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Assessment four types of separating medium on surface roughness of self cure acrylic resin processed by two methods "A comparative study"

نضال صاحب منصور/ مدرس
هيئة التعليم التقني / كلية التقنيات الصحية والطبية / بغداد

Abstract

Surface roughness is known to be factor in the entrapment of microorganisms on acrylic surface, significantly higher number of microorganisms cells were observed on roughened surface than on smooth surface. In present study olive oil, and glycerin oil are used as a substitute for tin foil & cold mold seal (alginate mold seal) in the process of curing clear cold cure acrylic resin against stone and evaluating these new materials as a separating medium on surface roughness of cold cure acrylic resin cured in air(bench curing), and in water**(**ivomat curing**).** A total of (64) specimens from clear cold cure acrylic resin were prepared for surface roughness test and divided into two major groups ,each major group subdivided into four subgroup according to the type of separating medium that used during processing .The major group one include (group A, group B, group C,& group D) ,the major group two include(group A_1,group B_1,group C_1,&group D_1) .From the result obtained, in *bench curing groups*, statistically significant differences in mean surface roughness value was observed of tin foil group compared with cold mold seal group ,from the other hand non significant differences between cold mold seal with olive oil group& glycerin oil groups ,also non significant differences between tin foil group with olive oil and glycerin oil groups ,but in *ivomat curing groups* , statistically significant differences between tin-foil group compared with cold mold seal group & olive oil group ,and highly significant difference between tin-foil group with glycerin group ,from the other hand non significant differences among cold mold seal group ,olive oil group and glycerin oil group.

الخلاصة

خشونة السطح من العوامل المعروفة في تجمع الكائنات المجهرية الحية على سطح الأكريلك ولوحظ تجمع تلك الكائنات على السطح الخشن أكثر من السطح الناعم.في هذه الدراسة تم استخدام مادتي زيت الزيتون وزيت الكليسيرين كمواد بديلة لمادتي رقائق القصدير المعدنية وبديل رقائق القصدير المعدنية (صوديوم ختم القالب) في عمل الأكريلك الشفاف البارد المضغوط في القالب الصخري وتقييم تلك المواد العازلة على خشونة سطح الأكريلك المبلمر في الهواء والمبلمر في الماء الحار. أربعة وستون عينة من الأكريلك الشفاف حضرت لفحص خشونة السطح وقسمت إلى مجموعتين رئيستين وكل مجموعة رئيسية تحتوي على أربع مجاميع حسب المادة العازلة المستخدمة خلال العمل.المجموعة الرئيسية الأولى تتضمن(group A, group B, group C& group D) أما المجموعة الثانية تتضمن (group A_1,group B_1,group C_1&group D_1) . أظهرت النتائج في هذه الدراسة بالنسبة للمجموعة الأولى المبلمرة في الهواء هنالك فرق إحصائي معنوي في خشونة السطح بين مجموعة رقائق القصدير المعدنية وبديل رقائق القصدير المعدنية(صوديوم ختم القالب) ,من جهة أخرى لا يوجد فرق إحصائي معنوي في خشونة السطح عند مقارنة بديل رقائق القصدير المعدنية مع مادتي زيت الزيتون وزيت الكليسيرين وكذلك عند مقارنة رقائق القصدير المعدنية مع زيت الزيتون وزيت الكليسيرين.أما في المجموعة الثانية المبلمرة في الماء الحار أظهرت النتائج هنالك فرق إحصائي معنوي في رقائق القصدير المعدنية مقارنة مع مجموعة بديل رقائق القصدير المعدنية ومجموعة زيت الزيتون , وهنالك فرق عالي بين مجموعة رقائق القصدير المعدنية وزيت الكليسيرين,من جهة أخرى لا يوجد فرق إحصائي معنوي بين بديل رقائق القصدير المعدنية ومادتي زيت الزيتون وزيت الكليسيرين .

