

THE EFFECT OF USING ANTIFUNGAL GEL ON RETENTIVE BOND STRENGTH OF TWO FORMS OF DENTURE ADHESIVES AN IN VITRO STUDY

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ABSTRACT

Purpose of this in vitro study is Recognition the effect of using of the miconazole gel opposing two forms of improving denture retention materials (Zinc-free Polygrip cream and Snug denture soft cushion) on their retention strength.

Materials and method: Eight heat cured acrylic samples were prepared having equal dimension flat tested surface. Two well adapted tested surfaces were matched and fixed to universal testing machine clamp. Vertical separating load was applied in a rate of 1mm/min to measure maximum load before failure of denture adhesive. These measurements were used to express the retention strength when improving denture material was used alone or opposed by miconazole nitrate gel.

Result and Conclusion: The mean difference of tensile strength showed significant reduction when antifungal gel opposed the two denture adhesive forms. Snug denture cushion showed higher retention strength when used alone or opposed by miconazole gel when compared with zinc-free Polygrip cream.

KEY WORDS: Denture adhesive-antifungal miconazole nitrate–denture retention strength

INTRODUCTION

One of the main problems facing complete denture wearers is retention and stability quality especially of the mandibular dentures. (Mañes et al.2011) ⁽²³⁾

Normally, after teeth extraction alveolar bone resorption starts and proceeds. Residual ridge resorption proceeds rapidly within 3-12 months after tooth removal, and continues throughout the patient's life Tallgren 1972.⁽³⁷⁾ Alveolar ridge resorption affects negatively denture retention and

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stability. Different methods have been developed to improve both the retention and stability of old dentures. These methods include denture rebasing or relining, denture adhesives, and endosseous dental implants. **(Duqum et al.2012)** ⁽⁷⁾

Denture adhesive is a material used to adhere a denture to the underlying oral mucosa **(Mañes et al.2011)** . ⁽²³⁾ It is used to improve denture retention, decrease soft tissue discomfort and reduce the need of frequent post insertion denture adjustments **(Han et al.2014)** ⁽¹³⁾ and **Kamran et al.2016)**. ⁽¹⁷⁾

Proper application of denture adhesives improves the interfacial surface tension. This provides better viscosity of the salivary film especially in patients suffering from decreased salivary flow **(Han et al. 2014)**. ⁽¹³⁾ Moreover, adhesives eliminate voids and this which is beneficial in absence of denture adaptation **(Hang et al. 2010)** ⁽¹⁴⁾ and **Shekar et al. 2016)** ⁽³⁵⁾. According to improved retention and stability quality, mucosal irritation, and food impaction beneath the denture base were reduced **(Kumar and Thombare 2011)**. ⁽¹⁸⁾ Finally, patient's chewing capability was improved with subsequent load distribution over the denture bearing structures was gained. **(Kamran et al.2016)**. ⁽¹⁷⁾

The improvement of retention started immediately after application of the adhesive and was maintained for the four hours of follow-up. It significantly reduced movement of the maxillary and mandibular dentures during chewing strokes. **(Grasso et al. 2000)** ⁽¹⁰⁾

Kumar and Thombare (2011) ⁽¹⁸⁾ stated that retention obtained with adhesive is more than double as compared to dentures used without adhesive. Moreover, Patients are satisfied with denture adhesives.

Adisman (1989) ⁽¹⁾ mentioned that more than five million denture wearers In the United States, used denture adhesives. **Hasegawa et al. (2003)** ⁽¹⁵⁾ stated that denture adhesives are used to improve the

retention and stability of dentures in a large number of patients without any advice from dentists. They added that the main cause of denture adhesive use was to compensate loose dentures and relief discomfort.

Grasso et al. (1994) ⁽¹¹⁾ stated that the improvement of denture retention according to adhesive use showed no significant difference if the denture was loose or well fit. Patients that used adhesives could exert higher bite force.

On the other hand, **Coates, (2000)** ⁽⁴⁾ demonstrated that 52% of surveyed patients sample tell that no need use of adhesive, while 20.5% of patients ignore what is denture adhesives; but interestingly 6.9% started and continued to use adhesive regularly.

