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Research Article

Bond Strength of Silicon-Based Soft Liner Cured in Microwave to Three Types of Denture Base Materials

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Abstract

Aims: The present study aimed to assess the tensile bond strength (TBS) of three types of denture base materials fabricated by the conventional heat curing technique, three-dimensional printing (3D) and computer-aided design computer-aided manufacture (CAD-CAM) milling technology, bonded to microwave cured silicon base soft liner, and to evaluate the effect of surface treatment (acetone and laser) on the TBS.

Materials and Methods: A total of 90 specimens, divided into three groups according to denture base type (Conventional, 3D and CAD-CAM), 30 specimens in each group, then subdivided into three subgroups according to the surface treatment (untreated, acetone and erbium, chromium-doped yttrium, scandium, gallium and garnet Er; Cr: YSGG laser), 10 specimens in each subgroup, the denture base materials were bonded to microwave cured silicone-based soft liner (DETAX Germany). TBS was tested using a universal testing machine. The mode of failure was tested by the stereomicroscope. The study results were statistically analyzed using the SPSS program Version 26, using one-way ANOVA and Duncan's test at $P \leq 0.05$.

Results: The CAD-CAM denture base showed a statistically significant increase in TBS value at $p \leq 0.05$ (1.88±0.135), whereas the 3D type denture base showed a lower TBS (0.93±0.058). The surface treatment with Er; Cr: YSGG laser (1.699±0.13) followed by acetone (1.378±0.06), respectively, showed a highly significant increase in TBS value, $p \leq 0.05$.

Conclusion: The CAD-CAM denture base demonstrated the highest TBS compared to the other types of denture base materials. The use of Er; Cr: YSGG laser and acetone, respectively, improves TBS.

Keywords: Conventional; 3D; CAD-CAM; Er;Cr:YSGG, Silicone based soft liner

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INTRODUCTION

Poly-methyl methacrylate (PMMA) resins were the dominant denture base material fabricated by the conventional heat-curing methods. More recently, a subtractive milling procedure fabricates computer-aided design and computer-aided manufacture (CAD-CAM) denture bases, which have minimum volumetric deviation as compared to the conventional denture base procedure, as the denture base is a disk milled from a pre-polymerized acrylic resin, with impermanent further polymerization shrinkage. Many in favor of CAD-CAM denture bases embrace minimizing the chair time, fitting improvement of the denture base, and dental prostheses and replacement electronic archiving(1,2).

Additive manufacturing has also been used for the construction of denture bases. After the milling technique of denture base processing, the convenience of additive manufacturing involves the capability to construct any shape, regardless of its complex dimensions or quantity. Additive manufacturing also produces minimal waste than milling, with finer detail reproduction (3).

Denture lining materials are important in dental prosthetic treatment. They are adapted to the intaglio surface of dentures to produce more equal force distribution(4). Removable dental prosthesis is negatively impacted by stress compression in the course of performance, which can cause serious damage to the supporting tissues. Increased ridge resorption causes a harmful effect on the denture-bearing areas. Re-lining of such a denture base can lessen the adversity to the supporting structures and improve stability and retention of the denture. Relining can be done on the chair-side or in the laboratory because of ease in technique. Reline are non-invasive and relatively economical procedure compared to remaking a denture (5).

The microwave energy usage for polymerizing resin was first reported by Nishii' in 1968. The efficiency of microwave irradiation was investigated and reported to be simpler, faster, safer, and cleaner than the other techniques.[6] Such methods were considered as an alternative PMMA processing approach and have since become widely popular compared to the conventional water-bath approach. It is not possible to use a metal flask in microwave curing because it transfers heat to the acrylic resin. The fiber-reinforced plastic flask (FRP) has become widespread as a part of the microwave oven polymerization approach (7). With microwave heating, the inner and outer surfaces of the sample are heated to almost the same temperature level, and the temperature increases rapidly(8).

Silicone based soft liners have poor chemical adhesion with the denture base PMMA, so it is advisable to use organic solvents such as methyl methacrylate and ethyl acetate to enhance the silicone based soft liner adhesion to PMMA by mechanical interlocking, because these solvents create softening and porosities on the bonding site at the PMMA surface that improves the adhesive penetration for the silicone based soft liners (9,10).

