

EFFECT OF DENTURE CLEANSERS ON RETENTION CAPABILITY OF DIFFERENT LOCATOR ATTACHMENTS: IN VITRO STUDY

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ABSTRACT

Purpose: To evaluate the retention capability of three Locator attachments after soaking in three different cleansing solutions.

Materials & Methods: Three implants were embedded into acrylic block, Locator abutments were placed onto the implants. 120 locator attachments divided into three groups (40 each): pink, white and purple Locator attachments were soaked in different denture-cleansing solutions: (water as control group, Efferdent, 5.25% Sodium Hypochlorite, Tantum Verde Mouthwash) ten each for a time resembling one year of clinical use. The Locator attachments were tested for load-to-dislodgement (retentive force; Newton) with a Universal Testing Machine. Data were collected, tabulated and statistically analyzed using Two Way ANOVA test followed by the Tukey's HSD test ($\alpha \leq 0.05$).

Results: There were no statistical significant differences between water, Efferdent and Tantum Verde mouthwash ($P > 0.05$) for all types of locator attachments while sodium hypochlorite gave statistical significant lower retention values and retention loss percentage ($P < 0.05$) than that immersed in other solutions.

Conclusions: Within the limitations of this study Efferdent and Tantum Verde mouthwash can be used as denture cleanser while sodium hypochlorite is not recommended.

KEYWORDS: Denture cleanser, Locator attachment, Implant overdenture.

INTRODUCTION

One of the most recommended treatment modalities of patients with edentulous mandible is implant retained overdenture,⁽¹⁾ as it increases patients' satisfaction by increasing retention and stability of dentures.^(2,3) Several types of attachments

were fabricated to help implants in its function; one of the most popular types nowadays is Locator® attachment.⁽⁴⁾

Locator® attachment is a solitary attachment having the advantage of low profile, dual mechanical interlocking and can compensate for angulation

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correction up to 40° degree.⁽⁵⁾ Locator has nylon insert which are provided in different colors with different retention values including yellow (0.6 Kg), pink (1.2 Kg), white (1.8 Kg) and purple (2.7 Kg) colors.⁽⁶⁾

Denture needs excellent hygienic care to prevent infection and consequently denture stomatitis.⁽⁷⁾ Methods of cleaning dentures can be classified into mechanical cleaning, chemical cleaning, or a combination of both. Mechanical denture cleansing can be done using brushing and/or using ultrasonic cleaners. Chemical cleansers include alkaline peroxides, alkaline hypochlorite, acids, enzymes and disinfectants.⁽⁸⁾ It was recommended that brushing alone is not enough for plaque removal,⁽⁹⁾ and patients should combine both brushing and soaking in cleansers according to the American college of Prosthodontists (ACP) guidelines.⁽⁷⁾

When evaluating the effect of denture cleansing solutions on locator attachment; conflicting results have been reported regarding the increasing or decreasing the retention capability of the attachment.⁽¹⁰⁻¹²⁾ Also; limitations have affected the previous studies either by short evaluating time^(10,11) or most research articles evaluated the effect of cleansing solution on the pink locator attachment only because of it is the most requested attachment in the dental market.^(11,12)

So, the aim of this in-vitro study was to evaluate the effect of some common denture cleansers on retention capability of different types of locator attachments. The null hypothesis is that there is no effect of denture cleansing solutions on retention capability of different colors of locator attachments.

MATERIALS AND METHODS

Three auto-polymerized acrylic resin blocks were prepared for this study using a stainless-steel split cylindrical mold with 20 mm length and 20 mm diameter. A stainless-steel base was made wider than the split cylinder so it can be seated inside this

base. The split cylindrical mold was cleaned and dried then vaseline was applied into the whole internal surface to ensure separation of acrylic block from the mold, The auto-polymerized acrylic resin powder and liquid were mixed according to manufacturer's recommendation, poured inside the split cylindrical mold and left for polymerization. After polymerization, the metal cylinder was removed and finishing and polishing of the acrylic cylinders was made .

