

Evaluation the Effect of Disinfectant Solution on Two Different Permanent Soft Liner Materials on Plaque Accumulation

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Received: April 10, 2017; **Published:** April 20, 2017

Abstract

Objective: To evaluate the effect of using a disinfectant solution as a denture cleanser on complete dentures relined by two different permanent soft liner materials, on plaque accumulation using digital computerized method.

Materials and Methods: Twenty completely edentulous male patients with age ranging from 45 - 60 years were selected. Patients were divided into two groups according to the type of relining material used: Group I: 10 patients with dentures relined with acrylic resin-based relining material (light cured). Group II: 10 patients with- dentures relined with silicone-based relining material. Patients were instructed to come in the follow up period which starts after denture adjustment by 1 week, 1 month and 2 months. In every follow-up visit, the maxillary denture was rinsed with tap water and stained with plaque detector by soaking the denture with a piece of cotton full of 0.1% methylene blue solution for 2 minutes. The denture was then photographed digitally.

Results: There was an insignificant increase in plaque accumulation between 1 week and 1 month periods while there was a significant increase between 1 month and two months before and after disinfection. There was an insignificant increase in plaque accumulation during the whole follow up period between both groups.

Conclusion: The visible light cured acrylic resin is better than auto cured silicone lining materials from the plaque accumulation point of view.

Keywords: *Disinfectant Solution; Soft Liners; Plaque Accumulation; Complete Denture*

Introduction

Residual ridges have been described as plastic in nature, always changing in topography and structure. A critical part of complete denture service is to maintain adaptation of the denture bases to the underlying ridges, therefore, to maintain the prosthesis-tissue relationship, reline or rebase procedures are commonly required [1].

Intraoral relining of removable prosthesis has many advantages over laboratory relining; among which is that it is less time consuming, for the intraoral relining technique, many resins have been used including. autocured acrylic resins,, however, presence of free monomer, theft inferior physical properties and the exothermic curing reaction have limited their use [2].

The introduction of the triad Visible Light Cured (VLC) denture resin system has led - to several useful VLC resin applications. Clinical evaluations have established the biocompatibility of the triad VLC resin and it was found that its mechanical properties are comparable to those of heat-cured acrylic resins [3].

Permanent soft denture liners have been a valuable assist for dentists. Because of their viscoelastic properties, they act as shock-absorbers and distribute the stresses on the denture-bearing tissues [4]. Also, their use gives more patient comfort during the treatment of the atrophic ridge, bone undercuts, bruxism and dentures opposing natural teeth [5].

Denture plaque is an important factor in stomatitis in patients who wear dentures with or without liners [6]. Cleaning of dentures and removal of plaque are important steps in the maintenance of good oral health [6]. Therefore, denture cleansers have been considered an efficacious aid to prevent denture plaque formation. Alkaline hypochlorite has been recommended as an effective denture cleanser for both temporary and permanent soft lining materials as well as in metal dentures [7-10]. So, the aim of this study was to evaluate the effect of disinfectant solution on dentures relined by two different soft lining materials on plaque accumulation.

Materials and Methods

Patient selection

For this study, twenty (20) male old complete denture wearers, age ranging from 45.60 years were selected from the outpatient clinic of the Prosthodontic Department, Faculty of Oral and Dental Medicine, Cairo University, according to the following criteria:

- All had loose, ill fitted denture.
- Free from systemic diseases that may affect the salivary flow or the oral environment as diabetes, endocrine disorders, autoimmune diseases, anaemias or nutritional deficiencies.
- Extremely resorbed ridges and flabby ridges were excluded.
- Angle class I.
- Non-smokers with normal oral habits.
- Patients with TMJ disorders were excluded.
- Cooperative and accept recalling when needed.

Denture construction

Primary impressions were made with alginate impression material for obtaining the primary casts. Acrylic resin special trays were constructed, border molding with green stick compound", then final impressions with zinc oxide/eugenol impression material. Final impressions were then poured with dental stone to obtain the master casts on which occlusion blocks were constructed. A duplicate for the upper cast on a semi adjustable articulator, and then the lower cast was mounted using the check bite (wax wafer) technique. Protrusive record was done to adjust the condylar guidance (horizontal and lateral) of the articulator. Setting up of cross-linked acrylic resin teeth was carried out. Face bow index was made for clinical remounting later on.

Try-in of the waxed-up dentures, flasking, packing, laboratory -remounting and finally finishing and polishing of the dentures were then done.