Introduction

Self- cure acrylic resin is one of the most frequently used materials in dentistry for repairs, relines, orthodontic appliances, maxillofacial prosthesis in addition to its use in crown and bridge work as a temporary coverage of prepared tooth [1,2,3,4]**.**Although self- cure acrylic has inferior properties than hot –cured acrylic, it is still widely used for its low cost, easy manipulation, easy fabrication and repair, natural appearance, it's simple technique at room temperature, less time consuming and less equipment required [5,6].

The heat activation is the chemical reaction of the acrylic resin; therefore, placing the provisional resin restoration in hot water is an accepted and often is recommended in the manufacturer's direction [4]. So pressure may affect mechanical and physical properties during curing of acrylic denture base [7] .

Separating medium is a coating applied to a surface serving to prevent a second surface from adhering to the first, or a material, usually applied on an impression to facilitate removal of the cast [8] **.** If the surface of the mold is not coated with a separating material, it will be found, that a layer of gypsum impregnated with polymer remains attached to the surface of the denture and is extremely difficult to remove [9] . The use of tin-foil as a routine separating medium will ensure dentures with smoother fitting surface and this may minimize some of the discomfort that some patients may feel from the slight movement of a rough surface on the mucosa .An alternative method of preventing the gypsum surface from absorbing the liquid acrylic resin is to paint the mold with a liquid tin-foil substitute to seal the pores of the artificial stone. Tin-foil substitute is available and used successfully if all wax residue are thoroughly cleaned [7].When clear acrylic resin is to be used it is necessary to tin-foil the model wherever the resin will come into contact with it, the commonest use of clear material is for the palate of a full or partial upper denture and the thinnest tin foil available should be used, tin foil is necessary on the model if complete transparency is to be obtained [10] .

Surface properties of denture material are of clinical importance since they may affect plaque accumulation and staining of the prosthesis [11] ,and accumulation of candida albicans [12] .*For this reason ;this study is designed to evaluate the effect of different types of separating medium on surface roughness of the self cured acrylic resin polymerized in air at 23 ◦C ± 5 ◦C (bench curing),and other polymerized in ivomat (60◦C & 30 psi).*

Materials & methods

The instruments and Equipments used in this study were

- Rubber bowel & spatula.
- Wax knife & sharp knife
- Disposable syringe.
- Fine brushes
- Classes patterns.
- Dental flask &Clamps (Hanau engineering Co.U.S.A.).
- Hydraulic press (Germany).
- Ivomat machine (Germany).
- Profilometer (hand held roughness tester /TR200)**.**figure(1)&(2)
- Olympus photo micro scope system (Japan).figure (3)



Fig. (1): Profilometer machine. Fig.(2) :sample during test Fig. (3): Olympus photo micro- cope system.

Materials

The materials used in this study are:

1- Self clear -cure acrylic resin (powder &liquid ,vertex , Germany)
2- Dental stone (elite model-THIOXTROPIC ,Italy).
3- Distilled water (Iraq).
4- Separating medium.

The separating media used in this study in **table (1) .**

Table (1) :Separating media used in this study

Types of Separating medium	Trade name	Manufacturer
Zinnfoile	Tin-foil	DENTAURUM PFORZHEIM
Mead way plaster coating solution	Cold-Mold Seal	India
Olive Oil	Zer	Turkey
Glycerin oil	Glycerin pure	Syria

Methods

General Preparation of the Acrylic Resin Denture Base Samples:

All steps of this research and tested the samples were in college of health & medical technology and in university of technology in 2010. Three different glasses patterns were constructed with correct dimensions to save time and effort .figure (4)