The denture adhesive should be formulated in an ideal way to be systemically and locally not toxic for short- or long term use .It should not enhance bacterial or fungal infection.it should improve the dentures' retention, stability, and functionality denture performance. The adhesive is easy to apply and remove; has an acceptable aroma, taste, and consistency. Moreover, it should not change or degrade the fitting surface of the denture base or modify the occlusion. Finally it maintains adhesive character for reasonable time; and it has a reasonable cost to be accepted for the patient **(Duqum et al. 2012)**. ⁽⁷⁾

Denture adhesives include three main groups. The first is adhesive agents as tragacanth, gelatin, methyl-cellulose, acacia, hydroxyl-methyl cellulose, Karaya gum, sodium carboxyl-methyl cellulose, pectin, and synthetic polymers like acrylamides, acetic, polyvinyl and polyethylene oxide. Second are the anti-microbial agents as sodium tetraborate, ethanol, hexachlorophene, and sodium borate. Third includes other agents as plasticizing agents, flavoring agents like oil of peppermint, oil of wintergreen, and wetting agents **(Kumar et al.2015)**. ⁽¹⁹⁾

Denture adhesives are commonly indicated for Immediate dentures, obturators, dry mouth, poor

ridge anatomy, single complete dentures, poor neuromuscular control and in public speakers like actors and politicians. They also could be used in jaw relationship record and to facilitate try in step for complete denture (**Muneer et al. 2013** ⁽²⁶⁾ and **Kumar et al. 2015**). ⁽¹⁹⁾

The marketed forms of denture adhesive include the soluble cream and powder forms and insoluble cushion and strips forms (**Pradies et al. 2009**) ⁽³¹⁾. The increased viscosity of the adhesive creams results in their lateral spread excluding air and saliva and so retention is improved. (**Kumar et al. 2015**). ⁽¹⁹⁾ Denture cushion is pliable cushions offers almost a custom fit for denture as it easily moulds itself to the shape of fitting surface. It is thoroughly recommended for temporary use. It has an advantage of not leave a sticky mess in patient's mouth. Some, however, find making the cushion custom fit is quite difficult and time consuming especially those who are older and lack the perfect neuromuscular coordination (dentureadhesiveguide.com)

Salman and Ibrahim (2005) ⁽³²⁾ concluded that the use of different types of the studied denture adhesives were accepted by patient whether vegetable gum or synthetic polymer, powder or paste. All can improve the retention of the complete denture.

The quality of life (QoL) is apparent affected in complete edentulous patients that wear complete dentures. A marked reduction of QoL was concluded after denture insertion. Reassessment; after using adhesives showed improvement of both **OHR-QOL** (oral health quality and quality of life) and ability to use their dentures (**Nicolas et al. 2010**). ⁽²⁸⁾

Candida albicans is a commensal in the oral cavity and is isolated from 45–65% of healthy individuals. It has affinity for dentures' acrylic surface (**Park et al. 2015**). ⁽³⁰⁾ *Candida* colonization is commonly resulted from Poor oral hygiene and mechanical trauma arises from ill fitted denture (**Liguori et al. 2009**). ⁽²⁰⁾ This may lead to occurrence of stomatitis

in the underlying mucosa which reach up to 11–67% of denture Wearers (**Llabot et al. 2007**). ⁽²¹⁾ Denture-related stomatitis represents the most common form of oral candidiasis. It is frequently occurs in elderly people, and in those who wear a complete upper denture. Denture-related stomatitis is common to appear when the denture is left constantly in the mouth without regular cleaning (**Mason et al. 2012**) ⁽²⁴⁾.

Makihira et al. (2001) ⁽²²⁾ investigated the changes occur in growth media of two types of candida with different six denture adhesives. They found single studied product significantly reduced the pH below 5.0 after candida was grown on the materials. They concluded a correlation between pH changes and type of denture adhesive. Only, one of the studied products (Collect Soft A) showed reduction of *Candida tropicalis* growth.

Many topical antifungal medications could be used as nystatin, amphotericin, miconazole, fluconazole or itraconazole Chlorhexidine Antimicrobial mouthwash is also prescribed for such condition (**Gendreau and Loewy, 2011**) ⁽⁹⁾. **Sampaio B et al. (2012)** ⁽³³⁾ concluded that some commercially available denture adhesive showed microbial contamination and others has significant inhibitory effect on *C. albicans* growth.

