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Comparison of Transverse Strength for different types of acrylic resin denture base materials after relining with visible light-cured material

مقارنة بين قوةعرضية لأنواع مختلفة من المواد الأساسية لطقم الأسنان ذو الراتنجات الأكريليك بعد اعادة تبطين بمواد مرئية معالجة بالضوء

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Abstract

The aimed of this study to evaluate the transverse strength for different types of acrylic denture base materials after being relined with visible light-cured material. Sixty samples were prepared from acrylic denture base and divided into two main groups according to polymerized material. Samples of heat-cured **(water bath, Vertex)** and visible light-cured **(Mega denta)** were relined with a hard light-activated material **(Mega denta).** Bulk denture base samples were also used for comparison of transverse strength test. Surface roughness was evaluated among roughened relined groups. Relining procedure was facilitated by the use of a bonding agent **(LlGHTDON-Bonding Dreve-Dentamid / GMBH Germany).** A three point load test was used to measuring transverse strength for both bulk and relined denture base material. Instron testing machine was used to evaluate transverse strength. The result obtained from this study revealed a slight improvement in transverse strength of all relined denture base samples after relining with visible light-cured material. The smooth relined samples exhibited non-significant increase in transverse strength compared to rough relined samples. Generally, it was concluded that the investigated transverse strength as a mechanical properties of relined samples are dependent on those of denture base polymer and on the ability of polymers to bond to each other.

الخلاصة

تهدف هذه الدراسة لاختبار القوة الانحنائية لمواد قواعد الطقم المختلفة بعد تبطينها بمادة مبطنة من الراتينج الاكريلكي المعالج بالضوء المرئي.تم تحضير **60** عينة من مواد الاكريلك المختلفة و قسمت الى قسمين رئيسيين تبعا لعملية البلمرة.لقد تم تبطين عينات من راتينج الاكريلك الحراري المبلمر بالفرن المائي **(VERTEX)** و المبلمر بالضوء المرئي براتينج الاكريلك الصلب المنشط ضوئيا **(MEGA DENTA)** و استخدمت عينات الطقم الخام لغرض المقارنة و فحص القوة الانحنائية.تم فحص خشونة السطح بين مجاميع العينات المبطنة اضافة الى ذلك سهلت عملية التبطين من خلال استعمال العامل الرابط **(Lightdon-bonding agent)**.اجريت قياس القوة الانحنائية لمواد قواعد الطقم الخام و المبطنة طبقا للمواصفات العالمية المعتمدة لمواد قواعد الاسنان.اظهرت نتائج الاختبارات تحسن طفيف في القوى الانحنائية لجميع مجاميع قواعد الطقم المبطنة براتينج الاكريلك المبلمر بالضوء المرئي, كما اظهرت العينات المبطنة ذات السطح الناعم زيادة غير ملحوظة بالقوة الانحنائية مقارنة بالعينات المبطنة ذات السطح الخشن.بصورة عامة تم الاستنتاج بانه قوة الانحناء والتي تعتبر من الخواص الميكانيكية المدروسة على قواعد طقم الاسنان المبطنة تعتمد على خواص بوليمرات قواعد الطقم وعلى قابلية ارتباط البوليمرات ببعضها.

Introduction

Problems involving the soft tissues and/or bony support are particularly serious. Preservation of the supporting structures is one of the greatest challenges for the dentist and the patient, for loss of denture support usually results in denture failure. When the bone has resorbed and the tissues are deformed so much that minor procedures no longer will make the dentures acceptable, the dentures must be relined or remade [1].One popular method for compensating a compromised fit of existing.

Denture is the reline [2,3]**.** Defines reline as "the procedure to resurface the tissue side of a denture with new base material, thus producing an accurate adaptation to the denture foundation area. To many patients, the word reline denotes a way to make ill-fitting denture like new again, this term, however; can mean many things, ranging from tissue conditioning in preparation for fabrication of new complete denture to laboratory-processed hard or soft liners[4]. The method used for relining dentures can be performed either directly in the mouth by chairside reline system, or indirectly, using laboratory-processed reline system depending on the type of the reline material[5], Accordingly, materials used for relining the denture to improve its fitness may be either hard processed reline materials or hard chairside reline materials.

Processed hard reline materials are identical to those from which denture bases are made, so they may be either a heat activated, chemically activated or light activated acrylic resin[6], In recent years there have been many new developments in polymeric materials that offer either flexibility of curing cycles or enhanced mechanical properties. A recent addition is "Triad", a visible light activated material[7].

