Evaluation of shear bond strength between thermosens as relining material and different denture base materials

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ABSTRACT

Background: Denture relining is the process of resurfacing of the tissue side of the ill fitting denture, the bond strength at the relining-denture base interface is most important for denture durability.The aim of present study was to evaluate the shear bond strength between the thermosens as relining material and different denture base materials that bonded by thermo fusing liquid. As this correctiveprocedureis the common chair side procedure in the dental clinic.

Material and method: Sixty samples were prepared and divided into three main groups according to the type of denture base materials.Group (A) referred to the heat cure acrylic samples which consisted of 20 samples. Group (B) referred to the high impact acrylic samples which consisted of 20 samples. Group (C) referred to the thermosens samples which consisted of 20 samples. All groups then subdivided into two groups; each one consists of 10 samples, according to the surface roughness: (A1, B1and C1 for groups with surface roughness and A2, B2 and C2for groups without surface roughness). Each sample consisted of two similar parts represent the denture base material each part of the sample was designed with dimensions of (70mm X 12mm X 5mmlength, width and depth respectively) having a stopper of depth 3mm. One part of the sample was placed on the other in a manner thatleaving a space between them of dimensions (12mm X 12mm X 3mm length, width and depth respectively) to sandwich the relining material.

Results: The results showed that the thermosens samples had the highest value of shear bond strength followed by the high impact acrylic samples, then heat cure acrylic samples which had the lowest value of shear bond strength. The results of present study showed that rough samples had reducedshear bondstrength in comparison with the smooth samples of the same denture base material.

Key words: Thermosens, thermo fusing liquid, shear bond strength. (J Bagh Coll Dentistry 2014; 26(4):28-31).

الخلاصة

خلفية : تبطين طقم الأسنان هي عملية اضافة طبقةالى سطح الطقم المواجه لانسجة الفم الساندة للطقم ، ان قوة الالتصاقبينمادة التبطين و مادة قاعدة الطقم هي الأكثر أهمية بالنسبةلمتانة الطقم. الهدف من الدراسة الحالية هو تقييم قوة الالتصاق بين مادة الثيرموسينس كمادة تبطين و مواد قاعدة طقم مختلةتم لصقها بواسطة سائل الثيرمو فيوشن. و هذه العملية التصحيحية هي من العلاجات الشائعة في عيادة الأسنان .

المواد و طريقة العمل: تم إعداد ستين عينة و تنقسم إلى ثلاث مجموعات رئيسية وفقا لنوع مواد قاعدةالطقم . المجموعة (A) تشير الى عينات الاكريليك المعالج بالحرارة التي تتكون من 20 عينة . المجموعة (B) تشير إلى عينات الاكريليك عالية التاثير التي تتكون من 20 عينة . المجموعة (C) تشير إلى عينات الثيرموسينس التي تتكون من 20 عينة . جميع المجموعات تم تقسيمها إلى مجموعتين ؛ تتكون كل مجموعة من 10 عينات ، وفقا لخشونة سطح العينة: (A1، C1, B1) تشير الى مجموعات العينات ذات الاسطح الخشنة و (A2، C2, B2)تشير الى مجموعات العينات ذات الاسطح الصقيلة. تتكون كل عينة من جزأين متماثلين تمثل مادة قاعدة الطقم تم تصميم كل جزء من العينة مع أبعاد (70مم12Xمم X 5مم طول وعرض وارتفاع على التوالي)مع وجود عتبة من ارتفاع3مم . يوضع جزء واحد من العينة على الآخر بطريقة تترك مسافة بينهما لتملئ بمادة التبطينبالأبعاد (12مم12X مم X 3مم طول وعرض وارتفاع على التوالي).