The ADA system may be used for prophylaxis; and treatment of oral candidiasis through controlled release of the antifungal drug from a polymer matrix (**Park et al. 2015**). ⁽³⁰⁾ **Garaicoa et al. (2016)** ⁽⁸⁾ concluded that antifungal agents keep their anti-fungal activities after they had been added to denture adhesive. This suggests the possibility for inclusion in adhesive formulations and their use as topical treatments for individuals suffering from denture stomatitis. **Duqum et al. (2012)** ⁽⁷⁾ mentioned a study of **Scher et al 1978** ⁽³⁴⁾ showed no significant difference in candida level when denture adhesive was accompanied with antifungal agent and amphotericin. However, denture stomatitis cases were reduced.

Zinc is an antimicrobial agent used in denture adhesives and other cutaneous medications. Maximum limit of daily use is 12mg. Cytotoxic symptoms of zinc overdose include diarrhea, cramps, nausea and headaches. (Duqum et al. 2012) ⁽⁷⁾ Had reported, in a table, eight published papers concerned to cytotoxicity of denture adhesives. Two of these studies have reported a connection between zinc toxicity and denture adhesive use. Moreover, Nations et al.(2008) ⁽²⁷⁾ stated progressive neurological symptoms were appeared after excessive and prolonged use of denture adhesives containing zinc

So, different denture adhesive usage needs more studies to clarify their biological effects so, Patients that use denture adhesive need periodic recalls (Duqum et al. 2012). ⁽⁷⁾

MATERIAL AND METHODS

Acrylic Samples:

- Eight acrylic samples were cured according to the conventional open flask heat curing technique. They were first prepared in modeling wax in the following dimensions; 0.7cm (width), 1.4cm (length) and 4.0 cm (height). The tested surfaces of wax samples were smoothed by compressing the warmed wax against wet glass slab. Wax samples were flaked, then wax was eliminated. Polymer and monomer mixture was packed according to manufacturer instructions and processed in water tank at 70° c for 90 minutes and then at 100°c for 30 minutes Makihira s, et al.2001. ⁽²²⁾
- Acrylic resin samples were finished with 600 – grit carbide papers and two well adapted and smooth acrylic tested surfaces of 0.7 cm×1.4 cm dimensions were obtained to be used for application of denture adhesives and antifungal gel in between. The two adapted tested surfaces were re-checked for predetermined dimensions.

- Acrylic samples were classified into four main groups A, B, C and D. Two acrylic samples were used for each group. Two well adapted tested surfaces were chosen and labeled for each group to preserve the position of the sample in each measurement.

Preparation of acrylic tested samples before fixation on universal testing machine clamps:

- **For group A**, one sample was immersed in water, while commercial denture adhesive cream (zinc free polygrip cream-Ultra-GlaxoSmithKline, Philadelphia, PA) of 2 ml volume was applied by plastic syringe and spread on the top of dry acrylic tested surface of the other sample *Garaicoa J L, et al. 2016.* ⁽⁸⁾
- **For group B**, one sample was immersed in water then 2 ml of antifungal gel (Miconazole-base 2%, Jamjoom Pharmaceutical co., Saudi Arabia) was applied by plastic syringe on the wet tested surface. Commercial denture adhesive cream was applied and spread on the top of dry acrylic tested surface of the other sample *as in group A (Cartagena, AF. et al. 2016).* ⁽³⁾
- **For group C**, one sample was immersed in water. A piece of denture cushion soft plastic sheet (*Snug*, Mentholatum Co.Ltd, East Kilbride, Scotland G74 5PE,UK) was cut in 1.4x.7 cm dimension and applied to the dry tested surface of the other sample following the manufacturer instructions.
- **For group D**, one sample was immersed in water then 2ml of antifungal gel (Miconazole-base 2%, Jamjoom Pharmaceutical co., Saudi Arabia) was applied on the wet tested surface. A piece of denture cushion soft plastic sheet was applied to the dry tested surface of the other sample as in group C.
- The two tested labeled surfaces for each group were assembled face to face and fixed to testing machine by an included specially designed

grasping device that hold the acrylic resin samples. Tensile bond strength was measured by Materials Testing Machine (Model 3345; Instron Industrial Products, Norwood, USA). The software (**Bluehill Lite; Instron Instruments**) provides the result data. The two acrylic tested surfaces are initially subjected to average compression load of 12 N to 15N for 30 seconds to mimic a gentle occluding load for group **A** and **B** and for 5 minutes for group **C** and **D** before apply separating vertical loading. The device was subjected to a slowly increasing vertical separating load (1mm/min) until total separation of upper and lower acrylic tested surfaces accompanied by decline in load-displacement curve recorded by (Bluehill Lite software). The maximum load before failure was collected and tabled in Newton force and these would express the adhesive retentive strength. The divided load over interfacial surface area of the tested acrylic surface is denoting the bond strength in mega Pascal (MPa) *Cartagena, AF. et al. 2016.*⁽³⁾

