

Denture Cleanser's Effect on Impact Strength of Heat Cured Acrylic

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ABSTRACT

Background: A chemical immersed denture cleanser is the most widely used method by patients to maintain a clean and healthy denture, but the use of such a cleanser may have harmful effect on the denture base materials. The aim of this study is to evaluate the effect of two prepared cleansers (4% tartaric acid & 4% sodium bicarbonate) solutions, and one commercial cleanser (Lacalut dent) on the impact strength of heat cure acrylic denture base material.

Methods: Forty specimens of heat cured acrylic with dimensions (55mm length* 10mm width* 5mm thickness) were prepared and divided into four subgroups, 10 specimens for each, according to the type of denture cleanser solution, (distilled water as a control group, solution of tartaric acid, solution of sodium bicarbonate, Lacalut dent solution). All the specimens in the four groups were immersed in the solutions and kept in an incubator at 37°C all the time between each soaking till the measurements were done. The testing machine was a Charpy type machine tester.

Conclusions: The conventional heat cured acrylic cannot be safely soaked in (4% tartaric acid) which contains isopropyl alcohol because it decreases the impact strength, so it is advised not to use solutions containing alcohol as acrylic denture cleansers. Lacalut dent which is an oxygenating commercial denture cleanser had the lowest adverse effects on the impact strength of heat cured acrylic.

Practical implications: It is advisable not to use a cleanser of (4% tartaric acid) which contains isopropyl alcohol because it decreases the impact strength. Lacalut dent is the best among the solutions used in this study.

KEYWORDS

Denture cleanser, impact strength, color stability, heat cured acrylic.

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تأثير ثلاث مطهرات لاطقم الاسنان على خاصية قوة تحمل الصدمة لمادة الاكريلك المبلمر بالحرارة

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مدرس - ماجستير في صناعة الاسنان. كلية التقنيات الصحية والطبية. قسم تقنيات الاسنان.

المستخلص

أن عملية تنظيف طقم الأسنان عملية مهمة للحصول على أفضل الفوائد. وتعتبر طريقة الغمر الكيميائي الطريقة الأكثر شيوعاً بين المرضى للمحافظة على نظافة وصحة طقم الأسنان، ولكن استعمال مثل هذه الطريقة قد تؤدي إلى تأثير ضار على مادة قاعدة طقم الأسنان. يهدف هذا البحث إلى تقييم تأثير ثلاثة أنواع مختلفة من المحاليل المطهرة على خاصية قوة تحمل الصدمة لمادة قاعدة طقم الاسنان المصنوعة من مادة الاكريلك المبلمر بالحرارة. محاليل المنظفات الثلاثة المستخدمة في هذا البحث: اثنان محضران وهما محلول محضر من 4% حامض التارتريك، ومحلول محضر من مسحوق بيكربونات الصوديوم. اما المنظف الثالث فهو منظف تجاري جاهز (لاكاليبت دينت Lacalut dent).

تم تحضير 40 عينة من الاكريلك المبلمر حرارياً، ابعاد العينات وفقاً للابعاد التي يتقبلها الجهاز المستخدم للقياس، (55 ملليمتر طول - 10 ملليمتر عرض - 5 ملليمتر ارتفاعاً).

قسمت كل مجموعة إلى أربع مجموعات فرعية، كل منها تتكون من عشر عينات:

في المجموعة الاولى تم غمر العينات في الماء المقطر كمجموعة قياسية. اما المجموعة الثانية من العينات فقد تم غمرها في محلول مطهر مكون من (حامض التارتريك)، بينما المجموعة الثالثة تم غمرها في محلول مطهر مكون من (مسحوق بيكربونات الصوديوم). واخيراً عينات المجموعة الرابعة تم غمرها في محلول مطهر جاهز من نوع (لاكاليبت دينت).

جميع العينات تم غمرها على مدار (7 أيام - مرتين باليوم ولمدة 15 دقيقة - يفصل بينهما فترة زمنية مقدارها أربع ساعات من عملية النقع). ثم تم شطفها بالماء المقطر ثم تنظيفها بقطعة من القطن قبل عملية القياس. تم استخدام جهاز (شاربي) لقياس قوة تحمل الصدمة.

