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Evaluating The Effect Of Propolis On Surface Roughness And Wettability Properties Of The Addition Silicon Impression Material

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Abstract

Dental impression materials should always be disinfected after contact with a patient's blood, plaque or saliva to prevent contamination from spreading. The disinfectants could have an effect on the surface roughness and wettability properties. The purpose of this study was to investigate the effect on the surface roughness and wettability properties of addition silicon impression material after immersion in two disinfectants (5.25% NaOCL for 10 min and 16 mg/ml propolis for 5,10, and 15 min). 50 heavy- and light-body addition impression materials specimens were randomly divided into test groups of five specimens for each test. The impression specimens were immersed into two disinfection solutions: 5.25% NaOCL for 10 min and 16 mg/ml propolis for 5,10,15 min but the control group received no treatment. A digital Profilometer was used to measure surface roughness while a Goniometer was used to measure the contact angle which was used to estimate the specimens' wettability. Accordingly, the study has s found that there was no statistically significant difference between the addition silicon imprint material's wettability and the surface roughness (P>0.05) when compared to the control group. The immersion in 16% propolis for 10 minutes shows no significant effect on the addition's wettability or surface roughness.

Keywords: Addition Silicon, Dental Impression Disinfection, Propolis, Surface Roughness, Wettability.

INTRODUCTION

Dental impressions are used to accurately record and replicate the patient's teeth shape and relationship to other oral structures in the patient's mouth[1]. They are almost contaminated with potentially harmful germs when they come into contact with oral tissue covered in blood, saliva, or plaque. Due to this, dental professionals, dental assistants, and laboratory workers may be exposed to contagious diseases, which can result in cross-contamination[2]. It is a common practice to disinfect impression material by immersing or spraying it[3]. However, the American Dental Association (ADA) advises using the immersion method since it enables a direct contact with cleaning agents on all impression surfaces[4]. Immersion disinfection reduces the risk of cross-infection but it has frequently been seen to have a negative impact on the quality of the cast produced and to change the dimensions of the impression materials[5,6]. Therefore, it is possible that the dental cast prosthesis's dimensions will change, which will eventually affect the ultimate restoration's ability to fit [7]. As advised by the Advisory British Dental Association Service, impression materials are frequently washed with tap water during routine dental procedures. However, even though part of the bacteria adhered to a dental impression's surface may be eliminated as a result, a considerable amount is still left, irrespective the fact that some countries' tap water contains halogenated chemicals[8]. This process kills almost 90% of the bacteria on the impression's surface[9]. A significant portion of the bacteria would survive, though. Disinfection solutions are advised in light of the most recent guidance[10]. Making an informed choice is difficult due to varying viewpoints on the best disinfection procedure[11]. The most popular disinfectants include sodium hypochlorite, chlorhexidine, alcohol, glutaraldehyde, and hydrogen peroxide[12]. It is essential to pick a disinfectant with strong antibacterial characteristics without altering the dimensional stability or surface qualities of the imprint as there is no universal disinfectant for all impression material[13]. It was also possible to utilize a variety of impression materials and disinfection combinations because the market offered a large selection of branded impression materials, including reversible and irreversible hydrocolloids, polyethers, polysulphides, and silicones, and gypsum-based castings. A disinfectant must maintain the original size of the gypsum model or the impression material while effectively destroying bacteria. This is crucial for a finished product to fits properly and perform as intended. Whether the disinfecting method worsens the impression or alters it is a matter of debate[14]. Due to their many advantages, elastomeric impression materials are frequently employed. Polyvinyl siloxane and polyether are two examples of such compounds that are most widely used and frequently come into contact with human saliva and blood, contaminating the stone cast[15]. Addition Silicon is a hydrophobic substance. Because of its increased antiseptic efficiency and ability to accommodate for the polymerization shrinkage of these materials, which enhances accuracy, the ADA suggests utilizing immersion, preferably in elastomers. One of the most effective ways to avoid cross-contamination is immersion[16]. An inexpensive, reliable disinfectant that is always present in dental offices is sodium hypochlorite which is a water-soluble disinfectant used for surface and water disinfection. When dissolved in water, it creates a hypochlorous acid that then breaks down into hydrochloric acid and oxygen atoms, having a powerful oxidizing effect[17]. According to the ADA guideline, it has a quick, powerful, and broad-spectrum antimicrobial impact[18]. The addition silicone dental impressions are disinfected by immersing them in 5.25% sodium hypochlorite; this demonstrates a good antimicrobial efficiency with no discernible alterations to the three-dimensional shape of the addition silicone dental impressions[16]. As a result, it served as a positive control in this investigation. Propolis is a naturally occurring dark-colored resin substance that bees collect from plant exudates and shoots for use in nest construction and hive adaptation, particularly to fill openings in their beehives, thus they mix propolis with wax for these purposes. Since ancient times, propolis has been utilized in traditional medicine[19]; it is successfully used in dentistry and exhibits anti-inflammatory, antibacterial, antifungal, hemostatic, and favorable responses to superficial tissue remodelling capabilities[20, 21, 22, 23, 24, 25, 26]. The null hypothesis assumes that there is no significant effect on surface roughness and wettability properties of addition silicone materials after immersion in 16 mg/ml Propolis disinfectant for 10 min.

