

The Effect of Some Disinfectants on Some Mechanical Properties of Nylon (Valplast) Denture Base Material

Ilham H. Al-Abdulla
BDS, MSc. (Asst. Lect.)

Prosthodontic Department
College of Dentistry, University of Kerbala

الخلاصة

اهداف الدراسة: تهدف الدراسة الى تقييم تأثير نوعين من المواد المعقمة (مادة اليود 10%)، كحول الايثانول (100%) على خشونة وصلادة سطح مادة قاعدة الطقم النايلونية الغالبلاست. **المواد وطرائق العمل:** تم عمل 40 عينة من مادة الغالبلاست وبابعاد (65 ملم، 10 ملم، 2.5 ملم) طول وعرض وسماك على التوالي. عشرين منها استخدمت لقياس خشونة السطح قبل وبعد وضعها في كحول الايثانول (100%) ولمدة (5 دقائق) وعشرة منها استخدمت لقياس صلادة السطح قبل وبعد وضعها في كحول الايثانول (100%) ولمدة (5 دقائق) والعشرون عينه المتبقية استخدمت بنفس الطريقة الاولى لقياس الخشونة والصلادة مع مادة اليود 10%. ولمدة (5 دقائق) ايضا. **النتائج:** اظهرت النتائج ان الاحصاء الوصفي لقياس صلادة السطح قبل وبعد غمر المادة في الايثانول او اليود انه ليس هناك فرق معنوي لكلا منهم ($P=0.3$) ($P=0.7$) على التوالي كما وانها ليس هناك فرق معنوي بين المحلولين من حيث التأثير ($P=0.3$). اما الاحصاء الوصفي لقياس خشونة السطح بعد غمر المادة في محلول الايثانول يوضح ان هناك زياده ولكن ليس ذو فرق معنوي ($P=0.2$)، ولكن زياده نقصان ولكن ليس ذو فرق معنوي ($P=0.1$). ايضا ليس هناك فرق معنوي بين المحلولين من حيث التأثير ($P=0.07$). **الاستنتاجات:** ان صلادة السطح لمادة قاعدة الطقم النايلونية تزداد بعد غمرها في محلول الايثانول (100%) وفي محلول اليود (10%) ولكن هذه الزيادة غير معنوي خلال (5 دقائق) اما خشونة السطح فانها تزداد مع الايثانول وتقل مع اليود كلتا الزيادة والنقصان ليست ذات اهمية تذكر خلال ال (5 دقائق).

ABSTRACT

Aims: To evaluate the effect of two disinfecting solutions (povidone iodine 10%, ethanol alcohol 100%) on the surface roughness and surface hardness of nylon denture base material. **Materials and Method:** 40 sample of valplast material were constructed with dimensions of (65mm,10mm,2.5mm) length, width and thickness respectively. (10) samples were used to measure the surface roughness before and after soaking in (ethanol material 100%) for 5 min., (10) samples were used to measure the surface hardness before and after soaking in (ethanol alcohol 100%) for 5 min., other 20 samples have been used in the same way as the 1st 20 but with iodine disinfectant. **Results:** Descriptive statistics for indentation hardness of valplast in ethanol and iodine indicate there is no significant difference for each one ($P=0.3$, $P=0.7$ respectively). T-test indicate there is no significant difference between them ($P=0.3$). Descriptive statistics for surface roughness in ethanol indicate there is an increase but it is not significant ($P=0.2$), while for iodine there is a decrease also it is not significant ($P=0.1$). T-test indicate no significant difference between them ($P=0.07$). **Conclusion:** Hardness of nylon denture base material increased by immersing in each of the ethanol and iodine but their increase is not significant (within 5 min.). Surface Roughness of nylon denture base material increases by immersing in ethanol alcohol while it decreases by immersing in iodine, this increase or decrease is not significant (within 5 min.).

Key words: Nylon denture base, polyamide sterilizations, surface roughness, surface hardness.

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INTRODUCTION

Favorable denture base material is needed for fabricating long lasting and biologically acceptable dentures. (1) Acrylic polymethyl-methacrylate (PMMA) is one of the most widely used denture base material with numerous advantages (2), but PMMA has poor mechanical properties like fracture due to unsatisfactory transverse strength, impact strength, or fatigue resistance (3), allergic reactions to PMMA are also reported (4).

Studies have been done to improve the

mechanical properties of (PMMA) and in recent years nylon polymer has gained attractive attention as a denture base material because of many advantages: favorable esthetic outcome (non metal clasp), toxicological safety to patients allergic to metals and resin monomer, higher elasticity than conventional heat polymerizing resins and sufficient strength for use as denture base material. (5)

Thermoplastic material in spite of all these benefits, it has some difficulty to adjust and polish (6).