أظهرت نتائج البحث ان محلول حامض التارتريك قد قلل بشكل هام (خاصية قوة تحمل الصدمة) للاكريلك التقليدي المبلمر بالحرارة وكان تأثير المنظف التجاري (لاكاليبت دينت) هو الاقل بين المنظفات التي استخدمت في هذه الدراسة على خاصية قوة تحمل الصدمة. وتم الاستنتاج ان محلول حامض التارتريك ليس بالامان الكافي لاستخدامه كمنظف للاطقم وذلك لاحتوائه على (ايذوبوبيل الكحول) والذي يقلل من (خاصية قوة تحمل الصدمة) مما يزيد من احتمالية كسر الطقم.

INTRODUCTION

Acrylic plastic has been the most widely used and accepted among all denture base materials and it was estimated that represents 95% of the plastic in prosthodontics⁽¹⁾. Acrylic resin successful as denture base and remain the most popular choice are due to its properties. In addition it required simple processing equipment and relatively of low cost of fabrication

process⁽²⁾.

The micro-porous surface of acrylic denture provides a wide range of environment to support microorganism that can be threaten the patient's health. The maintenance of clean denture prosthesis is important to maintain an esthetic, odor free appliance and to reduce the number of microorganism on dentures. The mechanical, chemical method and a

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combination of the two strategies are available to the patient to facilitate the denture hygiene⁽³⁾.

Denture cleansers are popular method used by denture wearers for cleaning, and the efficacy of denture cleanser in dislodging food debris, bio film and tobacco stain from denture surface has been reported⁽⁴⁾, but cleanser and cleaning methods may have harmful effect on the plastic or metal component of the denture, so the dentist must be able to recommend a denture cleanser that is effective, non-deteriorative to denture material and safe for patient's use⁽⁵⁾. Some denture cleansers may have adverse effect on denture materials. In the present study, the effect of three immersion type of denture cleanser on the impact strength of heat cure acrylic had been evaluated.

MATERIALS AND METHODS

Specimens Grouping:

- Forty (40) specimens of heat cured acrylic denture (powder and liquid) (Major base2/Ital) with dimensions (55mm length, 10mm width and 5mm thickness) were prepared and divided into four subgroups according to the type of denture cleanser solution that immersed in it:
- 10 specimens: soaked in distilled water as a (control group).
- 10 specimens: soaked in tartaric acid solution, (tartaric acid powder), (E. Merk, Darmstadt).
- 10 specimens: soaked in sodium bicarbonate solution, (sodium bicarbonate powder (Al-Mansur Co-Iraq) denture cleanser)
- 10 specimens: soaked in Lacalut dent., Commercial denture cleanser (Dr. Thesis Naturwaren, Homburg / Germany).

Preparation of specimens:

A wax mould with dimensions (55mm length, 10mm width, and 5mm thickness) was prepared. Using a conventional flasking technique for a complete denture. The lower portion of the denture flask was filled with freshly mixed dental stone (w/p ratio 25gm /100 gm) according to the manufacturer's instructions. Then the wax pattern was coated with separating media and placed over the stone mixture, after the stone was set the upper half of the flask was positioned on the top of the lower portion and filled with stone. When stone was hardened the wax patterns were removed.

The manufacturer's instructions were followed in proportioning and mixing the polymer and monomer, the p/l ratio was (2.25 gm: 1 ml). The measured

volume of liquid was placed in a clean dry mixing vessel followed by addition of powder, the mixture was then stirred with a wax knife and left until the dough was set. Then it was separated from the walls of the mixing jar. The packing process was performed while the acrylic was in the dough stage. The resin was removed from it in a mixing jar and rolled, then packed into the mould which had been previously coated with the separating medium. The two halves of flask were closed together and placed under the press with a slow application of pressure to allow even follow of the dough throughout the mould space, the flask was opened and the over flowed material was removed with a sharp knife followed by a second trial closure, then the two halves of the flask were finally closed together until metal to metal contact had been achieved. The flask was left for five minute under the press before clamping, and then transferred to water bath for curing.