The use of visible light-cured (VLC) resin for direct intraoral relining of complete and partial dentures has become popular[8]. Among the desirable properties of denture reline material, is the possession of adequate mechanical property to withstand the load of mastication,[9]**.** In addition, a good chemical bond between the reline material and denture base material is also required; a weak bond could result in bacterial proliferation and cause complete delamination of the two materials[10], This study is designed to evaluate the transverse strength for different types of denture base materials after being relined with visible light-cured material.

Materials and methods

Two different types of denture base acrylic resin were used in the study. (Vertex, dental BVG,VZeist the nether land .) conventional water bath acrylic resin and visible light curing resin(Mega denta, Germany). They were relined with a visible light activated material for the evaluation of the transverse strength (flexural strength).

Metal pattern preparation

A metal plate of 2.5mm in thickness was cut by a special machine into several metal patterns. The dimensions of the constructed patterns were (60mmX10mmX2.5mm), [11]

Mould preparation and mixing of acrylic

The conventional flasking technique for complete dentures was followed in the mould preparation. Three metal patterns were coated with a separating medium "Acrell sep, Japan" and allowed to dry before investing them in the lower half of the flask that contained stone mixed according to the manufacturer instructions and allowed to set. The patterns were inserted to one half of its depth.

The set lower half was coated with a separating medium and allowed to dry. The upper half of the flask was assembled, filled with stone mixture and left for setting. Stone was used due to its better hardness, On removal of the metal patterns, the two halves of the mould were coated with a separating medium to be ready for packing with acrylic dough. Concerning the visible light curing bulk specimens only a block of stone is fabricated during investing the metal patterns to let the prepared mould which will be packed with the visible light curing acrylic sheets being exposed to UVA light emitting from the Echo light box curing unit. This had been achieved by boxing the glass plate with straps of boxing wax (2 cm height), placing the metal patterns on a glass plate, coating them with a separating medium and pouring a layer of slurry stone to cover all the patterns till the edge of the boxing. The stone was left to have final setting before the glass plate separated from the block of stone. By this way we obtained a delicate stone mould consisting of only a block of stone and can be exposed to UVA light emitting from the light-curing unit. All materials were mixed and manipulated according to the manufacturer's instructions.[3] The mixing procedure was carried out in a glass jar with a clean metal spatula. The mixture was then covered and left to stand until it reached a consistency suitable for packing (dough stage). For the VLC resin, the sheets were cut with a clean wax knife to a size simulating the size of the mould and adapted into the mould with a moderate pressure applied through glass slab (slides) and also cured in the visible light curing unit through the glass slab.

Packing

The acrylic resin was packed in the late dough stage indicated by the clean separation of the resin from the walls of the glass mixing jar. For the Vertex the packing plasticity time is 24 minutes at 23˚ C.The acrylic resin dough was placed in the mould and covered with polyethylene sheet. The two halves of the flask were closed together and placed under the press with gradual application of pressure to allow even flow of the dough throughout the mould space; the pressure was then released. The flask was then opened and the over flowed material (flash) surrounding the mould space was removed with sharp knife. A second trial closure was performed; the stone surface was again coated with the separating medium, allowed to dry. After that the polyethylene sheet was removed .The two halves of the flask was finally closed until metal to metal contact had been achieved and left under press for 5 minutes before clamping was done.

Curing cycle employed

For heat-cure acrylic (Vertex), the flask is clamped and placed in Water bath, 1.5 hours at 74̊C followed by 30 minutes at 100·C. Then the flask was cooled in air for 30 minutes or more and then immersed in tap water for 15minutes[3]. The process of polymerization for the UVA light curing unit used in this study was 5 minutes. The unit operated by on/off switch and the polymerization time automatically switched over; figure (1). After completion of curing, the acrylic plate specimens were removed from the stone mould carefully.

Figure (1) UVA light curing unites used in the study.