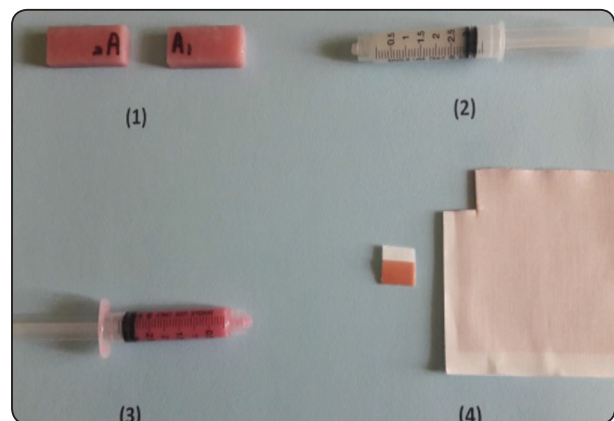
- Tensile bond strength measurement was repeated 7 times for each group. Acrylic samples were



Acrylic samples fixed to universal testing machine

cleaned; before each measurement; with neutral soap, washed with distilled water and dried with paper towel. *Cartagena, AF. et al. 2016.*⁽³⁾

- The collected data were statistically analyzed using SPSS.21 program (IBM Inc. Chicago, Illinois, USA). The P- value is the indicator of significance. A greater P-value than 0.05 is indication of non-significant differences, while lesser P- values than 0.05 is indication of significant differences.



- (1) Labeled acrylic samples.
- (2) Plastic Syringe loaded with miconazole nitrate 2%.
- (3) Plastic Syringe loaded with zinc free poly grip cream.
- (4) Cut Piece of denture soft cushion (1.4cmx0.7cm)

RESULT

The measurements of maximum tensile bond strength of well-adapted two acrylic tested surfaces; just before sample separation; were collected and subjected to statistical analysis using one –way analysis of variance. These measurements expressed the retention strength of two studied denture adhesive forces when either used alone or with opposed antifungal gel. The analyzed data revealed mean and standard deviation in different groups (**Table 1**).

The statistically analyzed data also revealed significance among different studied groups where P values ≥ 0.05 were considered non- significant

TABLE (1) Mean and Standard Deviation of studied Groups

GROUPS	Materials applied on the two tested acrylic samples	No. of measurements for each group	Mean	Standard Deviation
Group A	Denture adhesive Cream between two tested acrylic surface	7	22.3378	± 1.99434
Group B	Denture adhesive Cream opposed Antifungal gel	7	11.2663	1.20519 ±
Group C	Denture Snug Cushion	7	18.9797	± 1.43708
Group D	Denture snug Cushion opposed Antifungal gel	7	17.5751	± 1.93223

while P values ≤ 0.05 were considered significant (Table2). The mean difference between group A and group B showed significant reduction in tensile bond strength when antifungal gel opposed the denture adhesive cream. The results also revealed significantly higher tensile bond strength in group C, in which denture cushion Snug sheet was used, than that of group A where denture adhesive cream was used. Comparing group C with group D showed no significant change in tensile bond strength. Finally results revealed that the tensile bond strength of group D showed significant higher mean difference than group B (Table2).

TABLE (2) Comparisons between Mean of different studied Groups:

Comparison	Mean difference	Significance
Group A versus Group B	11.07148	0.000
Group C versus Group D	1.26308	0.171
Group A versus Group C	3.35813	0.001
Group B versus Group D	-6.45027	0.000