According to the previously mentioned drawbacks, the purpose of this study was to evaluate the TBS of three types of denture base materials fabricated by conventional technique, 3D printing, and milling CAD-CAM technology bonded to microwave-cured silicone-based soft denture liner, and study the effect of surface treatment on TBS improvement between the denture base and soft liner by increasing the mechanical adhesion.

This study aims to evaluate the TBS of three types of denture base materials (conventional, 3D-typing, and CAD-CAM manufacturing) to microwave-cured silicon-based soft liner. The effect of surface treatment (acetone and laser) on improving TBS between denture base materials and the soft liner. The null hypothesis when no significant differences in TBS among different denture base materials and among surface treatment groups. The alternative hypothesis when a significant difference in TBS among different denture base materials and among surface treatment groups.

MATERIALS AND METHODS

Preparation of a conventional heat-cure denture base specimen

A custom-made acrylic mold was designed first using computer software (Auto CAD 2021), and then the designs were saved in the form of an STL file. Three-dimensional designed specimens (3D) were exported to the Asiga 3D printer (Asiga Max). Denta base liquied asiga (3D print material for denture base) is used to prepare specimens.[7,11,12]

Dumbbell-shaped specimens are fabricated according to the American Society for Testing and Materials (ASTM) D412-1627 standard, with dimensions (36-mm-long brass patterns with widths of 7 and 12 mm) as shown in Figure (1) (13) Thirty specimens of denture base material were fabricated, the resin specimens were used for fabrication of mold using conventional flask procedure, after removing the resin from the mold which is ready for acrylic specimen preparation, a mix of powder/liquid ratio heat polymerizing acrylic resin is prepared according to manufacturer instructions (SR Triplex ® Hot, Ivoclar Vevadent) and placed in the mold a conventional flask procedure heat curing for the specimens in carried out(7,11,12).

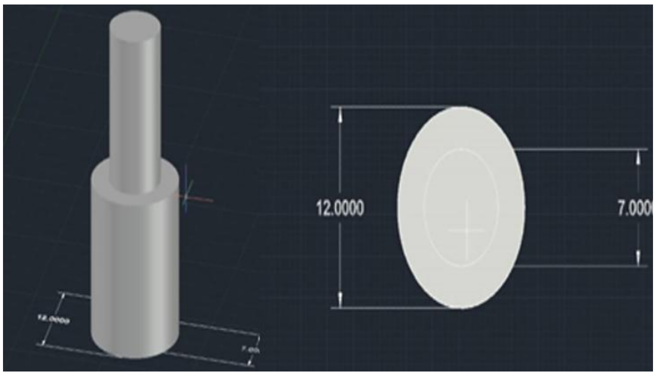

Figure (1): Dumbbell-shaped specimen design

Preparation of 3D printed denture base specimens

Specimens were printed on an Asiga 3D printer (Asiga Max, Asiga) as shown in Figure (2), DLP technology with LED wavelength 385 nm, high power. The STL file of the dumbbell-shaped specimen was constructed via AutoCAD (Autodesk). Thirty specimens were printed in correspondence to the Digital Light Projection (DLP) technology using photo-polymerized 3D printing liquid. After the printing had been completed, the group of samples was moved to the washing machine, washed twice for 10 minutes to remove any residue of uncured resin inside the spinning machine with 99% isopropyl alcohol (12,14).

Figure (2): Asiga dental 3D printer

Preparation of Ivo-base CAD-CAM denture base specimens

Milled CAD-CAM samples were fabricated using highly dense pressure-processed PMMA (IvoBase CAD 30mm puck; Ivoclar Vivadent), in a 5-axis milling CAD-CAM milling machine (MAXX DS 200-5Z, Korea). The dimensions were virtually designed using a software program (AutoCAD 2022). Then, STL files were imported to CAD software connected to the milling machine, as shown in Figure (3) (15-18).

Figure (3): Acrylic block CAD-CAM Specimen preparation

Surface treatment of the prepared denture base specimens

Group A: the surface of the acrylic side to be bonded to the silicone-based soft liner was not touched or treated with anything.

Group B: the surface of the acrylic side to be bonded to the silicone-based soft liner was treated with Dimethyl ketone 2-propanone (acetone) for 1 minute using a brush for application (19).

Group C: the surface of the acrylic side to be bonded to the silicone-based soft liner was treated with Er;Cr:YSGG water-lase (BIOLASE) technology, operating at a wavelength of 2,780 nm, and repetition rates of 20 Hz (20 pulses per second), and the power output was set at 3 watts(20).