النتائج: أظهرت النتائج أن عينات الثيرموسينس كانت أعلى قيمة لقوة الالتصاق تليها عينات الاكريليك عالية التأثير، ثم عينات الاكريليك المعالج بالحرارة التي كانت أقل قيمة من قوة الالتصاق. وأظهرت نتائج الدراسة أن قوة الالتصاق قلت فيالعينات ذات الاسطح الخشنة بالمقارنة مع العينات ذات الاسطح الصقيلة من نفس مادة قاعدة الطقم .

مفتاح الكلمات:الثيرموسينس وسائل الثيرموفيوشن و قوة الالتصاق.

INTRODUCTION

The patients treated with removable dentures always suffer from ill fitting denture after period of denture service due to bone resorption that led to soft tissue contour change; this problem is treated by relining or rebasing the denture. A critical part of the complete denture service is maintenance of the adaptation of the denture bases to the mucosa covering the residual ridges [1].

The tissue surfaces of intraoral prosthesis is necessary to be altered for proper fit and function due to change of soft tissue contours during prosthesis service, this may be achieved by relining [2]. "Relining is a process in which a film of plastic is added to the inside of the denture to obtain an improved fit with the denture bearing mucosa."[3]

The bonding between the denture base material and relining material is very sensitive technique that may led to microleakage at the denture base-relining interface then detachment of the relining material. The shear bond strength test is one of the most commonlyused methods to measure the bond strength at denture base-relining interface [4]. The shear bond strength at the denture base-relining interface was improved by using triad bonding agents with triad relining materials [5].

The present study was designed to evaluate the shear bond strength at denture base-relining interface by using the thermosens as relining material and (conventional heat cure acrylic, high impact heat cure acrylic and thermosens) as denture base materials with the use of thermofusing liquid as bonding agent then compare between them.

MATERIALS AND METHODS

Materials

The materials that used in this research were summarized in table 1.

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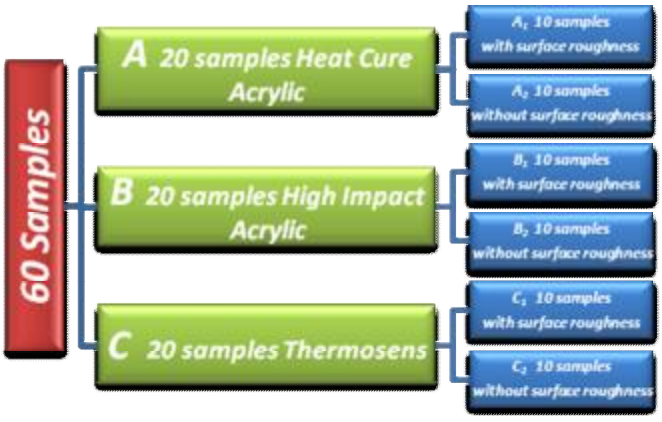
Table 1. Some of the materials used in the study

	Materials	Manufacturer
1	Thermosens denture base, relining material	Vertex – Dental B.V. 3705 HJ Zeist, Netherlands
2	Heat cure acrylic denture base	Vertex – Dental B.V. 3705 HJ Zeist, Netherlands
3	High impact heat cure acrylic denture base	Vertex – Dental B.V. 3705 HJ Zeist, Netherlands
4	Thermofusingbonding agent	Vertex – Dental B.V. 3705 HJ Zeist, Netherlands

Samples grouping

Sixty samples were prepared and divided into three groups according to the type of denture base material. Group (A) 20 samples were constructed from conventional heat cure acrylic.Group (B) 20 samples were constructed from high impact heat cure acrylic. Group (C) 20 samples were constructed from thermosens denture base material. Then each group was subdivided according to the surface roughness into two groups: (1) 10 samples with surface roughness and (2) 10 samples without surface roughness.



Samples preparation

Each sample consisted of two similar parts ofdenture base material placed one on the other in a manner that kept the relining material sandwiched between the two parts of the sample.

Wax Pattern Design

Wax patterns were designed with dimensions of (70mm X 12mm X 5mm length, width and thickness respectively) having a stopper of depth 3mm.One part of the sample was placed on the other leaving a space between them of dimensions (12mm X 12mm X 3mm length, width and thickness respectively) to sandwich the relining material [6,7].