Finishing, Polishing and conditioning

The finishing process was done by using laboratory engine (W&H DENTAL WORK),AUSTRILA and finishing assorted burs. Acrylic bur was use to remove the excesses then the mandrill sand paper bur is use to smooth the specimens. The lathe polishing machine was used to polish all the specimens. The bristle brush with pumice (Q.D England) was used in the polishing procedure and a cloth brush with rouge polishing material was used to carry out the final polishing of all the specimens. All the bulk specimens were conditioned in distilled water at 37'C for 31 days before they were tested. [11]

Preparation of relined acrylic specimens

The proportional thickness used for denture base material to reline material was I.5rnm: l mm according to [12]. By the same method followed in the preparation of the bulk specimens the relined acrylic specimens were prepared with only one difference in the dimensions of the specimens. Three rectangular metal plates, 60 mm in length, 10rnm width and 1.5mm thickness had been fabricated by the same machine. The stone mould was obtained from these patterns by the same way followed in the preparation of the bulk acrylic specimen. Relining was facilitated by placing each denture base specimen in the same stone mould (60 mm X 10 mm X 2.5 mm), which had been used previously for processing bulk acrylic specimens, For the rough groups a sandblast machine (Bego, Germany) of particles size210µ-290µ was used. The specimens were held in light contact to the nozzle for 45 seconds, after surface preparation, all samples were washed with distilled water and dried to remove any residue remaining on the prepared surfaces. The stone mould was again coated with a separating medium. The bonding agent (L1GHTDON-Bonding, Dreve Dentamid GmbH, Germany) was applied to the superior surface of each denture base specimen and was exposed to visible light generated from a light-curing unit (Echo light box) for two minutes,[11] a sticky inhibition remains, which is required for bonding. Thereafter, a light activated denture reline material was adapted with pressure into the mould and light cured through a glass slab (slides) for ten minutes. Each relined specimen was polished with pumice and rouge. The resultant thickness of the denture base and reline material was 1.5mm and 1mm respectively. The finished groups had identical outer dimensions. All specimens were verified with a micrometer at three points of each dimension to within 0.05rnm tolerance. The relined acrylic specimens were relined after 30 days of distilled water storage at 37"C, and tested 24 hours thereafter. Figure (2) shows the relined specimens before test.

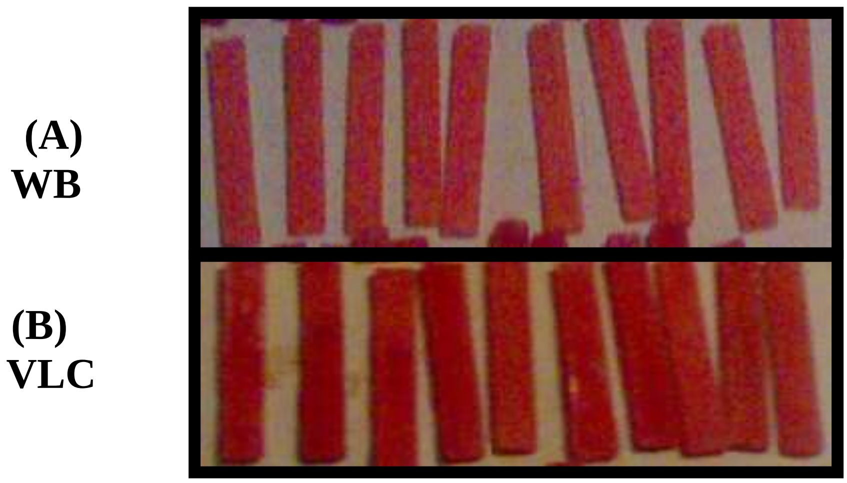

Figure (2): Relined specimens after finishing and polishing ready for testing.
(A WB: Water bath, B VLC: Visible Light cure)

Transverse strength test

a. Test specimen

A standard acrylic plates measuring 65mmX10mmX2.5mm for bulk acrylic specimens and relined acrylic specimens were prepared and shown in figure (3-4)illustrates the shape and dimensions of the transverse test specimen.

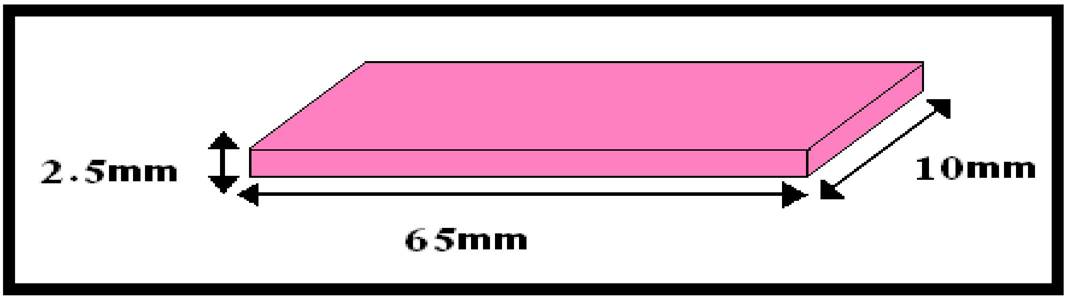

Figure (3): transverse strength test specimen.