For each patient; the finished 'upper denture was inserted on its duplicate master cast and a plaster index was made for the palatal surface of the denture extending from the palatal half of the artificial teeth till the posterior edge of the denture.

Plaster occlusal index

The plaster occlusal index was made for the upper finished denture to be repositioned in a fixed relation to photographic camera; the index was done as follows:

- All the polished surface of the finished maxillary denture including the teeth was painted with a separating medium.

- A thick mix of plaster of Paris was mixed and boxed by boxing wax, the denture was then placed on the mix till covering the incisal and occlusal third of the denture teeth, then left till set. After setting, the denture was removed and the plaster index was finished and smoothed.

Relining of the finished dentures

Proper adjustments of the dentures were done and clinical remounting was carried out by the face bow index for the upper dentures after 1 week from denture delivery, the upper denture was then reduced from its fitting surface by about 1 - 1.5 mm to allow a later relining of at least 2 mm of the relining material. Roughening of the reduced fitting surface was carried out to improve adhesion of the relining material to the denture. Then the denture was cleaned with water and air dried. Attention should be taken to avoid touching the denture borders of the dentures in order to preserve the peripheral seal of the denture.

Patients were divided into two equal groups according to the type of relining material used:

Group I: 10 patients with their dentures relined with acrylic resin-based relining material (light cured).

Group II: 10 patients with their dentures relined with silicone-based relining material.

Group I

(Light cured acrylic*-based permanent relining material)

- The powder of the light cured acrylic resin was mixed with the monomer according to the manufacturer's instructions and left until it reached a honey mix, then applied to the dry and clean fitting surface to form a layer of at least 2 mm thick.
- The denture was inserted over its duplicate master cast with the palatal plaster index on the polished surface, pressure is applied on the palatal plaster index to form a uniform layer of the lining material and held for 3 minutes then the denture is removed and excess material is trimmed.
- The denture was inserted in the patient's mouth and the patient was instructed to close in centric occlusion and perform masticatory and swallowing movements for 1 minute.
- The denture then was taken out and inspected for any excess material, and inserted into a light chamber and allowed to cure for 10 minutes.
- Then the denture was taken out. An air barrier provided with the soft liner set was painted with a soft brush and gently dried by air. The denture was reinserted in the light chamber for another 10 minutes to complete the curing process.
- Finally, the denture was delivered to the patient.

Group II

(silicone-based* permanent soft relining material)

- The fitting surface of the denture was painted by a soft brush with pure non-denatured alcohol (minimum 90% saturation) and let aerate for 1 minute.
- The adhesive supplied with the soft liner set was then painted with a brush and let to aerate for-1 minute.
- Equal length of both tubes (base and catalyst) of the soft liner was then mixed (in ratio 1:1) to give homogenous mix, and applied to the dry and clean fitting surface of the denture, the thickness of the soft liner layer should be at least 2 mm.
- The same technique as for group I is carried out using the duplicate master cast and the palatal plaster index for 1 minute.

- The denture was inserted in the patient's mouth that was instructed to close in centric occlusion for one minute and then instructed to perform masticatory and swallowing movements for 5 minutes.
- After the material had set, the denture was removed from the patient's mouth and let to complete the setting of the material. Finishing was started after 10 minutes of its removal and was done by sharp scissor or scalpel.
- A glaze was applied after finishing for sealing and smoothening the treated surfaces, by mixing equal number of drops of the glazing base and catalyst supplied with the soft liner set and applied with a smooth brush thinly and equally on the corresponding margins {fresh and dry cut areas}.
- Finally, the denture was delivered to the patient.

Patient's instructions

For both groups, patients were instructed to follow these guides:

- Use their dentures regularly and clean it after meals with tap water only without using brushes.
- Avoid having their dentures dry.
- Soak their dentures at night (after cleaning it) in tap water only for the first two months, and then use 1% sodium hypochlorite solution as a disinfectant for the following two months. 1% sodium hypochlorite was prepared as follows: 1 tea spoon of sodium hypochlorite was added to 8 ounces of tap water [11,12].

Follow up

The patients of both groups received their dentures and any necessary adjustments were carried out till they were satisfied to their complete dentures.

The follow up period is divided into two periods of two months each; for the first two months, patients of both groups were instructed to use tap water only and have their dentures soaked in it at night. During this time patients were recalled at these scheduled times for taking records:

1st period: after 1 week from time of denture delivery.