Air and water sprays from the hand-piece were adjusted to a level of 85% air and 85% water. Laser energy was delivered through a fiber optic system to a sapphire tip terminal 600 μm in diameter and 6 mm long. The laser beam was aligned to the polymerized acrylic surface perpendicularly at 1 mm, and the specimen was treated in a sweeping fashion. All these parameters are controlled through the usage of a surveyor, as shown in Figure (4). Each specimen was treated for about 1 minute(20,21).

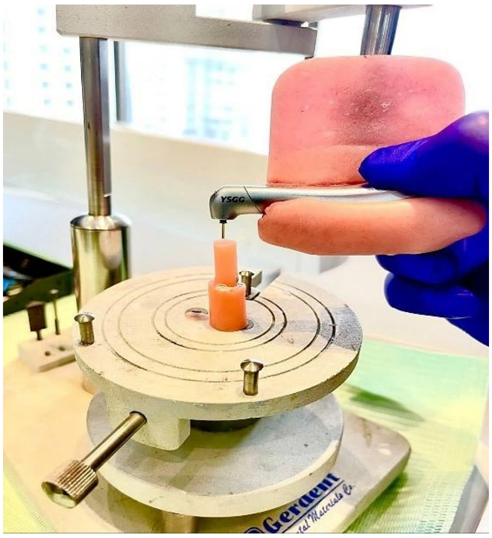

Figure (4): Application of a laser on an acrylic surface

Packing and microwave curing of the silicon-based soft liner

Two pieces of the specimen were joined together with 3mm wax spacers to provide space for the soft lining material. Preparation of microwaveable FRP (GC, Tokyo, Japan) dental flask. Then, half of the acrylic specimens were immersed in stone. After that, wax elimination and application of the silicon-based soft liner (DETAX, Germany) was completed, the half of the flask was placed over the first one and heat cured with a domestic microwave oven (Samsung) according to manufacturer instructions at 850 watts for 10 minutes(7,11).

After finishing, the specimens were removed from the flask after being cooled down slowly on the bench, then these specimens were stored in distilled water at 37◦C for 24 hours as described in ISO NO/12 specification 11405:(2003)(22).

Tensile bond strength (TBS)

The samples are grasped using clamps on both sides of the universal testing machine for measuring tensile bonding strength at a cross speed of 5 mm/min until failure.[2] The tensile bond strength (B) was calculated by using the following formula below (23).

B (MPα) = $\frac{F}{S}$, **S =** πr^2

r (radius) = 3.5 mm, S = 38.5 mm^2

Mode of failure

To identify the mode of failure of the specimens following the TBS, the de-bonded surface was examined using stereoscopic microscopy at 30x magnification. The mode of failure was classified as adhesive failure, cohesive failure, and mixed failure.

Statistical analysis

The statistical strategies were used to evaluate and interpret the study results using SPSS version 26. Assessment descriptive statistics, including mean and standard deviation values. The Shapiro-Wilk test of normality was first used to analyze the study result data for the TBS, and the result showed that the data were parametric and normally distributed. Descriptive statistics, mean, and standard deviations to clarify the group with the highest mean TBS at p-value ≤ 0.05. Assessment if there was a significant difference between study groups and within groups using the one-way ANOVA test. In order to evaluate the effect of interaction between different variables, analysis of variance (Two-way ANOVA) at p value ≤ 0.05, and Duncan's multiple range test were conducted.

RESULTS

The effect of denture base materials on TBS. The descriptive statistics for the three types of denture base materials are as shown in Table (1). One-way ANOVA showed that there is a highly significant difference in the mean value of TBS at P < 0.001 among the groups, as shown in Table (2). Duncan's multiple range test showed that the CAD-CAM denture base had significantly higher TBS, as labeled in Table (1).

The effect of surface treatment on TBS. The descriptive statistics for the control group and surface treatment groups are shown in Table (3). One-way ANOVA showed that there was a significant difference at P < 0.001 in TBS among groups, as shown in Table (4). Duncan's multiple range test showed that the surface treatment groups Er;Cr:YSGG laser and acetone, respectively, showed the highest mean TBS, whereas the untreated control group showed the lowest mean TBS value significantly, as labeled in Table (3).

Table (1): Descriptive statistics, TBS mean value (MPa) for the three types of denture base materials

Denture base type	Num.	Mean (MPa)	SD
Conventional	30	1.2567 (B)	0.05703
3D	30	0.9319 (A)	0.05828
CAD CAM	30	1.8887 (C)	0.13546

MPa= mega Pascal.