Figure (4): cross section after relining.

b. Equipment and procedure The transverse strength of the specimens was measured in air by three points bending on an Instron testing machine ;(figure 5)

Figure (5): Instron testing machine.

The device was supplied with a central loading plunger and two supports with polished cylindrical surfaces 3.2mm in diameter placed 50mm apart as a span distance. The supports were parallel to each other and perpendicular to the central loading line;**.** The test was carried out with a constant cross-head speed of 2mm/ minute; the load was measured by a compression load cell of maximum capacity of 500 Newton The test specimens were held at each end of the two supports, and the loading plunger placed midway between the supports. The surface of the denture base material was placed facedown for each of the relined specimens. The specimens were deflected until fracture occurred. The transverse strength was calculated using the following equation:

($Fs=3TL/2bd^2$)[12]

Statistical analysis

The usual statistical methods were used in this study to analyze and assess our results , included Descriptive statistics:*(*Tables ,Arithmetic mean , Standard deviation (S.D) ,Minimum, Maximum, Graphical representation by Bar-Chart*)and* Inferential statistics(One way analysis of variance (ANOVA), T-test student.)

Results

1. Bulk denture base specimens.

Table (1), mean value, standard deviations, minimum and maximum of transverse strength (N/mm^2) among bulk denture base specimens.

Control groups	N	Mean	SD	Min	Max
Water bath	10	0.8687	0. 21108	0.4708	1.188
Visible light-cure	10	0.7981	0.12542	0.5768	0.9888

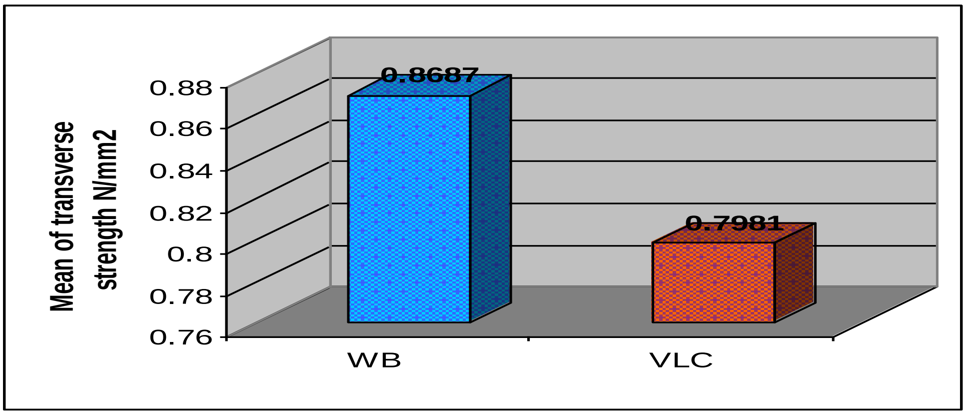

Figure (6) Bar chart of transverse strength mean values of bulk denture base specimens (control groups).

Mean value, standard deviation, minimum and maximum value are presented in table (1) Figure (6) for transverse strength among bulk denture base specimens (control groups) – showed that the water bath and the highest mean value of transverse strength (0.8687 N/mm^2) Followed by visible cure (0.79814 N/mm^2).

Table (2) student t-test of transverse strength among bulk denture base specimens (control groups).

Control group		P-value
Water bath	Visible light cure	s

S = significant difference of (P < 0.05)

Table (2) showed student T-test statistically there was significant difference at P <0.05 between two bulk specimens (control groups).

2. Relined specimens

Table (3) mean value, standard deviation, minimum, maximum and ANOVA of transverse strength (N/mm2) among the water bath specimens (control and test groups).