Three implants—10 mm in length with 4 mm diameter— (**Anyridges; MEGAGEN, Seoul, Korea**) were inserted in the cylindrical resin blocks vertically using dental surveyor to the level of the platform and perpendicular to the horizontal plane, **Figure (1)**. Another three resin blocks were fabricated and three metal housing of the Locator attachment were fixed to a suitable hole on top of the cylinders using self-adhesive resin cement.

The Locator abutments (**Meg-Rhein abutment Anyridges; MEGAGEN, Seoul, Korea**) were inserted into the implants and the nylon locator inserts pink (1.2 Kg), white (1.8 Kg) and purple (2.7 Kg) colors were attached to the metal housing inside the resin cylinders. **Figure (2)**

Table (1) shows the denture cleansing agents used in this study: water as control, Efferdent (**Efferdent, Johnson & Johnson, New Brunswick, NY, USA**), 5.25% Sodium Hypochlorite, (**Clorox, Oakland, CA, USA**) and Tantum Verde Mouthwash (**A.C.R.A.F. SPA, Ancona, Italy**). The locator attachments were soaked in beakers containing each of the cleansing solutions and metal discs (as heavy objects) were soaked over the cylinders to prevent it from floating to the top of the solution. According to manufacturer's instructions (for time equivalent of one year); the solutions were changed on a simulated daily basis. For example, Sodium Hypochlorite required 10 minutes of soaking per day; thus, it was changed every 10 minutes. At the same time, the locator attachments were rinsed with



Fig. (1) Implants in resin blocks.



Fig. (2) The Locator abutment with the metal cap and different nylon inserts.

TABLE (1): Experimental design and soaking periods.

Nylon insert Groups (40 each)	Solution (n=10)	Immersion time (per day)	Total immersion time for 12 months (hours)
GI (pink)	A: Water (control group)	8 hours	2880
	B: Efferdent	15 min	90
	C: 5.25% Sodium hypochlorite	10 min	60
	D: Tantum Verde M.W (Benzylamine)	8 hours	2880
GII (white)	A: Water (control group)	8 hours	2880
	B: Efferdent	15 min	90
	C: 5.25% Sodium hypochlorite	10 min	60
	D: Tantum Verde M.W (Benzylamine)	8 hours	2880
GIII (Blue)	A: Water (control group)	8 hours	2880
	B: Efferdent	15 min	90
	C: 5.25% Sodium hypochlorite	10 min	60
	D: Tantum Verde M.W (Benzylamine)	8 hours	2880

tap water for 20 seconds and then immersed in tap water. For Efferdent the solution was changed every 15 minutes by a new tablet, and every 8 hours for tap water and Tantum Verde Mouthwash.

The Locator attachments were tested for load-to-dislodgement (retentive force; Newton) on a Universal Testing Machine (Model 5566, Instron Corp, Norwood, MA) **Figure (3)**. The resin block containing the implant body was clamped and

stabilized to the lower member of the machine. A screw hook of the resin block containing the attachment was hold to the upper member. A tensile force at a 2 in/min crosshead speed was applied to the specimen until the Locator attachment was separated from the abutment. Each sample was pulled 10 times and mean retentive value (Newton) was calculated and recorded. Between each pull; a period of 10 seconds between was employed.¹³

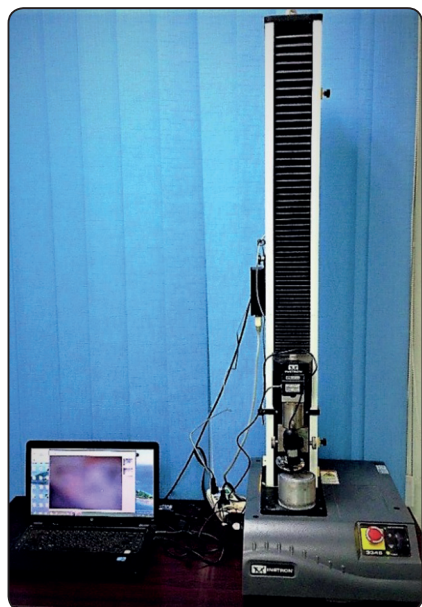


Fig. (3) Application of load-to-dislodgement (retentive force; Newton) with universal testing machine

The retention test was done before soaking in the cleansing solutions and after soaking for simulated one year period. The percentage of retention loss after soaking in the denture cleansers for one year were calculated by using the mean retentive value before soaking minus the mean retentive value after soaking for one year, divided by the mean retentive value before soaking:

% retention loss =

$$\frac{\text{before soaking} - \text{after soaking for 1 year}}{\text{before soaking}} \times 100$$

After finishing the test, the old nylon attachments were removed and new attachments were placed into the metal housing within the resin cylinder, and the test was repeated. Ten nylon attachments for every type of the Locator were immersed in the four cleansing solutions to give 120 sample and sample result.