Table (2): One-way ANOVA, statistical test for TBS (MPa) among the groups of different denture base materials

SOV	SS	Df	MS	F	Sig.
Between groups	14.204	2	7.102	28.409	.000*
Within groups	21.749	87	.250		
Total	35.953	89			

SOV= Source of variance. SS= Sum of Squares. df:=Degree of freedom. MS= Mean square. *Highly significant at p ≤ 0.001.

Table (3): Descriptive statistics, TBS mean (MPa), standard deviation for surface treatment groups

Type of Surface Treatment	Num.	Mean (MPa)	SD
Control	30	0.9994 (A)	0.09521
Acetone	30	1.3788 (B)	0.06719
Laser	30	1.6990 (C)	0.13888

Table (4): One-way ANOVA, statistical test for TBS (MPa) among the groups of surface treatments

SOV	SS	Df	MS	F	Sig.
Between groups	7.359	2	3.680	11.196	.000
Within groups	28.594	87	.329		
Total	35.953	89			

SOV= Source of variance. SS= Sum of Squares. df:= Degree of freedom. MS= Mean square. *Highly significant at $p \leq 0.001$.

Analysis of variance (Two-way ANOVA) for the interaction between variables showed no significant difference in TBS at $P \leq 0.05$, for the interaction between the variable's denture base material and surface treatment. As shown in Table (5).

Table (5): Two-way ANOVA of the interaction between variables

SOV	Type III SS	df	MS	F	P-Value
Surface treatment	7.359	2	3.680	21.648	.000*
Denture base type	14.204	2	7.102	41.783	.000*
Surface treatment * Denture base	0.622	4	.155	.915	.459
Total	202.188	90			

SOV= Source of variance. SS= Sum of Squares. df:= Degree of freedom. MS= Mean square. *highly significant at $p \leq 0.001$.

Duncan's multiple range test showed that the group of CAD/CAM denture base treated with Er;Cr: YSGG laser had a significantly higher mean TBS, while the group of the 3D control untreated group had the lowest mean TBS value, as illustrated in Figure (5).

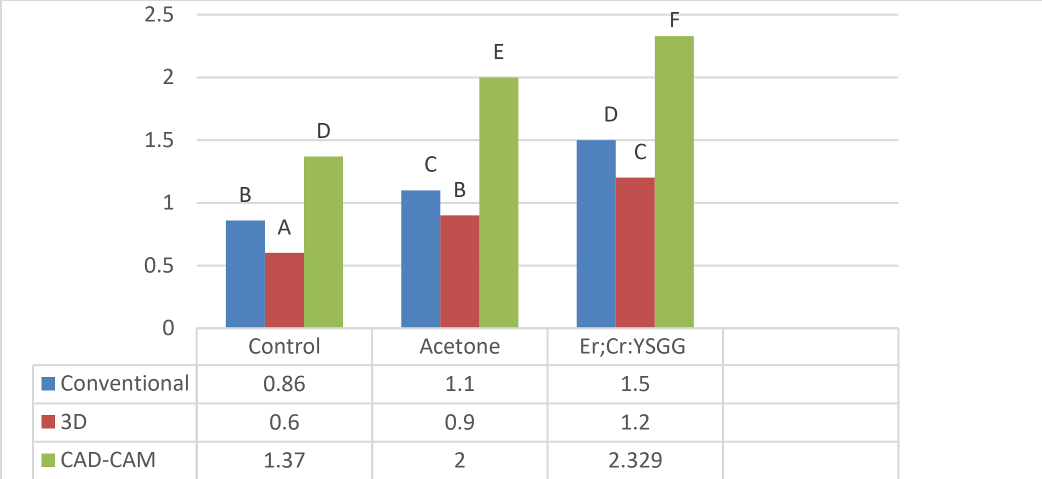

Figure (5): Duncan's multiple range test

Mode of failure

The de-bonded surfaces were evaluated using a reflecting light microscope, and the failure mode was categorized as follows: adhesive failure, characterized by a clean interface between the soft liner and the acrylic denture base material. Cohesive failure occurs within the soft liner. Mixed failure, both adhesive and cohesive failure. As shown in (Figures 6,7,8).

