MDJ
Investigation the Effect of Different Oils as… Vol.:18 No.1: 2022

Investigation the Effect of Different Oils as Separating Medium on Surface Roughness and Hardness of Tissue Surface of Flexible Denture Base

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Abstract

Background: Flexible dentures (thermoplastic material) are ideal alternatives to traditional methyl methacrylate dentures, since they not only give exceptional aesthetics and comfort, but also adapt to the continual movement of partially edentulous patients. During the manufacturing of acrylic denture base material, an effective separating medium must be used to separate the denture cleanly from the plaster to avoid direct contact between the denture base material and the mould surface.

Objective: The goal of this study was to investigate the effect of several types of oil (glycerin oil, olive oil, and black castor oil) on the surface roughness and hardness of flexible denture base material compared with cold-mould seal separating medium.

Methodology: 32 square shaped specimens of valplast resin with dimension of (2 cm length x 2 cm width x4 mm thickness) were fabricated and divided into four groups (n=8) according to the types of separating media utilized in this investigation: group A: cold mold seal (control group), group B: glycerin oil, group C: olive oil, and group D: black castor oil. For each group 2ml of separating medium applied by fine brush on the stone surface. Following the processing of flexible resin, surface roughness was measured in µm using the profilometer device and surface hardness (shore D) was used in scale D. The data were statically analyzed, using one -way ANOVA test and LSD test

Results: The lowest value of surface roughness was found in cold mould seal group (1.85 ± 0.57 µm) while black castor oil group showed the highest value with (2.77± 0 .73 µm). There was no statistically significant difference between the surface roughness of the flexible denture base material processed using cold mould seals and glycerin oil also between glycerin oil and olive oil ($p>0.05$). Black castor oil showed the highest value of surface hardness (62.65± 2.40) followed by glycerin oil (57.96±6.27), then olive oil (56.93± 7.53) and finally by cold mold seal (52.09±3.35).

Conclusion: the surface roughness of flexible denture base was decreased by using cold mould seal and olive oil as separating medium while the surface hardness increased by using black castor oil.

Keywords: flexible denture, surface roughness, surface hardness, separating medium, glycerin oil

Introduction

The introduction of flexible dentures made it easier for tackling such problems while fabricating dentures. The nature of flexible denture material which is flexible and strong at the same time makes it excellently adapted to the wide range of natural conditions in the mouth, simplifying design and allowing the flexible nylon resin to work as a built-in stress-breaker for enhanced function and stress distribution [1].

The flexible denture base was introduced in order to improve both aesthetic and functional limitations of conventional removable partial dentures. Flexible denture base resin is ideal for partial dentures and unilateral restorations [2]. The resin is a biocompatible thermoplastic nylon with unique physical and aesthetic qualities that allows for maximum design flexibility and removes the risk of allergic reactions to acrylic. The flexible partial permits the restoration to adjust to the patient's mouth's continual mobility and flexibility. It was noted that the flexibility, when paired with strength and lightweight, delivers comprehensive comfort and beautiful appearances [3].

A separate media is either a coating applied to a surface to prevent a second surface from sticking to the first, or a material added to an imprint to make the cast easier to remove [4].

Separating media are materials that are poured against a porous surface in order to facilitate the separation of other materials that are poured on them subsequently. As a result, the acrylic resin must be properly protected from the gypsum surface in the mold gaps during processing [5]. It is one of the most important factors in the success of dental prostheses because of its effect on polymerization rate as well as the optical and physical properties of the resulting denture base materials. [6]. Separating media are either Sheets, such as rubber dam, tin foil, and cellophane, were laid over the surface of the mould to offer the requisite protection, or liquids, such as alginates, were painted on to the empty mould to seal the pores of the investment [7], producing a very fine layer on the applied surface. For acrylic work, oil such as vaseline have been utilized as a separating medium [8] Glycerin was also used for heat cure and auto polymerizing resin [9] others have used olive oil and glycerin oil as separating media [10].

Because there is a clear correlation between adherent candida albicans and surface roughness, the surface qualities of any denture base material are of special concern [11]. The denture base's surface roughness contributes to bacterial colonization; microbe adherence to a surface is required for colonization. Surface roughness has clinical implications since it can affect biofilm formation or make it difficult to remove [12].

In prosthetic and dental restorative materials, a clinically acceptable threshold level of surface roughness (Ra) of 0.2 µm is required where no further reduction in plaque collection is expected [9].