2nd period: after 1 month from time of denture delivery.

3rd period: after 2 month.

In each recall visit, the denture was gently cleaned from any food debris, inspected and dried then stained, photographed and given back to the patient.

Staining of the denture plaque

Staining was carried out with plaque detector by soaking the denture- with a piece of cotton full of 0.1% methylene blue solution for 2 minutes, the solution should reach every fine detail in the fitting surface by repeated application. After the 2 minutes, the stained denture was rinsed with running tap water for 1 minutes to remove any unbounded dye, it was then left to dry.

The plaque present could then be visualized as deep blue areas and the stained dentures were photographed at a fixed object-film distance and in its plaster index. The denture was then given back to the patient till the next follow-up visit.

By the end of the first two months, dentures were taken from the patient and the soft lining layer was removed and a new fresh layer of the same lining material was applied with the same technique for each group. The dentures were delivered to the patients and now,

patients were instructed to clean their dentures normally followed by soaking them in 1% sodium hypochlorite solution as a disinfectant for 20 minutes, rinsing them carefully with water and keep them in water overnight.

For the next two months, patients were recalled at the same periods as in the first two months for taking records.

Calculation of the plaque stained areas

The technique of Minagi, *et al.* 1987 was followed in this study for the measurement of plaque stained areas, after photographing the stained dentures in their corresponding indices, photographs were transferred to the computer digitally, then the percentage of the plaque stained areas were measured in relation to the total fitting surface area by using special software program "Autocad" [13].

The measurements were done as follows:

- The fitting surface of the denture was demarcated to be bounded by the crest of the ridge anteriorly and laterally. Posteriorly, it was bounded by the posterior border of the denture. The total fitting surface area was calculated and measured.
- The most deep blue areas (plaque stained areas) were demarcated and also measured.
- The ratio of the number of pixels of the plaque stained areas was counted in relation to the total number of pixels of the fitting surface area. The percentage was calculated.
- The obtained data was summarized, tabulated and statistically analyzed.

Results

In this study, twenty completely edentulous male patients were selected and divided into two groups according to the type of soft denture liner used as follows:

Group I: 10 patients with dentures relined with acrylic resin-based relining material (light cured).

Group II: 10 patients with dentures relined with silicone-based relining material.

Patients were instructed to come in the follow up period which starts after denture adjustment and clinical remounting by 1 week (first follow up period), 1 month (second follow up period) and 2 months (third follow up period) with their dentures immersed in water only overnight. And another 1 week, 1 month and 2 months with their dentures soaked in sodium hypochlorite solution for 20 minutes and then immersed in water overnight.

Comparisons were done between water immersion and disinfectant immersion for the same lining material and also between the two lining materials before and after disinfection.

The collected data was statistically analyzed by SPSS 18.0 for windows using student t-test, the following results were obtained. P-value < 0.05 is considered a significant difference.

Visible light cured acrylic resin lining material

Before and after disinfection

There was insignificant difference in the VLC acrylic resin before and after disinfection in one week as the values were 21.62 ± 3.66 without disinfection and 20.49 ± 3.05 with disinfection with P-value of 0.11, while there was significant difference between them in the second and third follow-up periods as the values were 26.04 ± 1.58 without disinfection and 22.08 ± 1.59 and P-value of 0.03 with disin-

fection in 1 month follow up period, and values were 32.89 ± 1.88 without disinfection and 27.59 ± 1.51 and P-value of 0.02 with disinfection in 2 month follow up period.

Effect of time on plaque accumulation of the VLC group

There was an insignificant increase in plaque accumulation between 1 week and 1 month periods while there was a significant increase between 1 month and two months before and after disinfection.

Autopolymerized silicone lining material

Before and after disinfection

There was insignificant difference in the autopolymerized silicone before and after disinfection in one weak as the values were 24.55 ± 4.16 without disinfection and 22.62 ± 3.98 with disinfection with P-value of 0.13, while there was significant difference between them in the second and third follow-up periods as the values were 29.16 ± 2.19 without disinfection and 25.87 ± 2.01 and P-value of 0.04 with disinfection in 1 month follow up period: and values were 36.60 ± 1.92 without disinfection and 31.09 ± 2.52 and P-value of 0.02 with disinfection in 2 month follow up period.

Effect of time on plaque accumulation of the autopolymerized silicone group

There was an insignificant increase in plaque accumulation between 1 week and 1 month periods while there was a significant increase between 1 month and two months before and after disinfection.