Curing was carried by placing the clamped flasks in a water bath and processed by heating at 74oC for about an hour and half, the temperature was then increased to the boiling point for 30 minutes according to ADA. After the completion of the process, the clamped flasks were allowed to cool for 30 minutes at room temperature, and then immersed in water for 15 minutes after that acrylic patterns were removed from the mould.

All finishing of acrylic patterns were done with an acrylic bur, then the stone bur was used to get a smooth surface of the samples and followed by sand paper of medium grit to remove any remaining small scratches then the polishing was done with the bristle lathe brush and pumice, the glossy surface was obtained with a wool brush and polishing paste on dental lathe using low speed (1500) rpm and the specimens were continuously cooled with water to avoid over heating; then all measurements were done by using a vernier.

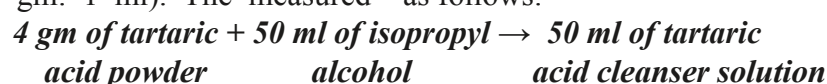
Preparation of denture cleanser solutions:

1.Commercial denture cleanser solution:

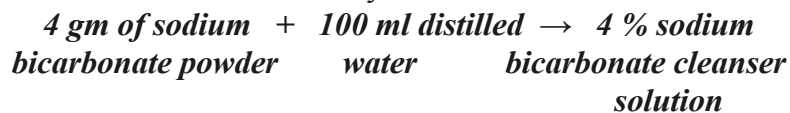
This cleanser consisted of Lacalut dent. This solution is ready-made and the immersion solution was prepared according to manufacturer's instructions.

2.Prepared denture cleanser solutions:

A fresh denture cleanser solution was prepared by dissolving the tartaric acid in isopropyl alcohol (E. Merck, Darmstadt), which was chosen as a solvent to the acid powder due to its non antiseptic effect⁽⁶⁾. And as follows:



The third denture cleanser solution used in this study was sodium bicarbonate solution which prepared according to manufacturer's recommendation by



Then, each of the three solutions was diluted with an equivalent volume of distilled water, (50ml of prepared denture cleanser added with 50 ml of distilled water to get 100 ml of 4% W/V fresh diluted denture cleanser solution). After completing the process, (the specimens and cleanser solutions were prepared). All specimens were immersed in the denture cleanser solutions for 7 days (15 minutes soaking, twice daily and with 4 hours between each soaking), The specimens were kept in incubator at 37° C all the time between each soaking till the measurements were done. Finally each specimen was rinsed with distilled water and cleaned thoroughly by a piece of cotton before testing.

Impact strength test:

The impact strength is usually measured by the work required to break a test piece. The testing machine was a Charpy type machine tester, (Charpy impact machine for impact strength test, Germany) of the University of Technology. And this was designed in such a way that tubs (pendulums) of different weights could be used according to the strength of the materials to be tested.

The specimen was clamped at two ends and struck by the swinging pendulum in the area at the center of the tested piece, the average readings gave the impact energy in joules. The absorbed energy by the specimen was noted.

The specimens were held horizontally and struck by the pendulum at the centre of the tested specimens. The scale reading gave the impact energy in (J). The value of the Charpy impact strength was computed by following formula of impact strength:-

$$\text{Impact strength (KJ/M}^2\text{)} = E/TW$$

where:

E, is the absorbed energy in (KJ),

T, is the thickness of specimen, while

W, is the width at the center of specimen ⁽⁷⁾.

Statistical Analysis:

The following statistical tests were applied:

Descriptive Statistics: Mean and Standard deviation were calculated for each variable, for each group, with statistical tables and graphical presentation by bar-chart.

mixing 4gm of sodium bicarbonate with 100 ml distilled water, as follows:

ANOVA test was applied to see the significant difference among the groups. T-test was applied to see the trend of different averages within the group.

RESULTS

The mean and standard deviation of (impact strength reading) of all groups were listed in **table (1)**.

The results indicated a very clear difference between the mean of the readings, with the higher mean value for distilled water (16.757); and the lower value for tartaric acid solution (9.187).