MATERIALS AND METHODS

- Heavy- and light-body addition silicon impression materials (Zhermack, DC, Germany).
- Sodium hypoclorite (5.25%, AQUA, Turkey).
- Propolis (As-sajad Beehives, Balad, Salahuddeen, Iraq).
- Alcohol 96%.
- a VINO Contact Angle Goniometer (China) for wettability test (University of Babylon).
- the digital roughness tester, stylus type, (Profilometer, JIMEC., China) for surface roughness test (Anwar Ar-razi Laboratory).

Preparation of propolis disinfectant

Propolis, 16 mg/ml, was prepared by adding 1.6 gram of the propolis of Salahuddeen, Iraq in a container and complete the volume to 100 ml by 96% of ethanol. Propolis and alcohol combined in the container; the lid sealed; and the mixture was shaken twice a day for two weeks in a warm dark environment. Then, the mixture filtered through a clean, extremely fine paper filter. The filtrate was a clear pure liquid that ranges in color from dark brown to slightly reddish. It was store in clean dark airtight containers[27, 28, 29].

Preparation of specimens

The used mold was in the form of a disc, 20mm in diameter and 2mm thick[30]. Twenty five specimens of putty soft addition silicon impression materials (Zhermack, DC, Germany) were prepared per each test according to the manufacturer's recommendations. They then were split into two groups of five specimens for each: a control positive (5.25% NaOCL) for 10 min, and a test group (16% Propolis) for 5, 10, 15 min. Both sodium hypoclorite (5.25%, AQUA, Turkey) and propolis (16mg/ml, newly manufactured) were utilized as disinfectants. The mold was placed on a clear glass plate before it had been overfilled. Pressure was applied for five seconds on a second glass slab of a similar size placed on the mold's apex. The samples were removed from a water bath that was held at 35 °C to mimic the temperature of the mouth after the specified amount of time[31].

Experimental design

A: Control group receive no treatmemt.

B: NaOCL group immersed for 10 min.

C: propolis group immersed for 5 min.

D: propolis group immersed for 10 min.

E: propolis group immersed for 15 min.

Evaluation of wettability

A VINO Contact Angle Goniometer (China) was used to measure the wettability of all specimen surfaces. The samples were put in their proper places on the mechanical stage of the goniometer. The surface of the specimens was moistened with one drop of distilled water by using an already inserted needle at room temperature. Using high resolution digital camera-equipped optics equipment, the falling water could be viewed. The moment the distilled water drop touched the surface of the specimen, many pictures were captured. After the drop landing, for a minute, the contact angle was measured immediately. On the right and left sides of the image, each drop's contact angle was measured twice. By averaging the two readings, the contact angle for each specimen was finally calculated[32, 33].