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Dental prosthesis passes in many stages within the laboratory such as flasking, finishing and polishing. It will come in contact with many instruments it will be contaminated. So disinfection of dental prosthesis is mandatory before delivery to the patient in order to reduce the risk of transfer of infection, elimination of bacterial, viral and fungal reservoirs and establishing discipline for asepsis. Iodophors, chlorine solutions, glutaraldehydes, or phenols are all acceptable for this step⁽⁷⁾.

In this study we used two types of disinfectants (Povidone iodine 10%, ethanol

alcohol 100%) to disinfect specimens were made of nylon denture base material and we measured their effect on the surface hardness and surface roughness of the specimens.

Materials and Methods

Valplast plastic bag (FDA, MSDs, ISO, USA) as in the Figure (1), Pumice, Rouge, Ethanol alcohol (100%), Povidone iodine (10%), Digital surface roughness tester (maximum reading 3 micron), Shore D hardness tester, Special heating flasks for plastic injection as in Figure (2), Finishing burs (tungsten carbide, stone, green finishing cone).



Figure (1): Valplast plastic bag



Figure (2): Injection machine

Specimens Grouping :

Forty samples of valplast base plate material were prepared with dimensions (65mm , 10mm, 2.5mm) length, width and thickness respectively⁽⁸⁾. They were divided as the following:

1. 20 sample were soaked in ethanol alcohol 100% (10 samples for the indentation hardness test & 10 samples

for the surface roughness test).

2. 20 sample were soaked in povidone iodine 10% (10 samples for the indentation hardness test & 10 samples for the surface roughness test).

Preparation of the nylon (valplast) specimens by the same conventional way for nylon injection as in Figure (3) and (4).



Figure (3): Valplast plastic bag



Figure (4): Injection machine

Finishing and polishing :

The nylon specimens were finished and polished according to the manufacturers recommendation. First by the use of tungsten carbide bur (5000 rpm) at low pressure to prevent melting of the material. Then stone

bur, then green rubber cone was used (5000rpm) to complete the finishing process and produce smooth surface . The final glossy surface were obtained by polishing with pumice , then with rouge on wool brush of dental lathe (10 times for each sample).As in the Figure (5).



Figure (5): Valplast samples after finishing

Mechanical tests :

Indentation hardness (shore D test) test, and Surface roughness. The specimens were divided into four groups .The indentation hardness test were measured by the use of shore D hardness tester for the First two groups . The first group were soaked in an

ethanol alcohol 100% for (5min.) in a closed container, While second group were soaked in povidone iodine 10% for (5min.) in a closed container. Then they were washed with tab water and dried to be ready for indentation hardness test measurement after soaking by the same device as in the Figure (6).



Figure (6): Shore D hardness test

Three readings were taken for each sample and the mean represent the hardness value for each sample.⁽⁷⁾

The surface roughness test were measured by the use of digital surface roughness tester (profilometer) ,where the diamond stylus surface analyzer move (2mm) across the surface of nylon specimen. This test were measured for the third and forth group .Then the third group were soaked in an ethanol alcohol 100% for (5min.) in a closed

container ,While forth group were soaked in povidone iodine 10% for (5min.) in a closed container. Then they were washed with tab water and dried to be ready for surface roughness test measurement after soaking by the same device.⁽⁹⁾ Two readings were recorded for each specimen and the mean value was the average of two readings for each specimen. The results were expressed in micrometer⁽⁹⁾ as in the Figure (7).



Figure (7): Digital surface roughness tester

Results

1. Indentation hardness:

The mean and standard deviation of indentation hardness values for ethanol and

iodine indicate that there is an increase in the hardness of nylon denture base material after soaking in each of the iodine and ethanol as in Table (1).

Table (1) :Descriptive statistics indentation hardness values of pre and post-soaking in each of the ethanol alcohol 100% and povidone iodine 10%

Hardness test	No.	Mean	SD
Presoaking in ethanol	10	69.840	2.860
Postsoaking in ethanol	10	70.840	1.890
Presoaking in iodine	10	70.090	1.010
Postsoaking in iodine	10	70.216	0.933

This increase is non significant (with ethanol P-value=0.3, with iodine P- value=0.7) as in Table (2), Mean is higher with ethanol

than with iodine but there is no significant difference between these two data (P value=0.3) as in Table (3).

Table (2) : T-test of indentation hardness test between pre and post-soaking in each of the ethanol alcohol 100% and povidone iodine 10%

Hardness test	No.	Mean
Presoaking in ethanol	69.840	0.373**
Postsoaking in ethanol	70.840	
Presoaking in iodine	70.090	0.770**
Postsoaking in iodine	70.216	

*P<0.05 significant ** P<0.05 non significant

Table (3) : T-test (significance) for the indentation hardness between postsoaking in the ethanol alcohol 100% and povidone iodine 10%

Hardness test	No.	Mean
Postsoaking in ethanol	70.840	0.367**
Postsoaking in iodine	70.216	

2.Surface Roughness:

The mean and standard deviation of surface roughness values for ethanol and iodine indicated that there is an increase in surface roughness with ethanol but it is not

significant difference (P-value=0.2) .While there is a decrease in surface roughness with iodine also it is non significant difference (P value =0.1) as in Table (4 and 5).