Preparation of heat cure and high impactacrylicsamples

The wax pattern was coated with separating medium and allowed to dry then the lower portion of the metal flask was filled with dental stone that mixed according to the manufacturer's instructions. The wax pattern was inserted into the dental stone slurry to one-half of pattern depth and left to set.After the stone was set, it was coated with separating medium and allowed to dry, then the upper portion of the metal flask was positioned on top of the lower portion and filled with stone, vibration was done to eliminate the air bubbles. Stone was allowed to harden before wax elimination.Wax elimination was performed using boiling water then the flask was opened. The flask was allowed for cooling at room temperature.Then the stone moldwas coated with separating medium and allowed to dry. The polymer and monomer of heat cure acrylic was mixed according to the manufacturer's instructions and when the mixing reached the dough stage, it was packed into the stone mold and then curedaccording to the manufacturer's instructions. After curing deflasking was done and the samples were removed then finished and polished except the areas that would be attached to relining material which represent the tissue surface of the denture.After polishing the samples were conditioned in distilled water at 37^{o}C for 48 hours [8]. The samples were ready for relining.

Preparation of thermosens samples

The same flasking techniques that weremention previously were followed in preparation of the thermosens samples with some difference. A dental stone slurry was poured into the lower half of the vertex thermoflask (special flask for injection), Then the wax pattern was inserted into the stone slurry to one-half of wax patterndepth and left to set.After the stone was set, it was coated with separating medium and allowed to dry, then wax sprues were used - major sprues with 6-8mm in diameter, minor sprues 2-4mm in diameter were attached to selected areas of the wax pattern [9] (Fig. 1). Then the upper portion of the special flask was positioned on top of the lower portion and the screws of the flask were tightened then filled with stone, vibration was done to eliminate the air bubbles. Stone was allowed to harden.Wax elimination was

performed using boiling water then the flask was opened. The flask was allowed for cooling at room temperature. After that the stone mold was coated with special separating medium which is called vertex thermo flow and allowed to dry then the two halves of flask were closed and fixed by screws of flask.

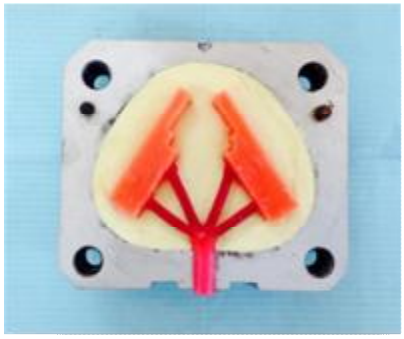


Fig. 1: Wax sprues attached to wax patternsin vertex thermo flask

Procedure of injecting of the thermosens denture base material

The procedure started with preheating ofthe cylinder of the thermoject machine to 290°C then the cartridge of the thermosens denture base material was inserted inside the cylinder and the flask was placed in its position in the machine, after that thermosens material started to be injected after heating time of 18minutes and a pressure of 6.5 barat 290°C according to the manufacturer's instructions. After injecting the thermosens material the program ended with cooling for 1 minute, and then the flask was removed from the machine and allowed for cooling at room temperature. The flask was opened and the samples were removed from it then the sprues were cut and the samples were finished and polished except the areas that will receive the relining material. The samples were conditioned in distilled water at 37°C for 48 hours [8]. Then the samples were ready for relining.

Surface roughness of samples (Group A1-B1-C1)

The samples were sand blasted by using laboratory air abrasive blaster with 100 µm aluminum oxide at air pressure of 4 bars for 1 minute.The samples were held with a specially designed fixture for standardization of the distance between the samples surface and the nozzle of the device to be 20mm [10].