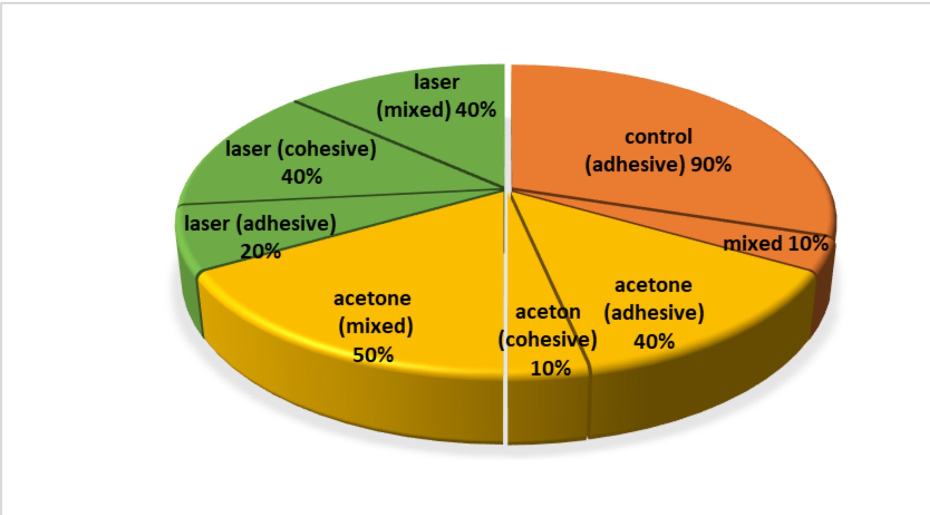

Figure (6): Mode of failure for Conventional denture base (Microwave curing of the soft liner)

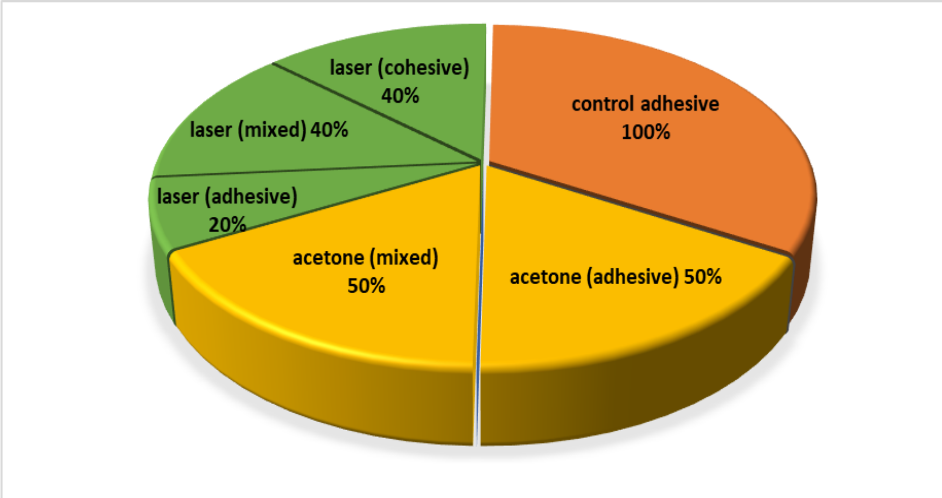

Figure (7): Mode of failure for 3D denture base (Microwave curing of the soft liner)