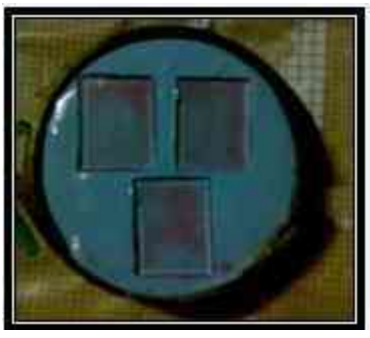

Figure (4) : The glass patterns of the flask

Dimensions and shape of each glass pattern were made according to the required tests. Rectangular- shaped glass pattern of (30mm X 25mm X 3mm) length, width, & thickness was constructed to be used in surface roughness tests [13].A total of 64 samples were prepared .The specimens were divided into two major groups(bench curing group & ivomat curing group) each major group contain 32 specimens & subdivided into four subgroup according the type of separating medium that are used during curing process (each group contain 8 samples) . Figure (5).

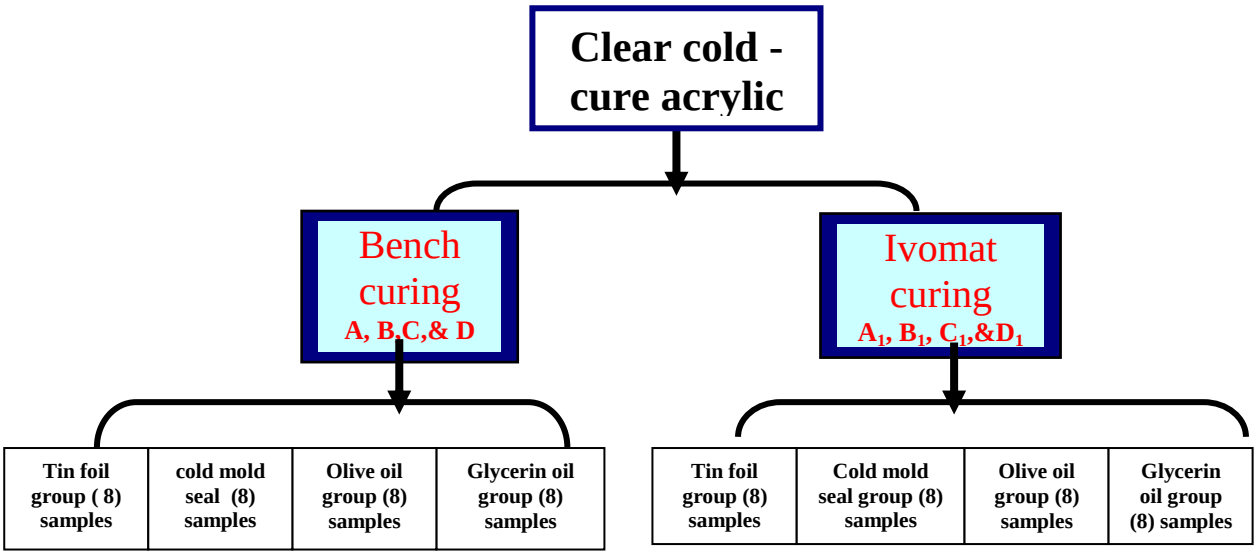

Fig (5): Diagram illustrates the distribution of the samples

The conventional flasking technique was followed in the mould preparation, according to the required measurements of the adopted specimens. Each glass pattern was coated with the separating medium (cold mold seal). Slurry stone was prepared according to the manufacturers' instruction (W/P ratio is 25 ml/100g) and poured into the lower half of the dental flask, then immerse the glass pattern in the slurry stone. After setting of the stone, a layer of cold mold seal separating medium was applied on the stone surface and another layer of stone was poured into the second half of the flask. The lid was adapted in its place and the flask was allowed to set for one hour, after that the flask was opened and the glass pattern was removed. Then the separating media was applied. In case of using cold mold seal ,olive oil ,and glycerin oil (2cc) was measured with a disposable syringe and applied onto the stone surface in each half of the flask, using brush .While when tin-foil separating medium was used, it was adapted to the stone surface in each half of the flask with fingers (the border of tin foil adhesion with the border of the flask by glue material to prevent the movement of tin foil piece), then the mould was ready for packing with acrylic dough [14,15] . Clear cold – cure acrylic was mixed according to manufacturer's instruction (2.5:1) by volume. The liquid was placed in a clean and dry mixing vessel followed by slow addition of powder. The mixture was then stirred with wax knife and left in a closed container at room temperature until it reach to the dough stage. The acrylic resin dough was packed into the mould, and then the two halves of the flask were closed together and placed under press with gradual application of pressure to allow even flow of the dough throughout the mould space. The two halves of the flask were finally closed under pressure until metal to metal contact had been established [16]. Then the flasks were left for curing. In this study two main groups of samples were included depending on the process of curing of the self cure acrylic resin: Flasks containing the acrylic resin dough to prepare the first major group of sample (group A, group B, group C,& group D) were left to cure in air for two hour on a bench under press at 23◦C ± 5 ◦C under 20 bar .While in case of preparing the second major group of samples(group A_1, group B_1, group C_1,& group D_1),the flasks placed under press for 10 min. under 20 bar ,then the flasks with acrylic resin were transferred for curing in the ivomat