Comparison between VLC acrylic resin and auto

Polymerized silicone lining materials without disinfection

There was an insignificant difference between the two materials without disinfection in all follow up periods as values were 21.62 ± 2.84 for group I and 24.05 ± 3.56 for group II with P-value of 0.12 in one week, while values were 26.24 ± 3.23 for group I and 29.11 ± 2.76 for group II with P-value of 0.09 in 1 month and values were 32.89 ± 3.60 for group I and 37.05 ± 3.11 for group II with P-value of 0.09 in 2 month follow up period (Table 1; Figure 1 and 2).

Follow-up period	Mean + S.D of Group I (acrylic)	Mean + S.D of Group II (silicone)	P-value
1 week	21.62+-2.84	24.05+3.56	0.12
1 month	26.24+3.23	29.11+2.76	0.09
2 month	32.89+3.60	37.05+3.11	0.09

Table 1: Comparison between means and standard deviation of the plaque stained areas of both VLC acrylic resin and autopolymerized silicone lining materials without disinfection.

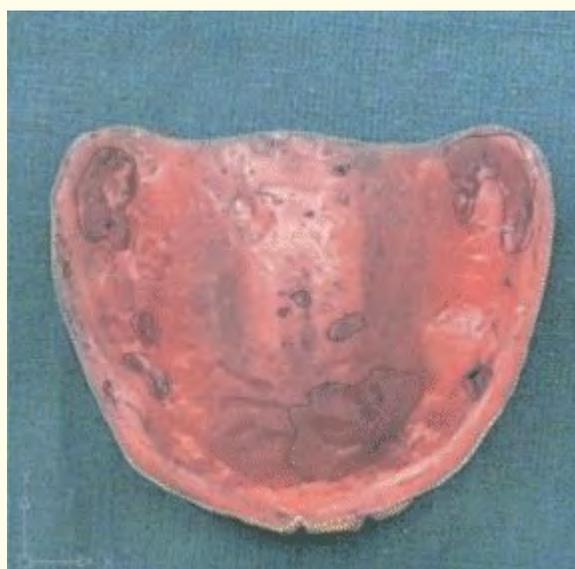


Figure 1: Plaque stained areas of VLC acrylic resin lining materials.



Figure 2: Plaque stained areas autopolymerized silicone lining materials.

Effect of time on plaque-accumulation between both groups without disinfection

There was an insignificant increase in plaque accumulation during the whole follow up period between both groups.

Comparison between VLC acrylic resin and auto polymerized silicone lining materials with disinfection.

Results showed significant difference between the two materials with disinfection in all follow up periods as values were 20.49 ± 1.48 for group I and 22.62 ± 1.53 for group 11 with P-value of 0.02 in one weak, while values were 22.08 ± 1.59 for group I and 25.46 ± 3.00 for group II with P-value of 0.01 in 1 month and values were 26.57 ± 1.51 for group 1 and 30.09 ± 2.18 for group II with P-value of 0.01 in 2 month follow up period.

Effect of time on plaque accumulation between both groups with disinfection

There was a significant difference in plaque accumulation during the whole follow up period between both groups.

Discussion

The selected patients were male to overcome the high oral yeast count which has been reported among females 15 and to avoid the effect of difference in sex hormones on the biology of the oral tissues [15].

The patient’s age ranged between 50 - 60 years to eliminate the effect of senility as old patients suffer from muscle atrophy, excessive amount of hyperplastic tissues as well as fiat ridges, pointed out that aging process is accountable for a number of unfavorable histologic changes in the oral mucosa [11].

Patients were selected to have previous experience with dentures to lessen the accommodation period to the denture as old denture patients know how to deal with new dentures as well as denture hygiene instructions which in turn affect the plaque accumulation analy-

sis. Moreover, the new extractions may alter the microbial flora of the oral cavity and most of the alveolar bone resorption occurs in the first six months following extraction, therefore it is better to postpone denture construction to after that period [12].

All selected cases were free from any systemic disorders that will enhance mucosal inflammation as endocrine disorders, diabetes mellitus, hypertension, anaemia, etc., as mucosa! Inflammation and plaque accumulation are not only interrelated but are also interdependent, which means, inflammation of the surface mucosa influences plaque formation and accumulation. Also, plaque accumulation on the denture surfaces contacting the oral mucosa causes its inflammation) [15].