(6)

Water bath specimen	N	Mean	S.D	Min	Max	p- value
Bulk specimen (control-group)	10	0.8687	0. 21108	0.4708	1.188	N.S
Rough relined specimen test group	10	0.9311	0.333	0.5768	1.636	
Smooth relined specimen test group	10	2.181	3.110	0.482	8047	

N.S = Non significant difference at P > 0.05

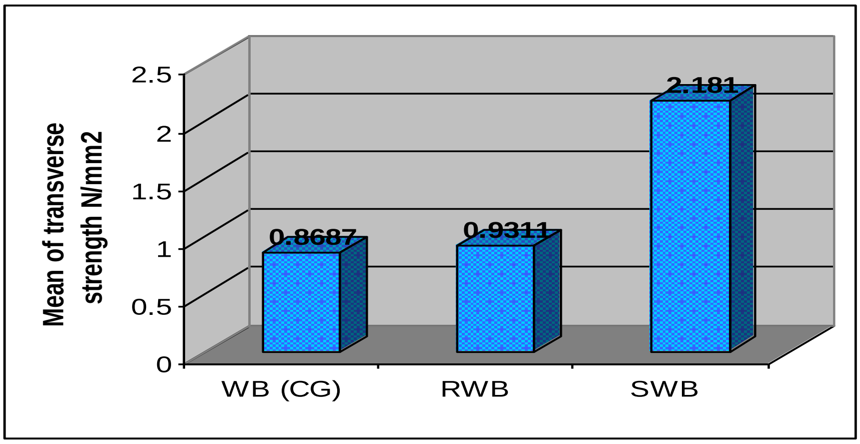

Figure (7) Bar chart show mean value of transverse strength among water bath specimens (control and relined test groups).

Mean value, standard Deviation, minimum, maximum value and ANOVA presented in table (3) figure (7) for transverse strength among water bath specimens (control and relined test groups). The highest mean value of transverse strength was obtained is smooth relined specimens (2.18135) N/mm^2); while the lowest mean value of transverse strength was obtained in bulk specimens control group (0.8687 N/mm^2).One way ANOVA show none. significant difference at P > 0.05.

Table(4): student T-test of transverse strength among water bath specimens.

Water bath groups		P. Value
Bulk specimens (control groups)	Rough relined specimen (test group)	N. S
Bulk specimens (control groups)	Smooth relined specimen (test group)	N.S
Rough relined (test groups)	Smooth specimen (test group)	N.S

N. S = Non significant difference at P > 0.05

In table (4) showed student T. test statistically there was non-significant difference at (P > 0.05) between bulk specimens (control group) and relined specimens (rough and smooth Also there was non significant difference was obtained between relined specimens (smooth and rough).

Table (5) means, stander deviation, minimum, maximum and ANOVA value of transverse strength (N/mm2) among the visible light cure specimens (control and test groups).

Visible light cure specimen	N	Mean	S.D	Min	Max	P. value
Bulk specimen	10	0.7981	0.1254	0.5768	0.988	
Rough relined	10	1.10384	0.44837	-0894	1.6480	N.S
Smooth relined specimen test group	10	1.32081	0.35780	0.6943	1.7304	

N. S = Non significant difference at P > 0.05

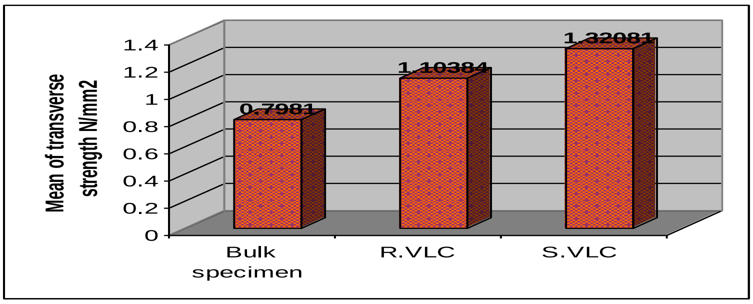

Figure (8) Bar chart show mean value of transverse strength among visible light cure specimens (control and relined test groups).

Mean value, stander deviation, minimum, maximum, value and presented in table (5), Figure (8) for transverse strength among V.L.C. specimens (control and relined test groups). The highest mean value of transverse strength was obtained in smooth relined specimen (1.3208 N/mm2). While the lowest mean value of transverse strength was obtained in bulk specimens control group (0.7981 N/mm2).

One away (ANOVA) showed that non-significant difference at P >0.05.

Table (6): student t-test of transverse strength among the visible light – cure specimens.