Furthermore, the Hardness is a key attribute in dentistry because it indicates how easy a structure can be finished and how resistant it is to service scratching. Hardness is defined as a material's resistance to plastic deformation as measured by an indentation load [13]. The Brinell, Knoop, Vickers, Rockwell, Barcol. The most common methods for testing the hardness of restorative materials are shore hardness tests. Each of these tests differs slightly from the others, but they all rely on the penetration of a small, symmetrically sharped indenter into the surface of the materials under test. The selection based on the material of interest and the anticipated hardness extent [14].

Because of the significance of these characteristics in clinical and material execution, the current investigation was aimed to estimate and compare the surface roughness and micro hardness of flexible denture base material processed with different separating media (glycerin oil, olive oil, and black castor oil) to those processed with cold-mould seal separating media.

2. Materials and Methods

2.1 Mould preparation

Eight square shaped wax patterns were constructed with dimensions of (2 cm x 2 cm x4 mm) length, width, and thickness respectively. This was done by sticking two sheets of base plate wax (Shanghai New Century Dental Materials Co., Ltd.) each with 2mm thickness together, then using a wax knife and ruler to cut out the square specimens. The dimensions of the wax patterns were measured by a caliper device (Renfert GmbH, Germany) with an accuracy of 0.01mm. Major sprues(6-8mm) in diameter and minor sprues (4 mm) in diameter (Renfert GmbH, Germany) was prepared and attached to each wax pattern. Other sprues were attached to the specimen to allow the compressed air to escape during injection procedure [15].

2.1.2 Flasking of wax pattern

The conventional flasking technique was followed. The slurry of dental stone type 3(Zhermack, Italy) was employed as directed by the manufacturer and poured into the dental flask’s lower half that was painted previously with separating medium (Isodent, SpofaDental, Czech Republic) then the wax patterns were positioned inside the dental flask into half of their thickness. After the stone was set it was coated with a separating medium (Isodent, SpofaDental, Czech Republic) and then poured by the second mixture of dental stone. After the complete setting of dental stone de-waxing was done by placing the flask in boiling water then removing from the water, open the flask, clean the excess of wax by boiling water. A total of 32 specimens were prepared from flexible acrylic resin. Divided into four groups (according to the types of separating medium that used in this study during packing). 8 specimens for each group: group A: used cold mould seal as separating medium and considered as control group, group B: used glycerin oil as a separating medium, group C: used olive oil as a separating medium and group D: used black castor oil as a separating medium. Disposable syringe was utilized to measure 2cc (2ml) of separating media. Apply a thin coat of separating media onto the stone surface in each half of the flask by fine brush [16].

2.1.3 Procedure of injection

After the wax was eliminated, the molten thermoplastic material (Valplast, International Corp New York) was injected according to the manufacturer's instructions. An injection –molding machine (AX-YD Manual Injection System, China) was used with the metallic cartridge containing thermoplastic grains that were heated to plasticize the resin at an injection pressure of 5bars, 550 to 560°F for 15 minutes. Once the processing was completed, the flask was allowed to cool at ambient temperature. This was followed by finishing. The prepared specimens were conditioned in distilled water for 48 hours before being subjected to the surface roughness and Shore D hardness tests [8].

2.2 Surface roughness test

The surface roughness test was performed on 32 specimens using the profilometer device (SRT-6200S Surface Roughness Tester, China) of ≤±10 % accuracy. Each specimen was set on a firm and stable foundation. (figure1). The device was regulate so that the stylus just touched the specimen's surface, and then the stylus was crossed along the specimen’s surface in the right direction with a length of (5 mm and a cut-off of 0.25) the final reading showed on the digital scale [17]. For each specimen, three surface roughness measurements were taken, and the statistical analysis was based on the mean average (Ra) values. Micrometers were used to express the results [18] [19].

2.3 Surface hardness test

In this investigation, a shore D hardness tester (ShoreD, HT-6510A,BYQTER,China) was utilized to measure the indentation or hardness of the specimens (figure 2). The Shore D hardness equipment was positioned vertically over a flat sample on a level, stiff platform. After three seconds of solid contact with the specimen, the indenter was driven down swiftly and forcefully on the specimen to capture the maximum reading. The reading was taken from the reading scale D directly. To avoid measurement errors, the shore hardness tester's contact surface must be parallel to the specimen support of the test stand. The distance between the specimen surface and the hardness tester's indenter should be between 5 and 12 mm. The contact period between the specimen and the indenter was set at 6 seconds during the test, and the load was around (5 N). Three spots were marked on each specimen with a 6 mm spacing between them, and the hardness value was computed using the average of these three readings with scale D. After taking the measurements directly from the scale, the reading was calculated [5,19]. All the data were statistical analysis by using SPSS software package for social sciences, version 20. The data were presented for each group as mean and standard deviations and One way ANOVA was done for all tested groups followed by multiple comparison test LSD (least significant difference) for comparison the difference between the different pairs of the four groups.