Patients selected were free from xerostomia or excessive salivation as they may affect denture stability, retention and subsequently the patient satisfaction [17]. Also, Grasso, *et al.* 1994, mentioned that patients with severely atrophied ridges and/or thin ridges covered with thin mucoperiosteum were excluded to avoid impairment of denture stability and/or soreness that may affect the patient's ability to chew different types of food and consequently their satisfaction with the denture [18]. Moreover, severe bilateral bone undercuts were avoided as it may be a factor enhancing mucosal inflammation.

Normal ridge relationship (Angle's class I) was considered in this study because muscle activity differs with abnormal ridge relation and respectively the amount of stress transmitted to the oral mucosa as there's a good evidence that mechanical trauma from the denture base is the primary etiology in denture stomatitis [1].

The soft liners were autopolymerizing soft liners as recommended using autopolymerized liners over conventional laboratory processed ones from a clinical aspect because the former is softer and performed more consistently over time [19].

It was mentioned that acrylic resin lining materials showed viscoelastic behavior and higher levels of cushioning effect which may best meet the requirements of the resilient denture liners from the point of the inherent viscoelastic properties. However, regarding the durability, silicone lining materials would be better. Moreover, it has been mentioned that the silicones have good elastic properties and retain their shape after setting despite of being subjected to masticatory loading. To be effective, the resilient layer must be of sufficient bulk and a proper thickness of 1.5-2.0 mm [20].

An adhesive was supplied with silicone-based soft denture liners to aid in bonding the liner to the resin denture base, as silicone denture base liners have little or no chemical adhesion to poly methyl methacrylate resins. Therefore, the bond strength of silicone denture base liners depends on the tensile strength of the material and adhesive used. For that before silicone soft liner application and after reducing 1 - 1.5 mm from the denture fitting surface, an alcohol was painted as humidity, saliva, monomer-containing synthetic liquids or other additives, will diminish the adhesion of the soft liner to the denture base [21].

Patients were instructed that denture must be left out of the mouth at night to provide needed rest from the stresses they create on the residual ridges. Failure to allow the tissues of the basal seat to rest may be a contributing factor in the development of serious oral lesions such as inflammatory papillary hyperplasia or may increase the opportunity for the growth of fungus infection such as candidiasis. When dentures are left out of the mouth, they should be placed in a container filled with water to prevent drying and possible dimensional changes of the denture base material [12].

Patients should be instructed to clean their relined dentures carefully with a soft brush because of the liner's low hardness and poor abrasion resistance [22].

Numerous clinical studies have demonstrated the relationship between denture plaque, mucosal inflammation and denture-induced stomatitis. It is well established that the use of denture cleansers helps to control or eliminate these conditions by reducing the amount of plaque residing on the denture surfaces [23].

The disinfectant solution used was 5% sodium hypochlorite in one half glass of tap water nearly as Craig, 1996, who mentioned that a solution of one teaspoon of Clorox (about 5% sodium hypochlorite) and two teaspoons of Clagon in one-half glass of water has been recommended for occasional overnight cleaning of acrylic dentures by immersion. Budtz Jorgensen, mentioned that if water temperature is 60°C or higher, significant whitening of the denture resin will occur [24].

Sodium hypochlorite was used as it is accepted by the American Dental Association for the cleansing and disinfection of complete dentures and non-metal partial removable dentures [25].

Moreover, Jagger and Harrison, mentioned that the best way to clean relined dentures with permanent soft materials as silicone and acrylic resin as well as temporary ones is rinsing the dentures with water after each meal and soaking for 20 minutes in an alkaline hypochlorite solution. A disinfectant was able to disinfect dentures in 10 minutes while it was unable to penetrate into the deeper region of the porous soft denture liners within 10 minutes, therefore it was recommended that extended exposure time would contribute to reduce the number of microorganisms [26]. The relined dentures in this study were soaked in the sodium hypochlorite solution for 20 minutes each night.

Alkaline hypochlorite is recommended for its superior cleansing properties. It is effective in dissolution of plaque, may inhibit calculus formation because of its effect on the plaque matrix, bleach stains and is bactericidal and fungicidal [2]. It may leave a residual unpleasant odor and taste, but soaking in water overnight should reduce this [26]. Additionally, sodium hypochlorite is helpful as a regular disinfectant in controlling plaque on prosthetic restorations as it is a strong antimicrobial agent, has strong effect on stain removal and on decomposition of organic substances [24].