Application of relining material to the samples

The two parts of the samples were seated one on the other in such manner that leaving a space between them for the relining material, this space was filled with wax. Then the sample was flasked in the vertex flask, the sample was invested with stone in the lower half of the flask then wax sprue was joined with the wax that was placed between two parts of the sample, then flasking and wax elimination was done as previously mentioned. Before closing the flask the facing surfaces of sample was coated with thermofusing "bonding agent" at relining areas only according to the manufacturer's instructions, then the injecting procedure was done, finishing, polishing and conditioning of samples were also done as mentioned in preparation of thermosens samples. After that the samples were ready for shear bond strength test.

Measuring Procedure of Shear bond Strength

The samples were subjected to shear load with cross head speed (1mm/min) using load cell capacity (1000N) of the Instron machine [11].The force of bond failure was recorded in Newton, which was divided by the area of the bonded surface to obtain the shear bond strength calculated in Mpa.

SBS=F/SA=Mpa

SBS=shear bond strength

F=force

SA=surface area of bonded site (mm^2)

RESULTS AND DISCUSSION

Mean values, standard deviation (SD), minimum values and maximum values of the shear bond strength results are presented in Table (2).

Table 2: Descriptive statistics of the shear bond strength of different groups in MPa

Groups	Mean	S.D.	Min.	Max.
A1	1.94	0.10	1.79	2.13
A2	5.05	0.19	4.77	5.38
B1	2.11	0.13	1.93	2.29
B2	5.34	0.21	5.06	5.62
C1	10.81	0.82	9.88	11.88
C2	19.98	0.58	19.17	20.97

In general the shear bond strength of thermosens denture base material samples (group C) showedthe highest mean values and the lowest bond strength was in heat cure acrylic samples (group A) and the high impact acrylic samples were in between (group B).The results also showed that theshear bond strengthdecreased in samples with surface roughness when compared with samples without surface roughness of the samedenture base material (between groups 1 and 2 of each group of denture base materials).

The study revealed that the three types of denture base materials showed different shear bond strength, this bonding can be attributed to reaction of the ester end of the thermo fusing liquid (which contains butyl alcohol, acetone, isopropyl alcohol and silicic acid tetraethyl ester homopolymer H_4SlO_4) with methyl methacrylate of the (heat cure acrylic or high impact acrylic) or with amide of the thermosens.

The results showed that there was no significant difference in shear bond strength between samples of heat cure acrylic and high impact acrylic tables (3 and 4), this may be due to similarity of the monomer of both material which was methyl methacrylate, while the shear bond strength was increased significantly in samples of thermosens tables (3 and 4), this increasing in the bond might be attributed to the high rate of cross-link between similar resin materials (denture base and relining materials and bonding agent) [12,13].

The results showed that the surface roughness reduced the shear bond strength significantly, table (5), and this might be attributed to:

Table 3: Comparison between the groups using ANOVA test

Surface treatment	ANOVA	F-test	p-value	Sig.
With surface Treatment	A1 & B1 & C1	1103.542	0.000	HS
Without surface treatment	A2 & B2 & C2	5207.785	0.000	HS

d.f. = 29

Table 4: LSD test after ANOVA

Surface treatment	Groups		Mean Difference	p-value	Sig.
With surface Treatment	A1	B1	-0.17	0.438	NS
		C1	-8.867	0.000	HS
	B1	C1	-8.697	0.000	HS
Without surface Treatment	A2	B2	-0.29	0.095	NS
		C2	-14.938	0.000	HS
	B2	C2	-14.648	0.000	HS

Table 5: Effect of surface treatment on the shear bond strength

Comparison	t-test	p-value	Sig.
A1 vs. A2	-44.952	0.000	HS
B1vs. B2	-41.903	0.000	HS
C1vs. C2	-28.830	0.000	HS

The liquidized thermosens has high viscosity which provided a low flowability that prevented the total engagement of thermosens with the micro pitting.

The micro pitting produced an elevation and depression at the surface of denture base material so the peaks of elevation act as a stress points to weaken the bond at the interface.

The rough surface decreased the surface tension which consequently affects interface adhesion.

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