite resin and increased the surface roughness of both the RestoFill and SwissTEC composites.

Key words: Composite resin, innovative measurement, surface roughness, thermocycling

INTRODUCTION

In dentistry, composite is an esthetic filling material so that it is used efficiently in endodontic specialties and restorative dentistry.[1] Composite materials are actively and successfully used in restorative dentistry because they are highly durable and biocompatible.[2] Composite materials are similar in their role, which are used to restore the structure of an injured or broken tooth in restorative dentistry. The composite materials are mostly used in filling the injured posterior teeth in recent times.

Composite is usually a mixture of two phases; the most commonly used composite is resin composite which is composed of resin polymer and glass fillers.[3] As the composite used in dentistry is a hybrid of two constituents, the composites used have high durability. However, there are failures of composite materials noted in few studies,[4] stating the degradation of the composite materials due to abrasion, wear of the composite material, and enzymatic and hydrolytic action.[5,6] Degradation of composite materials is a process that leads to microleakage of the teeth that are restructured. The mixture of different substances

Address for correspondence:
Dr. S. Balaji Ganesh,
White Lab - Materials Research Center, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai - 600 077, Tamil Nadu, India.
E-mail: balajiganeshs.sdc@saveetha.com

Submitted: 27-Apr-2022 **Published:** 30-Dec-2022
Accepted: 05-Aug-2022

Access this article online	
Quick Response Code:	Website: www.japtr.org
	DOI: 10.4103/japtr.japtr_255_22

How to cite this article: Imtiaz T, Ganesh SB, Jayalakshmi S. Surface roughness changes of two composite resin restorative materials after thermocycling. J Adv Pharm Technol Res 2022;13:S466-9.

results in the formation of different composite materials; the individual properties of each material are important to increase the mechanical property of the composite.[7,8]

Surface roughness is the value of the texture on the surface of a material. Surface roughness is crucial in restorative dentistry as it attracts the plaque formation, discoloration, and mechanical wear of the composite materials.[9] Thermocycling is a method that exposes the required material to a wide range of temperatures to determine the compatibility and strength of composite materials.[10] Surface roughness is determined by the calculation of Ra, Rz, and Rq values. Ra value in surface roughness determines the vertical deviations from the initial sample. Hence, the surface roughness is crucial in determining the durability of the composite material. Thus, the composite materials are substances with good physical and elastic properties, but their durability also depends on the environment of the oral cavity.[11] Our research and knowledge have resulted in high-quality publications from our team.[12-26] This study aimed to determine the surface roughness changes of two composite resin restorative materials after thermocycling.

MATERIALS AND METHODS

RestoFill and SwissTEC are flowable composite materials used for the *in vitro* testing. Five samples were prepared from each composite material, as shown in Figure 1. The sample size was examined and reviewed by the institutional review of board. A round mold with 10 mm diameter and 3 mm height was prepared, and using a Teflon instrument, the composite materials were filled into the mold carefully. The filled mold was then light-cured for 30 s in two intervals. The composite disks were removed from the mold and polished using a micromotor, and the composites' disk dimensions were measured using a digital caliper for uniformity of the sample.

The surface roughness before thermocycling of the prepared composite disks was determined using a stylus profilometer SJ310 Mitutoyo with the diamond-tipped stylus (tip size 2 mm), as shown in Figure 2. After obtaining the presurface roughness, the composite disks were thermocycled at 10°C (cold) and at 60°C (hot) in an integrated thermocycler, TC-4 SD Mechatronik for 1000 cycles which equated for 6 months. The dwell time was set to be 30 s and the drain time to be 10 s in every cycle. The postsurface roughness was obtained after the thermocycling process using the same stylus profilometer. The surface roughness of the composite materials before and after the thermocycling process was obtained and tabulated. SPSS software version 21.0 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) was used to analyze the results using independent sample tests and was graphically represented.

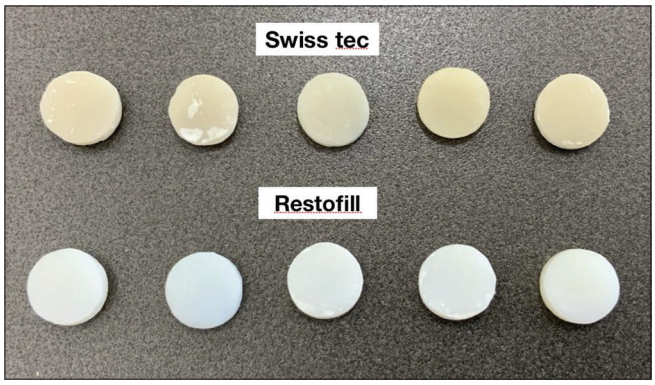

Figure 1: SwissTEC and RestoFill composite samples

RESULTS

Table 1 represents the values of the samples that were calculated and tabulated for better descriptive understanding of the influence of thermocycling on the surface roughness of composite. From the data obtained, the results were calculated and found that the SwissTEC composite material had comparatively lesser surface roughness pre- and post-thermocycling compared to RestoFill type.