3. Results

3.1 Surface roughness

The surface roughness mean values and standard deviations (SD) of the studied groups with different separating media are presented in (figure 3). Inferential statistical methods represented by analysis of variance “ANOVA” test showed that the surface roughness of cold mould seal group and olive oil group were lower than the other 2groups.The statistical analysis showed that there was no statistically significant difference at (P>0.05) between cold mould seal group (1.85±0.57 µm), olive oil group (1.91 ±0.87 µm), and glycerin Oil group (2.27±1.06 µm). No significant difference was found when compared glycerin oil group (2.27±1.06 µm) with olive oil group (1.91 µm±0.87 µm) and black castor oil group (2.77±0.73 µm) (p>0.05), but when compared black castor oil group (2.77±0.73 µm) with cold mould seal group (1.85±0.57 µm) and olive oil group (1.91 µm±0.87 µm) there was significant difference as shown in table (1) (p<0.05).

3.2 Surface hardness

Surface hardness mean values and standard deviations (SD) of the tested groups with different separating medium are presented in (figure 4). Inferential statistical methods represented by analysis of variance “ANOVA” test showed that the surface hardness was the highest in black castor oil group (62.65±2.40). There was no statistically significant difference at (P>0.05) when compared between cold mould seal group (52.09±3.35) and olive oil group (56.93±7.53) also when compared glycerin oil group (57.96±6.27) with olive oil group (56.93±7.53) and black castor oil group (62.65±2.40). There was a statistically significant difference at (P<0.05) when compared cold mold seal group (52.09±3.35) with glycerin oil group (57.96±6.27) and black castor oil group (62.65±2.40). Also, significant difference when compared olive oil group (56.93±7.53) with black castor oil group (62.65±2.40) as shown in table (2).

4. Discussion

Separating media are made up of oil distributed in water, and their action (separation of distinct materials) is determined by the medium's high interfacial tension [20].

The goal of the polishing technique for dental materials is to generate an appropriately smooth and shiny surface and so inhibit bacterial plaque development by progressively eliminating rough layers from the surface [18]. The roughness of the denture base's surface contributes to bacterial colonization, and microbe attachment to a surface is required for colonization [12]. According to the descriptive statistic concerning the mean of each group it can reveal that (cold mould seal, olive oil and glycerin oil) can be used as a separating medium during processing of flexible denture base while (castor oil) failed to act as an acceptable separating medium in relation to the surface roughness of fitted tissue flexible denture base that became more than 0.2 µm which is the highest acceptable clinical level of roughness need no further smoothness.

This study shows that group A (cold mould seal) offers the smoothest (lowest surface roughness) of flexible surface. These finding conflict with AL-Khayyat, 2013 [17] who reported that when using cold mould seal, the surface roughness of both base materials (acrylic and nylon denture base) is substantially higher than when using glycerin.

In addition AL-Khayyat, 2013 [17] also found that when glycerin was utilized as a separating medium, the roughness of both resins was reduced, and this finding could be attributed to a number of factors. The first is that the 1.4/2 Pas viscosity of glycerin allows the material to permeate and fill any voids or porosity discovered due to the material's high coefficient of penetration. The surface tension of the separating medium, caused by the adhesion force that exists between its molecules, could be the second reason. The greater the surface tension of the separating medium, the better the sealing and separation of the investment material from the polymers denture base materials.

The study finding disagree with AL-musawi, 2005 and AL-Taie, 2006 who found that cold mould seal offers highest value in relation to surface roughness of acrylic denture base. These results could be due to three factors: first, the separating medium's viscosity; each material with a low viscosity allows the material to permeate and fill any voids or porosity found; this was related to material's high coefficient of penetration allows the material to penetrate and close any porous found. The second, the material's wet ability, that permit the separating medium to flow readily along the surface of the gypsum product which demonstrate by the contact angle of the molecule of separating medium on the stone surface, the third reason could be related to the surface tension of the separating medium after it has set , which is created by the adhesive force that occurs between its molecules, high surface tension of the separating medium, high sealing and separation between dental stone and acrylic denture base [9] [19] [21] . This study's findings are also consistent with AL-musawi,2005 [9] who stated that non-significant differences were found between cold- mould seal lined specimens and glycerin lined specimens, while there was a statistically significant difference between glycerin and cold-mould seal on one hand and tin-foil lined specimens on the other hand.