Evaluation of surface roughness

The stylus type, digital roughness tester, contacting surface roughness (Ra) measuring device (Profilometer, JIMEC., China) was used to measure the surface roughness of the specimens with a precision of (0.001 m). Ra is a measure of the roughness of the specimen's average surface[34]. The sample was set down on a firm, stable surface during the period of measurement. while maintaining contact with the surface, a diamond-tipped contact stylus profilometer makes physical motions in the directions of X, Y, and Z. The surface roughness was measured on the whole surface of each specimen, and then the mean was found.

RESULTS

The data met the fulfillment assumption of normal distribution and homogeneity of variance and the results showed that that there is an insignificant effect, i.e., normal distribution of data($P>0.05$).

Table (1) Descriptive Statistics of Wettability and Surface Roughness; Mean, Std Deviation, Std Error.

wettability	Test groups	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
	A	5	63.9858	6.21291	2.77850	56.2714	71.7001	54.13	70.95
	B	5	72.9701	2.55396	1.14216	69.7989	76.1412	70.61	76.87
	C	5	64.6253	3.31085	1.48066	60.5143	68.7362	59.99	67.95
	D	5	64.6012	3.99551	1.78685	59.6401	69.5623	61.53	71.37
	E	5	66.1531	3.77160	1.68671	61.4701	70.8362	61.97	71.88
	Total	25	66.4671	5.09160	1.01832	64.3654	68.5688	54.13	76.87
Surface roughness	A	5	.1938	.00923	.00413	.1823	.2053	.19	.21
	B	5	.1846	.00451	.00201	.1790	.1902	.18	.19
	C	5	.2334	.00999	.00447	.2210	.2458	.22	.25
	D	5	.1954	.00568	.00254	.1883	.2025	.19	.21
	E	5	.2020	.00806	.00361	.1920	.2120	.19	.21
	Total	25	.2018	.01849	.00370	.1942	.2095	.18	.25

Table (2) ANOVA statistics of Wettability and Surface Roughness.

wettability		Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared
	Between Groups	277.090	4	69.273	4.015	.015	0.45
	Within Groups	345.095	20	17.255			
	Total	622.185	24				
Surface roughness	Between Groups	.007	4	.002	28.904	.000	0.875
	Within Groups	.001	20	.000			
	Total	.008	24				

*Eta Squared - 0.01 (small effect), 0.06 (medium effect), 0.14 (large effect).

*The effect size value of Eta Squared was > 0.14 (Large effect).

Table (3) Multiple Comparisons (Post Hoc Tests) of Wettability and Surface roughness

wettability	Test groups	Mean Difference	Std. Error	Sig.	Lower Bound	Upper Bound
	A to B	-8.98430*	2.62715	.003	-14.4644	-3.5042
	A to C	-.63950	2.62715	.810	-6.1196	4.8406
	A to D	-.61544	2.62715	.817	-6.0956	4.8647
	A to E	-2.16736	2.62715	.419	-7.6475	3.3128
	B to C	8.34480*	2.62715	.005	2.8647	13.8249
	B to D	8.36886*	2.62715	.005	2.8887	13.8490
	B to E	6.81694*	2.62715	.017	1.3368	12.2971
	C to D	.02406	2.62715	.993	-5.4561	5.5042
	C to E	-1.52786	2.62715	.567	-7.0080	3.9523
	D to E	-1.55192	2.62715	.561	-7.0321	3.9282
Surface roughness	A to B	.00920	.00492	.076	-.0011	.0195
	A to C	-.03960*	.00492	.000	-.0499	-.0293
	A to D	-.00160	.00492	.748	-.0119	.0087
	A to E	-.00820	.00492	.111	-.0185	.0021
	B to C	-.04880*	.00492	.000	-.0591	-.0385
	B to D	-.01080*	.00492	.040	-.0211	-.0005
	B to E	-.01740*	.00492	.002	-.0277	-.0071
	C to D	.03800	.00492	.000	.0277	.0483
	C to E	.03140	.00492	.000	.0211	.0417
	D to E	-.00660	.00492	.195	-.0169	.0037