Table (4): Descriptive statistics of surface roughness for pre and postsoaking in each of the ethanol alcohol 100% and povidone iodine 10%

Roughness test	No.	Mean	SD
Presoaking in ethanol	10	0.964	0.174
Postsoaking in ethanol	10	1.134	0.370
Presoaking in iodine	10	1.006	0.207
Postsoaking in iodine	10	0.881	0.162

Table (5): T-test (significance) of surface roughness between pre and postsoaking in each of the ethanol alcohol 100% and povidone iodine 10%

Roughness test	Mean	P-Value
Presoaking in ethanol	0.964	0.215**
Postsoaking in ethanol	1.134	
Presoaking in iodine	1.006	0.153**
Postsoaking in iodine	0.881	

*P<0.05 significant ** P<0.05 non significant

T-test of surface roughness between ethanol and iodine post-soaking indicated

that there is no significant difference (P value=0.07) as in Table (6).

Table (6) : T-test (significance) of the surface roughness between postsoaking in the ethanol alcohol 100% and povidone iodine 10% ethanol alcohol 100% and povidone iodine 10%

Roughness test	Mean	P-Value
Postsoaking in ethanol	1.134	0.072**
Postsoaking in iodine	0.881	

Discussion

Nylon is a crystalline polymer, this crystallinity accounts for the nylon resistance to solubility in solvents, high heat resistance and high strength coupled with ductility.⁽¹⁰⁾

Most popular chemicals used for denture disinfection are household bleach, chlorhexidine and glutaraldehyde. They act by destroying microorganisms but not their spores.⁽¹¹⁾ It has been reported that ethanol is a propylalcohol, chloroform, formalin and acetic acid may be used for occasional disinfection of dentures and to avoid contamination.⁽¹²⁾

Tieng (2008) investigated the effect of oxygenating denture cleanser on surface roughness and hardness of nylon denture base material and on conventional heat cured acrylic. The study indicated that the surface roughness and hardness of nylon was significantly decreased while no significant effect on the surface roughness and hardness of conventional heat cured acrylic.⁽¹³⁾

Nylon is relatively insensitive to non-polar solvents, however, because of the presence of the polar groups, nylons can be affected by polar solvents, particularly water.⁽¹⁴⁾

Nylon exhibits high physical strength, heat resistance and chemical resistance.⁽¹⁵⁾

Hardness: Is a term used to describe the resistance of the material to indentation and also it is a measure of the resistance to wear or scratching.⁽¹⁶⁾ Many methods for evaluating this property have been described including Brinell, Knoop, Viker, Rockwell and Shore.⁽¹⁷⁾

In this study Shore D hardness test was used which was found to be suitable for nylon denture base material. Statistical analysis of the results showed that there is no significant difference on hardness of nylon by ethanol also by iodine and no significant effect between ethanol and iodine.

This result occurred due to that nylon polymerized by condensation polymerization leading to the formation of aliphatic polymer without cross linking polymer chain.⁽¹⁸⁾

Other explanation is that, nylon is more packed and less intermolecular spaces polymer, the polymer chains are not contain side groups so less water diffusion. This agreed with Yota (2010)⁽¹⁰⁾ who stated that nylon is a highly chemical resistant material due to its high degree of crystallinity too less water and alcohol absorption. So this may explain the non significant effect of ethanol and iodine on nylon hardness.

Increase the surface roughness has a detrimental effect on the esthetic of the denture, the smooth shiny surface of the denture base help to resist the build up of stain, debris and plaque. Deterioration of the polished surface lead to stain build up, plaque accumulation, loss of surface detail and made the ingress of the bacteria that penetrate the denture base much easier.^(19,20)

The profilometer appears to be excellent device for studying the surface roughness of restorative material. It gives a quantitative measurement with low percentage of error that can be evaluated and compared statistically.^(21,22)

The result of the surface roughness of nylon by ethanol and iodine showed that there is no significant difference in surface roughness of nylon. This means absence of the effect of disinfectant on nylon surface geometry. There is no other study in the literature for direct comparison.

Conclusion

1. Hardness of nylon denture base material increased by immersing in each of the ethanol and iodine but their increase is not significant (within 5 min.).

2. Surface Roughness of nylon denture base material increases by immersing in ethanol alcohol while it decreases by immersing in iodine, this increase or decrease is not significant (within 5 min.).

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