curing device ,as shown in figure (6) ,containing water under air pressure 30 psi for 15 minutes at 60◦C [13,16,17] . After completing the curing, the flasks were allowed to cool slowly at room temperature for 30 minutes and immersed in water for 15 minute .The acrylic patterns were removed from the stone mould and placed the samples in container full with distal water until its measured .Each group contain (8) samples in order to perform the statistical needs in present study. All samples of surface roughness were not polished after deflasking (as tissue fitting surface of denture base) [14, 15] .The final shape of each specimen mention in figure (7).

Figure (6): ivomat machine

Figure (7): the final shape of each specimen

Surface roughness test:

1-First method:

Under optical microscope (at magnification 4X) tested specimens were examined and the severity of roughness was determined [13].Figure (10),(11),(12),(13),(15),(16),(17)&(18).

2- Second method (Test equipment and procedure):

64 specimens were used in the test using the profilometer machine; the surface of the sample must be very flat according to American dental stander institute [18]. All specimens were not polished after deflasking, fixed to the horizontal base of the profilometer .This device is supplied with a surface analyzer (sharp stylus) shown figure (1)&(2) to trace the profile of the surface irregularities and record all the peaks and recesses characterizing the surface. Examine the specimen was done drawing the three lines (Horizontal, vertical, diagonal) on the dorsal side, the reflected lines can be seen on the reverse face because the specimen was clear figure (8). Number of the surface roughness in each specimens were measured the means were recorded [13]**.**

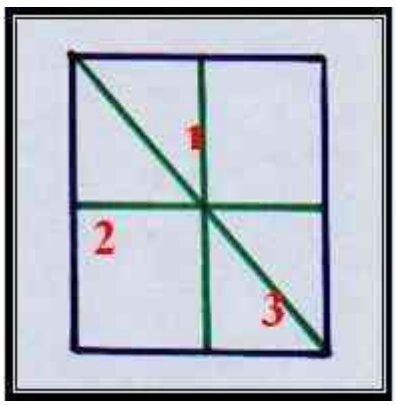

Figure (8): surface roughness specimens show the three Lines(1. vertical , 2. horizontal, 3. diagonal) testing.

Results

Surface roughness test:

Mean values, standard deviation (SD) and standard error (SE) for bench curing groups are presented in (**table 2)** and figure (**9)** for surface roughness test.

Table (2) : Mean distribution of surface roughness among studied groups (bench curing groups)

Groups	No.	Mean	Standard error	Standard deviation	Minimum Value	Maximum Value
Tin foil Group A	8	1.65783	.25777	.63140	.711	2.516
Cold mold Seal group B	8	2.61983	.18581	.455	2.155	3.255
Olive oil group C	8	2.12050	.12220	.29932	1.634	2.389
Glycerin oil group D	8	2.22067	.15908	.38967	1.509	2.601
Total	32					

Graphical presentation by bar chart between the mean surface roughnesses of the four groups (bench curing groups), shown in fig (9).