DISCUSSION

The surface roughness and wettability of the addition silicon material was unaffected after immersion in 16 mg/ml propolis for 10 minutes as demonstrated by the current study. The null hypothesis was therefore acceptable. Due to its superior physical qualities and handling characteristics, addition silicone as synthetic elastomeric impression substance, is now the material of choice in many clinical settings[35;36]. However, it is recommended that impression materials be examined individually in order to assess the disinfectant's efficacy and provide a proper disinfection strategy. Immersion disinfection is the best practice since it guarantees that the impression tray and the entire impression will be covered with the disinfectant agent. Additionally, the CDC and ADA advise that the maximum immersion disinfection times for elastomeric materials be no longer than 30 minutes [37, 38]. Finding a disinfectant that is effective against bacteria that is also simple to apply, affordable, and unlikely to change the fundamental characteristics of impression materials is essential. The only method that works to get rid of bacteria in dental impressions is to employ chemical agents because heat cannot sterilize them[39]. One of the substances employed for disinfection in recent years is propolis[29] which was tested against other disinfectants to see how well it disinfected dental impressions contaminated with C. albicans. Since the propolis in alcohol has useful antimicrobial activity,[29] this solution was used in the present study. NaOCl was employed in the present investigation as the gold standard since it is the best disinfectant for addition silicon impression material according to ADA recommendation. In 10 minutes, its 5.25% concentration was utilized. This disinfectant has several benefits, such as low cost, high efficacy, and the capacity to disinfect equipment and instruments[40], as well as quick action against a wide range of microorganisms[41]. However, one of its drawbacks is its high contact angle, which leads to limited wettability[42].

Surface tension, a contractile force that exists within liquids, inhibits drop from spreading over a solid surface and promotes drop formation. Wetting is the process of a drop spreading out on a solid surface. A surface's ability to be wettable by a specific liquid is determined by the increasing contact angle. The likelihood of air accumulating on the surface increases with higher contact angle, which could result in cavities in the impression or dies. As a result of evidence that has showed a relationship between the contact angle of water on the impression material and the quantity of bubbles formed in the dies, moistening the impression surface with a die stone is essential[43]. The elastomeric (silicone) impressions should be treated with a wetting agent, typically a detergent, before pouring the cast because these impression surfaces are hydrophobic[44]. The samples in the current investigation were washed and dried before being tested for wettability; no surface wetting agent was employed. The contact angle measurement used in this investigation was limited because it was done on a flat surface rather than the non-flat surfaces of "actual" dental impressions. Roughness of the surface is another key issue. The dental cast and, ultimately, the prosthesis, should represent how accurately an imprint material captures the characteristics of the mouth cavity. The surface of a cast made from a rough imperfect impression will be rougher than the rough imperfect impression. As a result, the degree of roughness of the impression should not be affected by sterilizing and disinfecting procedures. A roughness value of less than 0.2 m is appropriate for any prosthesis, since values higher than this threshold may indicate significant plaque buildup and values lower than them may indicate additional food reduction or plaque growth that cannot be predicted. The soft tissues that support a prosthesis may easily get inflamed due to the rougher surfaces of the device [45–46]. A shift in hydrophilicity and surface roughness may come from disinfectant treatments that modify the surface chemistry of an imprint material, according to some study.

CONCLUSION

Within the parameters of the study, the null hypothesis assumes that there is no significant effect on the surface roughness and wettability properties of addition silicone materials after immersion in 16 mg/ml propolis disinfectant for 10 min.

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