Table (2) represents t-test between control and different experimental groups. It indicate that there is a highly significant difference in impact strength between control group and both (sodium bicarbonate & tartaric acid) solutions. Also, this table shows that there is a significant difference of impact strength between control group and Lacalut dent solution.

One way analysis of variance test (ANOVA), **Table (3)** shows a statistically high significant difference between all groups regardless to the denture cleanser.

F = 84.37, P < 0.01). The results indicated a very clear difference between the mean of the readings of the solutions, with the higher mean value for distilled water (16.757); and the lower value for tartaric acid solution (9.187) as shown in **Figure (1)**.

DISCUSSION

Impact strength is an important property of acrylic denture base materials which tend to fracture if accidentally dropped on to a hard surface ⁽⁸⁾.

The impact strength is describes as how much of load can be applied before a specimen yields or breaks ⁽⁹⁾. Harrison, found that an immersion type cleanser is the most suitable because of its low abrasive and effective remove of organic debris ⁽¹⁰⁾.

In this study, the impact strength of heat cured acrylic resin was tested by Charpy Impact Strength after the immersion the specimen in the cleanser solution (distilled water, tartaric acid, sodium bicarbonate, Lacalut dent). The results showed highly significant differences between all different groups regardless to the denture cleanser as in table (3).

Concerning the results of the heat cured acrylic,

O' Brien in (2008)⁽¹¹⁾ explained the difference in impact strength between two polymers in relation to the strength and number of primary bonds between the atoms and secondary (hydrogen bonds) between adjacent chains, the weaker the bond the weaker the material.

Oxalic acid, citric acid and tartaric acid (weak organic acids) are found in many plants and vegetables⁽¹²⁾. Tartaric acid is obtained from cream of tartar present in grapes, it is used as acid constituents of some baking powders to release carbon dioxide from the baking soda when water is added⁽¹³⁾.

Hatim in (2003)^(6,14) prepared denture cleanser solution by dissolving citric, or acetic acid, or tartaric acid in isopropyl alcohol and they examined the effect of 4% w/v solutions of those prepared denture cleanser on acrylic resin regarding surface roughness, weight loss, staining removal and compared them with other commercially available cleansers (Steradent). They found that they have the same effect as Steradent and can be safely used as denture cleansers.

The results showed highly significant differences between the tested conventional heat cured acrylic immersed in distilled water as a control group and those tested after soaking in tartaric acid solutions. This may be due to that the chemical agents used in this study which are aqueous-based solutions with alcohol.

This is in agreement with Tehmina et al (1992)⁽¹⁵⁾, who stated that alcohol – based disinfectant decrease the impact strength of heat cured acrylic because it acts as solvent that causes crazing making them more prone to fracture around crazing line.

John et al (2006)⁽¹⁶⁾ stated that a solution containing alcohol should not be used for cleaning or storing denture because it causes crazing in certain denture plastics. Anusavice in 2003⁽¹⁷⁾ reported that water molecules interfere with the (PMMA) polymer chains and act as a plasticizer and interfere with its mechanical properties, thus decreasing acrylic resin strength.

Table (1): Data concerning Impact Strength Test (KJ/M²) of heat cured acrylic specimens after immersion in cleanser solutions, (distilled water) as a control group and (sodium bicarbonate solution, tartaric acid solution & Lactalut dent solution) as experimental groups.

	<i>distilled water (Control group)</i>	<i>Sodium bicarbonate cleanser solution</i>	<i>Tartaric acid cleanser solution</i>	<i>Lactalut dent cleanser solution</i>
Mean	16.757	13.232	9.187	15.282
SD	0.839	1.05	1.188	0.951

Table (2): T-test between control group (distilled water), with other experimental groups (sodium bicarbonate solution, tartaric acid solution & Lactalut dent solution).