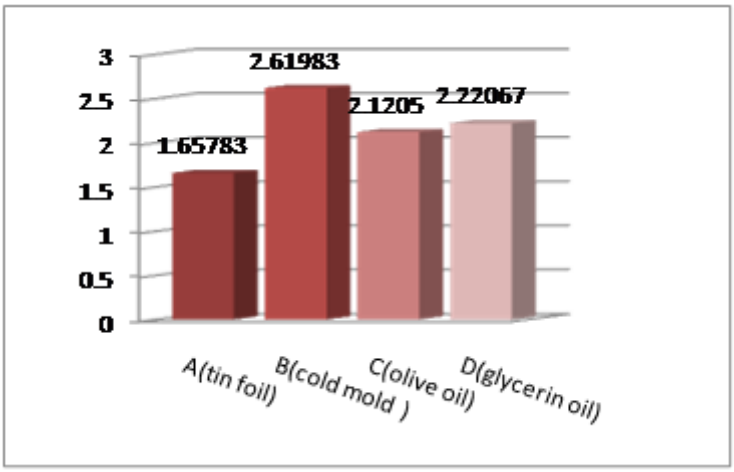

Figure (9): Mean distribution of surface roughness (μm) **among studied groups(bench curing groups)**

Inferential statistical methods represented by analysis of variance test show that there are no statistically significant difference at (P>0.05).The source of difference is investigated by further complement analysis of data by using LSD (least significant difference) test to examine the difference between the different pairs of the four groups as shown in table (3)

Table (3) :The least significant difference(LSD)of multiple comparison tests for surface roughness among studied groups (bench curing groups)

Studied groups (Bench curing groups)		Sig.
Group A	Group B	sig. P(<0.05)
	Group C	Non sig. P(>0.05)
	Group D	Non sig. P(>0.05)
Group B	Group C	Non sig. P(>0.05)
	Group D	Non sig. P(>0.05)
Group C	Group D	Non sig. P(>0.05)

Olympic photo microscopic used for showed the degree of surface roughness for bench curing groups figure (10) ,(11) ,(12)&(13)

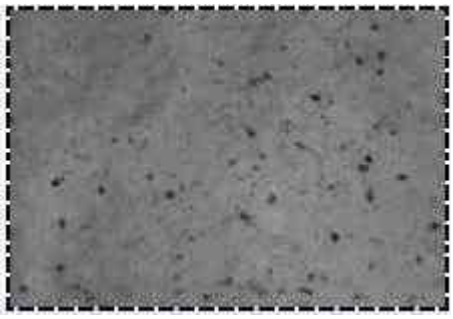

Figure (10): Photomicrograph of self-cured acrylic used tin foil

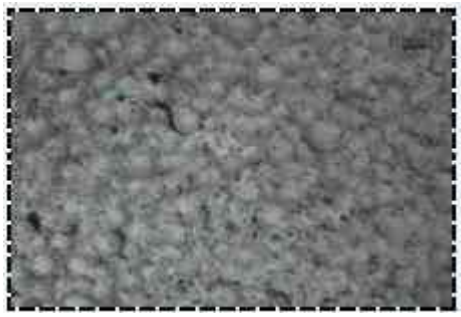

Figure (11): Photomicrograph of self cured acrylic used cold mold seal

Figure (12): Photomicrograph of self-cured acrylic used olive oil

Figure (13): Photomicrograph of self-cured acrylic used glycerin oil

Voids and scratches of different sizes and locations were observed in all tested specimens ,very little and small were seen in tested specimens with tin foil separating medium , large were shown in olive oil and glycerin oil groups and finally in tested specimens with cold mold separating medium group .