The results of the current study revealed that the black castor oil group created the highest mean value in surface hardness followed by the glycerin oil group and olive oil group while the cold mould seal group showed the lowest mean value. Moreover, the result showed significant difference between olive oil (group C) and black castor oil (group D), and non-significant difference between cold mould seal (group A) and olive oil (group C). This agree with Al-Ta'ie, 2015 [22] who revealed that there were no significant differences between olive oil and cold mold seal on hardness of acrylic resin. This could be explained by water sorption phenomenon of methyl methacrylate denture base material that is mean the cold mold seal film is not fully water eliminator and this inhibit complete polymerization of acrylic [23,24].

The findings of this investigation agree with Mohammed, 2014 [5] who concluded that in comparison to cold-mould seal separating medium, glycerin is the best form of separating medium for high hardness, and who discovered in comparison to heat-cure acrylic lining with glycerin and cured in a water bath, produced high hardness than heat-cure acrylic lining with cold mold seal and cured in a microwave device. These findings might be attributed to variances in curing procedures and methods of polymerization of acrylic denture bases, with the water bath approach producing the best hardness results.

Conclusion:

Within the limitations of this in vitro investigation, it can be concluded that less surface roughness of the final processed flexible acrylic resin was obtained when using cold mould seal and olive oil as a separating medium. The surface hardness of the flexible acrylic denture base material was the best when black castor oil was used as a separating medium

Conflicts of Interest

The authors reported that they have no

conflicts of interest

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Table (1): The least significant difference (LSD) of multiple comparison tests for surface roughness (µm) among studied groups

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	P-Value	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Cold Mould Seal	Glycerin Oil	-.4242	.41635	.317	NS	-1.2770	.4287
	Olive Oil	-.0592	.41635	.888	NS	-.9121	.7936
	Black castor Oil	-.9237*	.41635	.035	S	-1.7766	-.0709
Glycerin Oil	Olive Oil	.3649	.41635	.388	NS	-.4879	1.2178
	Black castor Oil	-.4996	.41635	.240	NS	-1.3524	.3533
Olive Oil	Black castor Oil	-.8645*	.41635	.047	S	-1.7174	-.0116

Based on observed means.

The error term is Mean Square (Error) = .693.

*. The mean difference is significant at the .05 level.

Table (2): The least significant difference (LSD) of multiple comparison tests for hardness among studied groups

Dependent Variable: Surface Hardness

LSD

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	P-Value	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Cold Mould Seal	Glycerin Oil	-5.8750*	2.66028	.036	S	-11.3243	-.4257
	Olive Oil	-4.8438	2.66028	.079	NS	-10.2931	.6056
	Black Castor Oil	-10.5625*	2.66028	.000	S	-16.0118	-5.1132
Glycerin Oil	Olive Oil	1.0313	2.66028	.701	NS	-4.4181	6.4806
	Black Castor Oil	-4.6875	2.66028	.089	NS	-10.1368	.7618
Olive Oil	Black Castor Oil	-5.7188*	2.66028	.040	S	-11.1681	-.2694