VLC groups		P-value
Bulk specimens (control group)	Rough relined specimen (test group)	N.S
Bulk specimens (control group)	Smooth relined specimen (test group)	S
Rough relined specimens (test group)	smooth relined specimen (test group)	N.S

N. S = non-significant difference at P >0.05
S = Significant difference at P <0.05

In table (6) showed student T-test statistically there was non-significant difference at (P>0.05) between bulk specimens (control group) and Rough relined specimens. Also there was non-significant difference between the test group (smooth and rough) relined specimens. While there was significant difference between bulk specimen (control group) and smooth relined specimens (test group).

Discussion

The use of visible light cured (VLC) resin for laboratory and chairside relining of complete and partial dentures has become popular. Due to gradual resorption of the edentulous ridge bone, complete and partial prostheses often require denture base relines to improve fit and stability. Denture reline material must possess adequate mechanical properties. The satisfactory strength of a relined denture base could be expected when the mechanical properties of the denture base material and the denture reline material as well as the bonding characteristics of the adhesion are to be investigated. The present study carried out to evaluate the transverse strength of different acrylic denture base after relining with visible light-polymerized material.

1. Bulk denture base specimens

The result of present study show that in **table (2) figure (6)** significant difference of transverse strength between bulk denture base material, (CG).the water bath heat cured denture base material had the highest transverse strength, followed by VLC denture base material. It might be due to the degree of polymerization factor which is related to the type of resin & polymerization rate and the time has been spent in the activation of each type. This is in good agreement with [13]who stated that "The slower the rate of polymerization, the stronger the material" Since the heat-cured material polymerized in water bath for a longer period of time compared to light-cured material, it's logically to obtain more degree of polymerization Also agreement with [14] who stated that high transverse strength of water bath heat cured denture base material when compared with VLC material because of more degree of polymerization.

2. Relined specimens

From the result obtained in **table (3), (4)**, it's clear that all denture bases, regardless the activation process, after relining with visible light-activated material gained a slight increase in transverse strength compared to bulk denture base material (control). The improvement in transverse strength of relined denture base specimens could be mainly related to the ability of the reline material to bond to the denture base properly. Although the bulk reline material "VLC" showed decrease in transverse strength than the water bath, its clinically acceptable and the results of transverse strength of the bulk reline material "VLC" was close to those obtained by [11]

Clarifying the results in **table (5), (6)**, the present experimental study relined all denture base materials identically with the same procedure and the same thickness of the material; however, various denture base materials improve their strength to a different extent. This phenomenon can not be explained simply by the exchange of a part of the denture base with the visible light activated material, because the effect would have been the same among the different denture base materials. The varying effect of the reline material on the denture base materials which is represented by the varying ratio of improvement among different relined denture base materials is thus best explained by the ability of the reline material to bond to the denture base. Essentially, the denture base material that has better bonding with the reline material exhibits better strength after relining. Thus, the light-cured relined specimens had the highest ratio of improvement (1.09) followed by water-bath (1.08) respectively. These observations are supported by the fore-mentioned explanation which is simply deals with the ability and compatibility between the reline material and denture base material. These findings are in agreement with [11] In regard to surface texture, all the roughened relined specimens exhibited a non significant reduction in transverse strength than smooth relined specimens. One explanation for this reduction could be attributed to the weakening effect that has been created during roughening the specimens by the process of sandblasting. The denture base part affords most of the load applied on the relined specimens. Probably weakening this part by creating stress concentration areas produced weaker denture base-reline composite. Surface roughness is mainly related to surface area and retentive properties of the material. There is a relation between transverse strength and tensile bond strength. [15]stated that the denture base material that has better bonding with the reline material exhibits better strength after relining. Accordingly, the reduction of the transverse strength among the roughened relined specimens may be due to that surface roughness has a reducing effect on the adhesion between the reline material and denture base material. This explanation is in agreement with [16] who found that increase in surface roughness of the tissue surface of the dentures, would decrease its retention and he claimed that light polishing of the tissue surface of the denture would be unlikely to impair retention. However, the explanation is in disagreement with [17] who claimed that increasing roughness would increase the interfacial area for adhesion between denture and saliva; the strength (retention) of that union would be improved. This study agreement with [14] who stated that surface roughness non-significant reduced the transverse strength in rough relined groups in relation to the smooth relined groups.

Conclusions

The use of visible light-cured material (Mega denta) side to side with the supplied bonding agent (LIGHTDON-Bonding) to reline any of the tested denture base materials slightly improved its transverse strengths., Surface roughness non-significantly reduced the transverse strength in the rough relined groups relative to the smooth relined groups, The water bath heat-cured denture base material had highest transverse strength when compared with VLC material

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