Mean values, standard deviation (SD) and standard error (SE) for ivomat curing are presented in table (**4)** and (**figure 14)** for surface roughness test.

Table (4) : Mean distribution of surface roughness (μm) **among studied groups (ivomat curing groups)**

Groups	No.	Mean	Standard error	Standard deviation	Minimum value	maximum Value
Tin foil group A_1	8	1.58667	.15842	.38804	.873	1.923
Cold mold Seal group B_1	8	2.38450	.13932	.13932	1.975	2.902
Olive oil group C_1	8	2.04133	9.84E-02	.24109	1.688	2.438
Glycerin oil group D_1	8	2.42117	.20905	.51205	1.964	3.218
Total	32					

Graphical presentation by bar chart between the mean surface roughness (μm) of the four groups (ivomat curing groups), shown in fig (14).

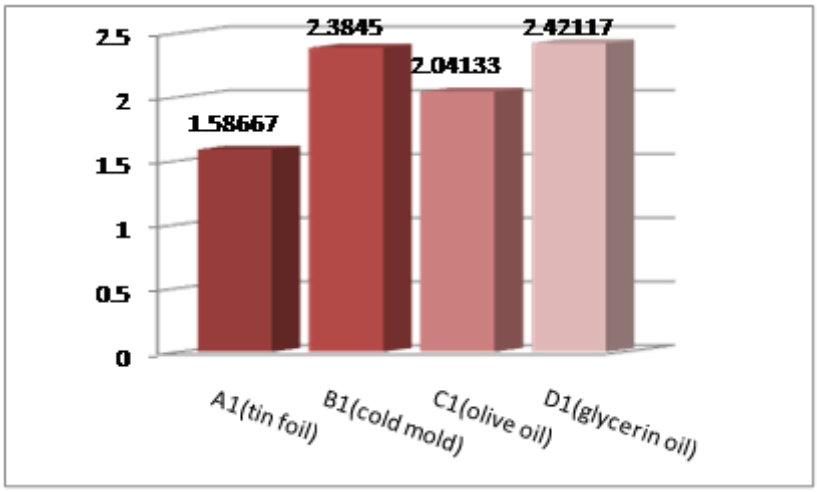

Figure (14): Mean distribution of surface roughness (μm) among studied groups (ivomat curing groups)

Inferential statistical methods represented by analysis of variance test show that there are statistically significant difference at ($P<0.05$). The source of difference is investigated by further complement analysis of data by using LSD (least significant difference) test to examine the difference between the different pairs of the four groups as shown in table (5)

Table (5) : The least significant difference(LSD)of multiple comparison tests for surface roughness among studied groups (ivomat curing groups)

Studied groups (ivomat curing groups)		Sig.
Group A_1	Group B_1	sig. P(<0.05)
	Group C_1	sig. P(<0.05)
	Group D_1	Highly sig. P(<0.01)
Group B_1	Group C_1	Non sig. P(>0.05)
	Group D_1	Non sig. P(>0.05)
Group C_1	Group D_1	Non sig. P(>0.05)

Olympic photo microscopic used for showed the degree of surface roughness for ivomat curing groups figure (15) ,(16) ,(17)&(18)