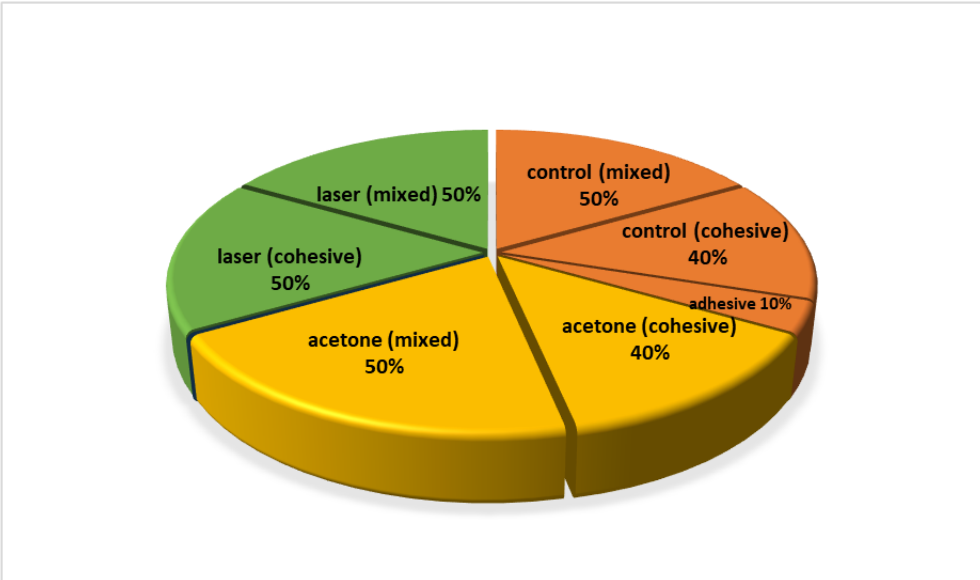

Figure (8): Mode of failure for CAD-CAM denture base (Microwave curing of the soft liner)

DISCUSSION

This study intended to evaluate the effect of different types of denture base materials bonded to microwave-cured silicone-based soft liner and surface treatments on the TBS value. Three types of denture base materials were used, which are the conventional heat-cure denture base, 3D, and CAD-CAM denture base. Two different surface treatments were used: acetone and the Er: Cr:YSGG laser.

The statistical result revealed a highly significant increase in the mean value of TBS. In CAD-CAM denture base material, the TBS mean value was highly significant (1.88

MPa) as compared to the other denture base materials, which are the conventional (1.256 MPa) and 3D printing (0.93MPa) denture base materials, as shown in Table (1). This difference in TBS among the different denture base groups might be explained by the dissimilar chemical content of the denture bases that the soft liner bonded to. The conventional fabricated and CAD-CAM milled denture base specimens are constructed from PMMA, while the printed 3D denture base is made up from a light-polymerizable denture base resin containing methacrylate monomer, diurethane dimethacrylate, propylidynetrimethyl trimethacrylate, and pigments (2). Also, there is a chance of the presence of residual uncured layers that may affect the properties of the 3D denture, leading to the lower TBS result (24,25).

An important cause of the result of our study is explained by the study of Pripic *et al.*(26) who compared the mechanical properties of the three types of denture materials that we used in our study. He announced that the 3D-printed acrylic denture base materials have lower mechanical properties than most other denture base materials, which might be the cause affecting the TBS when bonded with soft liner.

Also, the cause behind the highest TBS of CAD-CAM blocks might be the manufacturing construction characteristic, because it is made under high heat and pressure conditions with condensed acrylic resin, with minimal shrinkage and porosity, bringing an ideal, ready-to-use block of fully polymerized PMMA (26,27).

Another cause that the CAD-CAM milled denture base material had significantly the highest mean TBS might be that it consisted of more pores than the other types of denture base specimens. These pores could be the result of the increased mechanical interlocking between the denture base materials and silicon based soft liner (2).

Another reason explaining the difference in the TBS value between different denture base materials is the differences in material properties, in addition to the determination of the composition and the construction technique. In conventional construction techniques, the equation of powder/monomer, the polymerization time, and the thermal degree are critical parameters for denture base processing (28,29). On the other hand, we had the 3D printed denture with the lower value of TBS, which might be explained by the additive manufacturing procedure steps that might affect denture base properties, such as the print orientation (vertical orientation or flat orientation), which causes heterogeneous characteristics of the 3D printed denture base material (29).

The result of our study is in agreement with the result of Awad *et al.(*2), who announced that CAD-CAM milling denture base materials bonded to soft liners provide the highest mean statistically significant TBS value, whereas the 3D printed denture base produces the lowest TBS value at $P < 0.05$. Also, the study of Azpiazu-Flores *et al.*(11) agreed with our findings; they announced that the lowest TBS values were found between additive-manufactured 3D denture base materials bound to soft liners.

Also, in agreement with our findings, the study of Vuksic *et al.(*30) announced a significant difference in TBS values between different denture base materials that are bonded to silicone-based soft liner, in which the 3D constructed denture base materials showed lower values of TBS at $P \leq 0.05$, when compared to the heat-cured PMMA and subtractive manufactured denture base materials.

Studies in disagreement with our result, the study of Wemken *et al.*(31) he announced that there was no statistically significant difference in the TBS values between different denture base materials, conventional heat-cured PMMA, 3D printed, and ACD-CAM denture base materials when bonded to denture soft liner. Also, the study of Choi *et al*.[32] disagreed with our findings. He announced that resilient denture liners bonded to CAD-CAM denture bases bring the minimal TBS, which is in contrast to our results. This might be due to the fact that he used one acrylate-based and two silicone-based soft denture liners in their study.