<i>No.</i>	<i>Sodium bicarbonate cleanser solution</i>	<i>Tartaric acid cleanser solution</i>	<i>Lactalut dent cleanser solution</i>
T-test	9.168	24.04	3.105
P-value	P<0.01	P<0.01	0.003
Sig	HS	HS	S

*P<0.05 Significant

Table (3): ANOVA Test & LSD between experimental groups (sodium bicarbonate solution, tartaric acid solution & Lactalut dent solution)

	<i>F-test</i>	<i>P-value</i>	<i>Sig</i>
Between groups	84.37	P<0.01	HS

<i>LSD</i>	<i>P-value</i>	<i>Sig</i>
Sodium bicarbonate cleanser solution & Tartaric acid cleanser solution	P<0.01	HS
Sodium bicarbonate cleanser solution & Lactalut dent cleanser solution	P<0.01	HS
Tartaric acid cleanser solution & Lactalut dent cleanser solution	P<0.01	HS

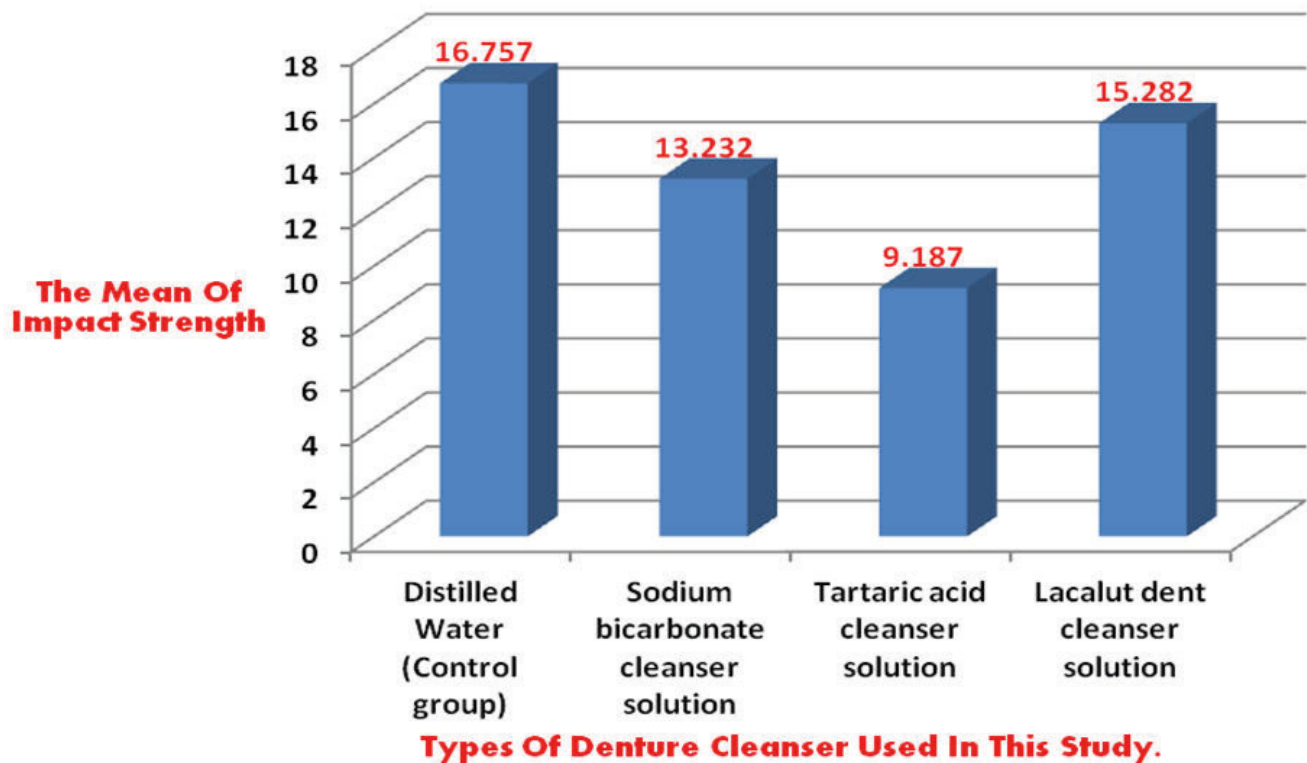


Figure (1): Means of impact strength of specimens (KJ/M²) after immersion in different types of denture cleansers, (distilled water) as a control group & (sodium bicarbonate solution, tartaric acid solution & Lactalut dent solution) as experimental groups.

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