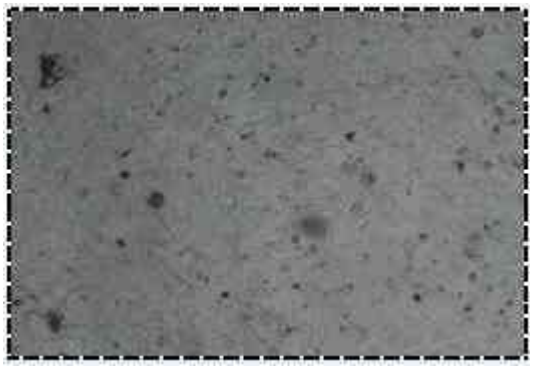

Figure (15): Photomicrograph of self-cured acrylic used tin foil

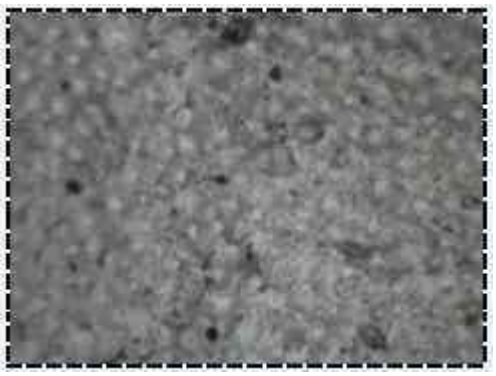

Figure (16): Photomicrograph of self-cured acrylic used cold mold seal

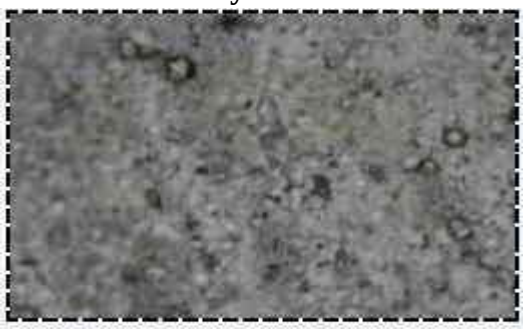

Figure (17): Photomicrograph of self-cured acrylic used olive oil

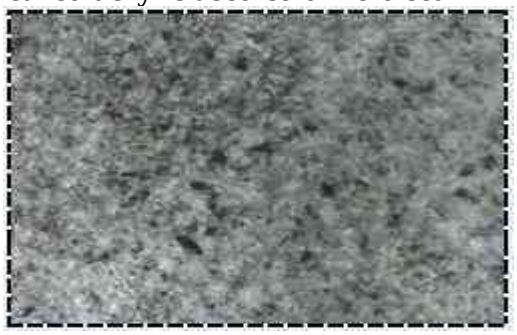

Figure (18): Photomicrograph of self-cured acrylic used glycerin oil

Voids and scratches of different sizes and locations were observed in all tested specimens ,very little and small were seen in tested specimens with tin foil separating medium ,large were shown in olive oil group followed by glycerin oil group and finally in tested specimens with cold mold seal separating medium .

Discussion

The examination of surface roughness in the tested specimens by profilometer device [13].

In table (2)when used different types of separating medium for self cure acrylic resin and bench curing(major group one) ,showed the highest mean surface roughness value was obtained in self cure acrylic resin with cold mold seal separating medium (2.61983).While the lowest mean surface roughness value was obtained in self cure- acrylic resin with tin foil separating medium (1.65783).Figures (10),(11),(12),&(13).

Table (3) represent the least significant difference (LSD)of multiple comparison test; showed that there was a non-significant differences at ($p > 0.05$)between different types of separating medium except between cold mold seal group and tin foil group ,the result showed significant difference at ($p < 0.05$).The results indicated that the smoother surface showed in self cure acrylic resin with tin –foil separating medium .

This results agree with Al-Taai A.Z.[15] showed the highest mean surface roughness value was obtained in heat-cured acrylic resin denture base and cold-mold seal separating media. While the lowest mean surface roughness value was obtained in heat-cured acrylic resin denture base and tin-foil separating media, and found a statistically no-significant difference between cold-mold seal and olive oil separating medium. While a significant difference was found between tin foil and cold-mold seal separating media .