When analyzing our study with the aforesaid studies, it can be claimed that the materials utilized were from the coequal groups of materials but not from the coequal manufacturers. Also, the specimen establishment, surface preparation, and the methods of testing vary hugely, which could be the cause of the dissimilarity in the results between studies (30).

For the surface treatment groups, the statistical result discloses a highly significant increase in the mean value of TBS, and showed a significantly higher TBS in Er;cr:YSGG laser (1.69 MPa), than the acetone group (1.37 MPa), and the control group had the lowest TBS value (0.9 MPa), as shown in Table (3).

The increase in the TBS value among the surface treatment group Er;Cr:YSGG laser at 3 W, 20 Hz is related to the laser application on the outer-layer of the bonding site between the denture base and the soft liner, which causes some chemical adjustments on the acrylic surface because of the thermal degradation(20,33).

These incidents were supposed to be dependent on the noted increases in TBS values of the acrylic specimens treated with the Er;Cr:YSGG laser. An important explanation about the Er;Cr:YSGG laser used in our study is its cooling effect on the outer-surface, minimizing the temperature as minimally as possible, and discarding any potential detrimental unwanted side-effects by preserving the acrylic properties, improving TBS.(21,33).

This increase in TBS in the Er;Cr:YSGG laser group at 3 W, 20 Hz, can also be explained by the high energy of the Er;Cr:YSGG laser. This, in turn, would interact with the water droplets, creating water molecule agitation leading to water drops micro-expansion and enterprising, this enterprising would lead to an increase in the outer-surface layer area by melting the surrounding material, leading to an increase in TBS because maximizing the surface outer-layer is in direct correlation with the TBS. Also, this Increase in the surface outer-layer helps with the mechanical interlocking (20,33).

An important explanation for this result is that the application of Er;Cr:YSGG laser on the acrylic outer-layer would increase the surface roughness, leading to minimizing the contact angle between PMMA and its liquids, which in turn provides the benefit of penetration of the soft liner into the acrylic micro-irregularities(20,21,33).

On the other hand, the use of acetone improves the TBS at $P \leq 0.05$, after laser group respectively, and this result could be due to the acetone moistening and utilization may guide to superficial crack generation and several pits formation, evaporation of the solvent upon the surface of the acrylic creating roughness in the outer-layer which improves the adhesive penetration and providing mechanical interlocking of the polymer chains(34).

Nearly the same idea explanation by Osathananda and Wiwatwarrapan(35), they stated that the decomposition of the resin by the chemical solvent might cause bloating of outer-surface outer-layers, and dissipation of the solvent. The linear monomers diffuse, perforate the resin pores, and form a percolating polymeric network. The greater the surface bloating, the greater the consequence of the porous outer-layer, and as an outcome, the maximum adhesion between the liner and the denture base.

Another important chemical explanation of the reason that the acetone group improvement of the TBS as shown in table (3), is that Dimethyl ketone 2-propanone (acetone) is capable of passing deeply through into the polymer chains and ease the invasion of adhesive primer, Akin *et al.(*36) stated that When chemicals solvent and PMMA interact with each other, surface roughening and maximized bonding strength is the result. This is related to the alkyl groups of the methacrylate, which will sort hydrogen bonds with the C-H groups. These chemicals have dissolving effects on the outer-layer of the denture base resin, leading to surface roughening and increasing the bond strength.

In line with our results of the surface treatment group, the study of Yildirim *et al*(37) announced that Denture liner materials penetrate the cracks or inconsistencies adapted by the laser, maximizing roughness in the bonding site and improving the bonding strength. Also, in agreement with our findings, the study of Korkmaz *et al*(20) announced that the Er;Cr:YSGG laser helps in maximizing the bonding strength of the liners to the denture base. Also, the Study of Kreve *et al*.(34) and Surapaneni *et al* (19) agreed with our findings about acetone surface treatment, announcing that the acetone surface treatment maximizes the adhesion, providing the interlocking of the polymer chains.

In disagreement with our results, the study of Gundogdu *et al.*(38) announced that the use of laser treatment Er:YAG did not increase the bond strength of PMMA resin to silicone-based soft liners. Regardless of the maximizing in surface roughness, the maximum TBS over specimens was not statistically significant. This might be due to the sweeping move of the laser hand at the time of treatment, leading to different extents of micropores formed, which might not ease the flow of liner material. Also, in our study, different parameters of the laser were used, which is also a cause of this dissimilar result.