DISCUSSION

RestoFill has greater surface deviation before and after thermocycling than SwissTEC (based on the Ra values of the two samples). Moreover, using the independent sample test, the *P* value was obtained as 0.080 which is >0.05; thus, the Ra values are not significant. Moreover, it was found that the Ra values of both RestoFill and SwissTEC were high after thermocycling, but SwissTEC had less surface roughness compared to RestoFill.[27]

The surface roughness was found to be comparatively less in SwissTEC composite than RestoFill composite before thermocycling. The surface roughness was found

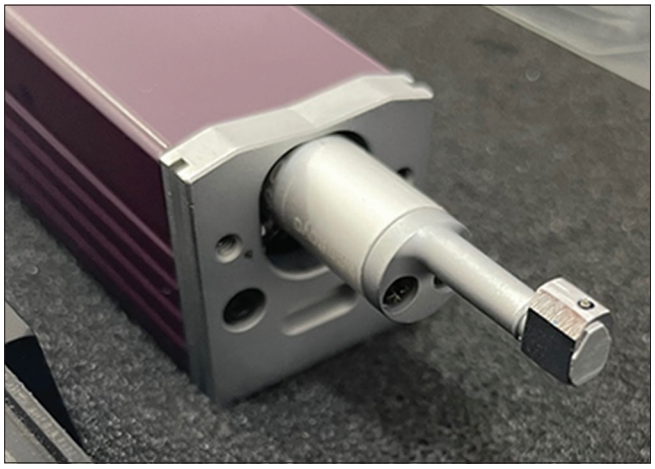

Figure 2: The diamond tip of the stylus profilometer

Table 1: The mean of Ra, Rq, and Rz and standard deviation values of SwissTEC and RestoFill

Groups	*n*	Mean	SD	Significance
Ra mean difference				
RestoFill	5	−0.0280	0.00837	0.080
SwissTEC	5	−0.0220	0.01789	
Rq mean difference				
RestoFill	5	−0.0340	0.02702	0.010*
SwissTEC	5	−0.0440	0.01140	
Rz mean difference				
RestoFill	5	−0.2040	0.33813	0.034*
SwissTEC	5	−0.3620	0.12755	

$P<0.05$, Hence statistically significant. SD: Standard deviation

to be comparatively less in SwissTEC composite than RestoFill composite after thermocycling. Hence, based on the Rz values of the two composites, SwissTEC is a better commercially available composite than RestoFill both before and after the thermocycling process based on the Rz values. Moreover, using the independent sample test, the *P* value was obtained as 0.010 which is <0.05; thus, the Rz values are significant. Both the composites show remarkable differences before thermocycling; thermocycling tends to increase the surface roughness of both the composite materials. Thermocycling increases the surface roughness because it causes the hydrolysis of the coupling agents influencing stress to the matrix filler, which is associated with a significant increase in the surface roughness.[28,29]

The Rq parameter before and after thermocycling was calculated and determined that the SwissTEC had less surface presurface roughness when compared to RestoFill, so SwissTEC is a better composite even before the process of thermocycling. Hence, overall, the SwissTEC composite shows less surface roughness than RestoFill because of less deviation from the initial surface roughness before and after thermocycling. Hence, it is a good commercially available composite. Good commercially available composites should have good properties.[30] The ideal properties includes increased durability, high srength, good resistance to mechanical wear, low density and resistance to creep. Hence, the commercially available SwissTEC composite may be a better choice than RestoFill because of the less surface roughness before and after the thermocycling process. The study had a few limitations, including a small sample size and the possibility of including more than 2 composites to provide a better selection of commercially accessible composite materials. Only the surface roughness was discovered; the study may have included other variables. The thermocycling procedure was limited to 1000 cycles.

CONCLUSION

The surface roughness of composite resin was altered by thermocycling; the present study's conclusion being that it raised the surface roughness of both the RestoFill and SwissTEC brand composites.

Acknowledgments

The first author is grateful to the White Lab for helping to finish the field work on stimulated time.

Financial support and sponsorship

The study was financially supported by Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, and Faamys Fashions, Chennai.

Conflicts of interest

There are no conflicts of interest.

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