From the other hand this results disagreement with Al-Taai A.Z[15], said that significant difference was found between tin-foil and olive oil separating medium for both heat and cold cured acrylic denture base. This could be due to the bleaching or the clouding which is related to the penetration of the outer layers of resin by molecules of water, or This could be related to that, heat-cured materials processed against tin foil are substantially dry at the end of the curing cycle, while those processed against tin foil substitute approach saturation during curing. Also in the present study it was found that highest mean value for surface roughness in self cure acrylic resin with cold mold seal separating medium .This results also agreement with Al-Musawi R.M [14] concluded that the highest mean value for surface roughness was obtained in the cold- mold seal lined specimens prepared in heat cure acrylic in plaster mould, while glycerin lined specimens showed less surface roughness compared to cold- mold seal.On the other hand all cold-cure specimens despite the investing materials and the separating media showed a lower mean value surface roughness, and glycerin showed satisfactory results regarding surface roughness. This agrees with Graig R.G & powers J.M,[7] when they stated that soaking gypsum dies or casts in glycerin or different oils makes the surface smooth, that means glycerin when used for coating dies will give similar results to the investing plaster and stone regarding surface roughness.

In major group two (self cure acrylic resin curing by ivomat) ,the value of surface roughness varied according to the types of separating medium that are used .**Table (4)** ,showed that the highest mean surface roughness value was obtained in glycerin oil separating medium (2.42117), followed by cold mold seal separating medium ,and followed by olive oil separating medium ,while the lowest mean surface roughness was obtained in tin foil separating medium (1.58667).figures (15),(16),(17)&(18).

Table (5) represent the least significant difference (LSD)of multiple comparison test; showed that was a significant difference at ($p<0.05$) between cold mold seal separating medium group and tin foil separating medium group ;also between tin foil group and olive oil separating medium group ,and no significant difference at ($p>0.05$)between cold mold seal separating medium group when compare with olive oil group and glycerin oil group ,also non significant between olive oil separating medium group and glycerin oil groups .While the result showed highly significant difference between tin foil group and glycerin oil group .This is due to the fact that, olive oil and glycerin oil may be effected by heat and lead to more roughness on the surface of self cure acrylic resin [14] .Also this may be related to that tin foil substitutes films which are permeable to water allowing it to pass from the gypsum mold and enter the acrylic resin denture base during the process

unlike tin foil [19]. This in agreement with Al-Musawi R.M [14] found that non-significant differences between cold- mold seal lined specimens and glycerin lined specimens, while there was a statistically significant difference between glycerin and cold- mold seal on one hand and tin-foil lined specimens on the other hand .

Our result in agreement with Al-Taai A.Z[15] showed a statistically no-significant difference between cold-mold seal and olive oil separating medium. While a significant difference was found between tin foil and cold-mold seal separating media on one hand, tin foil and olive oil separating media on the other hand for both heat and cold-cured acrylic resins denture base.

Davis G.B. et al.,[20] stated that, the surface yielded by the acrylic resin formed against tin foil separating medium provided better retention for the rubber base than any other surface tested .

Still many authorities consider that tin-foil is the best separating medium, the process of tin-foiling, however, is tendious and time-consuming unless a technician has had extensive practical experience with it [9] .

Graig R.G & Powers J.M. **[7]** stated that for many years tin-foil was the most acceptable separating medium.

Conclusions

From the present study the following conclusions can be withdrawn:-

1-In bench curing groups, statistically significant differences in mean surface roughness value was observed of cold mold seal group compared with tin-foil group, in the same time non significant between cold mold seal with olive oil group& glycerin oil groups, also non significant between tin foil group with olive oil and glycerin oil groups, can be concluded that the olive oil and glycerin oil can be use safely as separating medium for the self cure acrylic resin when bench curing

2-**In ivomat curing groups ,** statistically significant between tin-foil group compared with cold mold seal & olive oil group, and highly significant between tin-foil group with glycerin oil group ,from the other hand non significant among cold mold seal group ,olive oil group and glycerin oil group. In this groups the best result obtain from tin foil group followed by olive oil group followed by cold mold seal and glycerin oil groups.

3- The best result outcome from tin –foil groups (in bench and ivomat curing) because less surface roughness value, & it easily open the flask and easily remove the specimens from the stone.

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