McNeme., *et al.* found no detectable color changes in any of the acrylic resin samples after 72h. immersion in 1% sodium hypochlorite solution [27]. According to Molinari and Runnells, the Centers for Disease Control have recommended the use of 0.05 - 0.5% sodium hypochlorite as an effective agent in inactivating hepatitis B virus [28]. Also, Pavarina., *et al.* [29] suggested that 1% sodium hypochlorite could be used as an immersion solution in the infection control protocol described in his study.

This study used a piece of cotton filled with 1% methylene blue instead of immersion of the denture in the solution, because in the immersion technique, the teeth and the polished surface will be stained with blue color which is very difficult to be removed. So, staining the fitting surface only by cotton to preserve the esthetics of the denture with good patient satisfaction.

In this study, analysis of plaque accumulation was done by computer graphic analysis of the stained scanned photographs of the denture's fitting surface. This analysis technique is objective, quantitative method for measuring plaque accumulation, reproducible and the human judgment was greatly minimized. The fitting surface was considered to be bounded by the crest of the ridge anteriorly, and laterally, and posteriorly by the posterior border of the denture, these limitations were done to avoid variations in the contour of the denture flanges that might affect the reliability of the results [13].

The resilient materials present problems during clinical use such as the loss of resiliency, color alterations and porosity. The loss of resiliency may be due to the leaching out of the plasticizer and other components, which in turn can alter the bonding surfaces of the resilient materials, so, become brittle with change in the bond strength properties. Moreover, the increased porosity of the resilient lining materials can lead to plaque accumulation and *Candida albicans* colonization [30].

There was an overall significant reduction in plaque formation in the cleanser group compared with the water-only group which is in agreement with Brace and Plummer, who found that using a disinfectant solution shown to be effective procedure in decreasing the number of microorganisms by reducing the amount of plaque residing on the denture surfaces [31]. Moreover, Sheen and Harrison, men-

tioned that, initially, plaque forms at a faster rate on the dentures cleaned with water only than on the dentures cleaned with cleansers. But eventually, plaque deposition in both cases reaches a steady state; this state would be reached more quickly in the water group [23].

Kazanji and Watkinson, explained the significant difference between using a disinfectant or using water only, due to the higher ionic concentration (sodium and potassium) of the denture cleanser compared to water, which lead to a higher release of the soluble components (plasticizer) in the cleanser group leaving empty spaces or bubbles which are responsible for the roughness, these bubbles increase in size resulting in craters. The crater boundaries diminish with time leaving a smooth surface leading to less plaque accumulation [32].

While with water immersion, the loss of the soluble component was less, so, the empty spaces did not increase in size, resulting in high surface roughness and in turn, and more plaque accumulation. When comparing between autopolymerized silicone and visible light cured acrylic resin lining materials, there was a significant difference between the two materials after denture disinfection which might be explained by McCabe and Walls, findings, that although silicone materials remain permanently soft, its modulus of elasticity decreases due to water absorption which is followed by bacterial and fungal growth on the soft liner. In addition, in cold-cured silicone soft lining material, there is a tendency for the lining to peel away from the base despite the use of the adhesion primer leaving rough surface liable to bacterial invasion [20].

Moreover, Pinto., *et al.* mentioned that, silicone denture base liners have little or no chemical adhesion to poly methyl methacrylate resin, the obtained bond strength depends on the tensile strength of the material and the adhesive supplied with it. So, since this bond is weak, water absorption occurs in the interface between polymethyl methacrylate denture base material and the silicone soft lining material leading to swelling and consequent stress build up, and eventually bond failure occurs creating a potential surface for bacterial growth and plaque accumulation [21].

On the other hand, the visible light cured acrylic resin relining material showed high bond strength to the denture base resin according to Razavi., *et al.* [9], McCabe, Walls [20] and Zissis., *et al* [33]. Moreover, Leon., *et al.* [34] concluded that light polymerized liners showed the lowest solubility values which in turn contributes to less - plaque accumulation.

Conclusion

- In both groups, plaque accumulation increased by time.
- The use of denture disinfectant is recommended for plaque control after careful selection of type and concentrations of the solution.
- Using disinfectant gives better results considering plaque accumulation for both light cured acrylic or autopolymerized silicone lining materials.
- The visible light cured acrylic resin is better than auto cured silicone lining materials from the plaque accumulation point of view.

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Volume 9 Issue 6 April 2017

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