P values ≤ 0.05 were considered significant

DISCUSSION

This study analyzes the effect of miconazole gel on retention strength that gained from two forms of commercial denture adhesive. According to research based knowledge, candida infection occurs frequently in old denture wearer patients specially those have poor oral hygiene and /or questionable suppressed immune response (Mason et al. 2012) ⁽²⁴⁾. Cream form denture adhesive is showing more resistance to dislodging forces when compared with powder form which cause patient discomfort sensation (Chowdhry et al. 2010) ⁽⁵⁾. Poligrip adhesive cream showed significantly increasing in retention strength as concluded by (Karman et al. 2016) ⁽¹⁷⁾ and An Y et al, 2016) ⁽²⁾. Denture Cushion is temporary solution has an accepted level of adhesiveness to denture and mucosa. It is adaptable soft plastic plate has refit capability to loose dentures and a different consistency characters (Snug, Mentholatum Co. Ltd, specifications) ⁽³⁶⁾ which could interfere with mixture of miconazole which could occur with adhesive cream. Equal amount of denture adhesive cream and miconazole were used to eliminate factor of amount on studied retention strength (Mañes J F 2011) ⁽²³⁾ and Cartagena, AF. et al. 2016) ⁽³⁾

Acrylic samples were made from heat cured acrylic resin and was cured according to the widely used conventional open flask heat curing technique. The acrylic sample tested surfaces were prepared flat smooth to facilitate adaptation (**Makihira S et al. 2001**).⁽²²⁾ The tested acrylic samples were wet by water before tensile strength testing was performed to imitate oral cavity hydration state which enhances the adhesive effect. (**Panagiotouni et al. 1995**)⁽²⁹⁾ and **Guo et al. 2008**)⁽¹²⁾. A compression load was applied to the contact tested surface before separating vertical loading of tensile strength in order to mimic the closing occluding load that patients were advised to do as manufacturer instructions stated. (**Cartagena, AF. et al. 2016**).⁽³⁾ Miconazole nitrate is one of the first broad spectrum triazole antifungal agents used in treatment of superficial mucosal candidiasis. The gel form is the most available formula Miconazole nitrate (**Cartagena et al. 2016**).⁽³⁾

Ingredients of Polygrip Denture adhesive Cream are mineral oil, cellulose gum, silica, poly (methylvinylether/malic acid), flavor and sodium-magnesium-zinc partial salt (**An Y et al. 2016**)⁽²⁾. The mechanism of adhesiveness was demonstrated by (**Salman Y M and Ibrahim I K 2005**)⁽³²⁾ and **Ilakkiya. 2015**)⁽¹⁶⁾ as Karaya gum or CMC come in contact with saliva, the hydrate material is formed, swells in presence of saliva / water and flows under pressure, and so eliminates voids between denture base and bearing tissue and increase viscosity of saliva. Results showed decrease in retention strength when miconazole gel was opposed the polygrip cream. This could explained as miconazole gel, after compression loading, was enforced in denture adhesive cream. Miconazole nitrate has a very low aqueous solubility leading to erratic and unpredictable bioavailability (**Cartagena et al. 2016**).⁽³⁾ Moreover, the hydrophobic ingredient as included hydrocarbons (petroleum and oils) in denture ad-

hesive cream could alter polymer hydration, gelation and denture adhesive effectiveness. Finally, the failure of adhesive property starts chemically at interface lie between the adhesive material and polymethyl meth-acrylate, and then fibril formation occurs and ended by complete denture adhesive failure (**An et al. 2016**).⁽²⁾ The location of denture adhesive failure, in this study, was not detected if it is cohesive or adhesive one. The atomic force microscope could be used to analyze area of failure and assessment of materials remnants in between the two tested acrylic surfaces (**Dadarlat and Post 2003**,⁽⁶⁾ **Marshall et al. 2010**).⁽²⁵⁾

On the other hand, results of this study showed denture adhesive cushion plates have higher retention strength when compared with denture adhesive polygrip cream when opposed by miconazole gel. This could be attributed to physical and mechanical nature of the insoluble plastic plate structure that could resist inclusion of miconazole gel and/or capability of plastic plates to squeeze miconazole gel out the adhesive/acrylic interface (**Snug Mentholatum Co.Ltd, specifications**).⁽³⁶⁾

CONCLUSION AND RECOMMENDATIONS

- 1- During treatment of oral candidiasis by antifungal gel (miconazole 2%), denture adhesive cushion soft plastic liner (Snug Cushion) could be used, as other indicating factors permit, instead of denture adhesive cream (non- zinc polygrip cream) .
- 2- Denture adhesive cushion soft plastic liner (Snug Cushion) has higher retention strength than Polygrip denture adhesive cream without antifungal gel application.
- 3- Newly developed denture adhesives including antifungal agent could be another treatment option.

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