Our study results for the mode of failure between the denture base materials and the soft liner are mostly adhesive failure for the conventional and 3D-printed denture base materials and mostly cohesive and mixed failure for the CAD-CAM denture base materials. After surface treatment, all denture bases exhibit mostly cohesive and mixed failure because surface treatment improves TBS.

Our results are in line with the studies of Awad *et al.(*2) and Vuksic *et al.(*30), who announced that the 3D-printed denture base, relined with soft liner showing adhesive failure, whereas the CAD-CAM Milled denture base showed cohesive and mixed failure. Also, the study of Nakhaei *et al.* (39) reported adhesive failure between denture base material and silicone-based soft liner before the use of surface treatment, and cohesive and mixed failure after surface treatment usage. In disagreement with our results, the study of Wemken *et al.*(31) and Choi *et al.*(32) announced that the type of failure is massively adhesive for all the denture base materials.

CONCLUSIONS

Within the limitations of the current study, it is possible to conclude that:
Different types of denture base materials significantly affect the TBS to denture base soft liner. The CAD-CAM denture base materials significantly increase the TBS. This study concluded that the 3D printed denture base materials had lower TBS than denture base materials. Also, a conclusion of this study is that the use of surface treatments improves the TBS. Er;Cr:YSGG laser and acetone, respectively, improve the TBS for all types of denture base materials bonded to silicone-based soft liner.

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Authors' Contribution

Mahmood IA and Hasan RH. completed the conceptualization, data curation, formal analysis, finding acquisition, investigation, resources, software, validation, visualization, writing- original draft, writing- review, and editing. Methodology, Project administration by Mahmood IA. Supervision, Visualization by Hasan RH.

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Ethical statement: Not applicable

Conflict of interest

The author declares that there are no conflicts of interest regarding the publication of this manuscript

Availability of data and materials: All data generated or analyzed during this study are included in this published article and its supplementary information files.

Declaration of Generative AI and AI-assisted technologies

During the preparation of this work, the authors used a grammar tool to improve the readability of the manuscript. The authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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قوة الترابط بين البطانة اللينة المصنوعة من السيليكون والمعالجة بالميكروويف وثلاثة أنواع من مواد قاعدة طقم الأسنان

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الملخص

الأهداف: تهدف الدراســـة الحالية الى تقيم قوة ترابط الشـــد لثلاث أنواع مختلفة من قواعد الاطقم Conventional, 3d, CAD-CAM)) مع مواد التبطين الســـيليكونية المصـــلبة بالمايكروويف. كذلك بإضـــافة معاملات ســـطح مختلفة (الليزر والاسيتون) على السطح الرابط بين الطقم ومادة التبطين. **المواد والطرائق العمل**: تم تحضـير 90 عينة في الدراسـة الرئيسية 30 عينة في كل مجموعة من الأطقم للثلاثة و10 عينات في كل مجموعة معامل ســـطح يتم فحص العينات باختيار قوة ترابط الشد ويتم بعد ذلك تحليل نتائج الدراسة احصائيا باستخدام اختباري One way ANOVA وDunca. **النتائج**: أظهرت نتائج قوة ترابط الشـــد زيادة معنوية عالية في القيم لنوع الطقم (CAD-CAM) مقارنة بالأنواع الأخرى ($p \leq 0.05$.) واقل قيمة نتائج قوة ترابط الشــد وجدت عند نوع الطقم (D3)، كذلك أظهرت النتائج ان إضـــافة معاملات الاســـطح الليزر والاســـيتون أفضـل مقارنة بالمجموعات الضـابطة ($p \leq 0.05$.). **الاستنتاجات**: ان مادة الطقم (CAD-CAM) أعطت أفضـل نتائج قوة ترابط شد بين مادة قاعدة الاطقم ومادة التبطين واقل نوع هي ال (D3)، وأخيرا ان إضافة معاملات الاسطح الليزر والاسيتون له تثير على زيادة قوة الترابط بي مادة قواعد الاطقم ومادة التبطين السيليكونية.

الكلمات المفتاحية: تقليدي؛ ثلاثي الأبعاد؛ CAD-CAM؛ Er؛Cr:YSGG ، بطانة ناعمة أساسها السيليكون