*. The mean difference is significant at the .05 level

Figure (1): Specimen under the profilometer device for surface roughness test

Figure (2): specimen under the Shore D device for surface hardness test

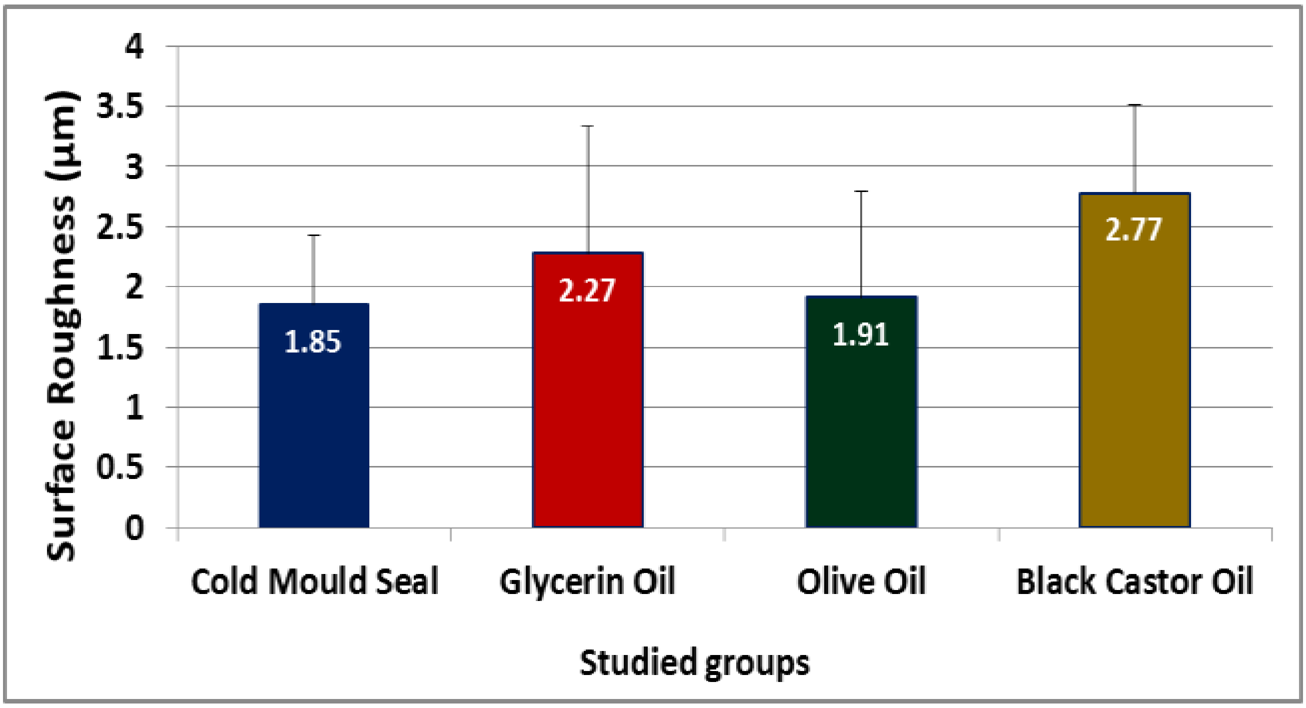

Figure (3): Bar chart shows the mean distribution of surface roughness (µm) among studied groups

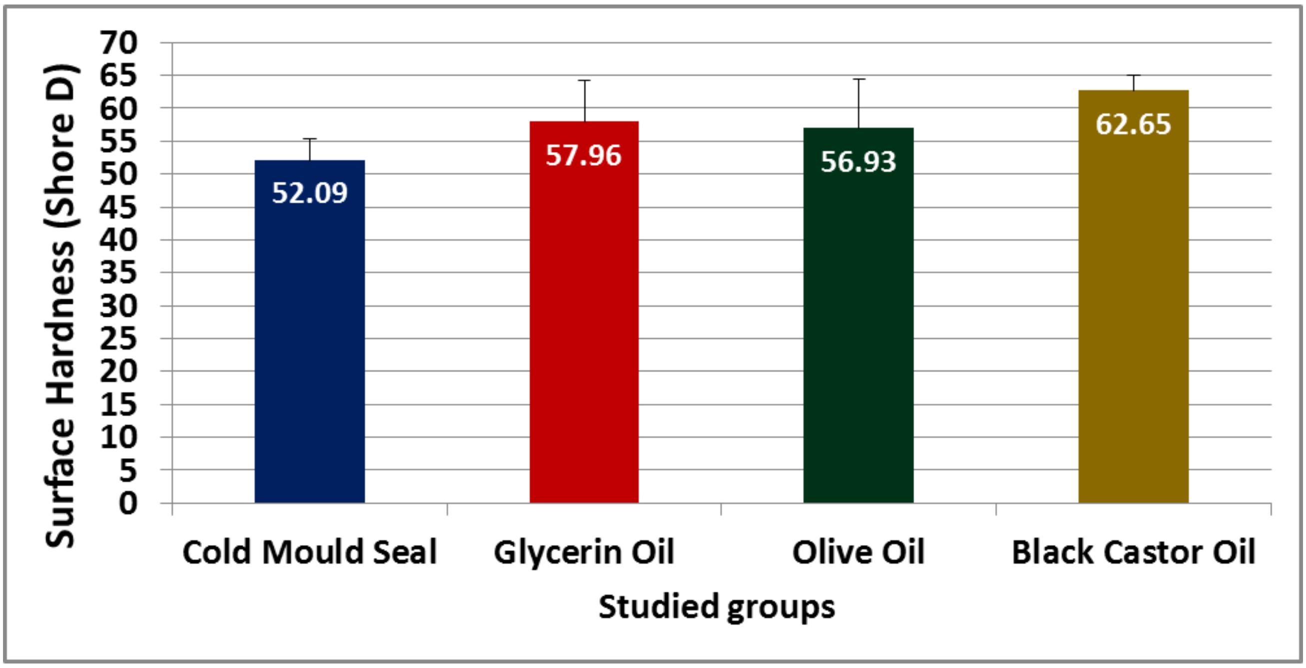

Figure (4): Bar chart shows the mean distribution of surface hardness among studied groups