Data were collected and tabulated and the loss in retention after the initial pull and the final pull and the percentage of retention loss after one year of soaking in denture cleansers were compared using Two-way ANOVA followed by Tukey's Post-hoc HSD Test if statistical significant differences were found ($P < 0.05$).

RESULTS

Mean \pm SD of retention values before and after soaking and percentage of retention loss of the three Locator attachments in three cleansing agents plus water are shown in **table (2)** and **Figure (4)**.

Sodium hypochlorite resulted in huge lowering the percentage of retentive capability of the locator attachments (pink: $43.99\% \pm 15.22$, white: $35.38\% \pm 8.94$ and purple: $22.41\% \pm 4.79$) than water as

TABLE (2): Mean \pm SD of retention values and percentage of retention loss of the three Locator attachments before and after soaking in three cleansing agents beside water.

	Water			Efferdent			Naocl			Tantum		
	Before	After	Changes %	Before	After	Changes %	Before	After	Changes %	Before	After	Changes %
Pink	20.20 \pm 0.57	19.6 \pm 0.69	2.98 \pm 2.61	20.00 \pm 1.1	17.55 \pm 1.3	12.33 \pm 3.4	20.44 \pm 0.75	11.42 \pm 2.99	43.99 \pm 15.22	19.97 \pm 0.89	17.40 \pm 0.87	12.48 \pm 4.43
White	30.33 \pm 0.85	29.66 \pm 0.92	2.20 \pm 1.73	30.51 \pm 0.72	28.1 \pm 0.81	7.81 \pm 2.43	30.08 \pm 0.90	19.4 \pm 2.49	35.38 \pm 8.94	30.7 \pm 0.82	28.49 \pm 0.53	7.143 \pm 2.88
Purple	38.90 \pm 2.12	38.06 \pm 2.01	2.147 \pm 0.84	38.98 \pm 2.28	37.99 \pm 2.43	2.56 \pm 0.96	39.75 \pm 1.34	30.83 \pm 2.01	22.41 \pm 4.79	39.6 \pm 1.94	37.75 \pm 1.92	5.126 \pm 1.32

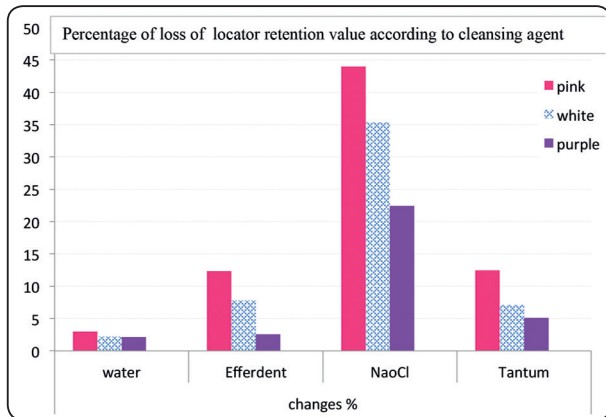


Fig. (4): Mean of percentage of retention loss of the three Locator attachments after soaking in three cleansing agents beside water.

a control (pink: 2.98%±2.61, white: 2.2%±1.73 and purple: 2.147%±0.84). while Tantum Verde Mouthwash and Efferdent solution results were less reduction of the retention percentage (pink: 12.84%±4.43, white: 7.143%±2.88 and purple: 5.126%±1.32) and (pink: 12.33%±3.4, white: 7.81% ±2.43 and purple: 2.56% ±0.96) respectively.

Two-way ANOVA followed by Post-hoc Tukey’s HSD Test results showed that sodium hypochlorite showed statistical significant differences with water, Efferdent and Tantum Verde despite type of locator attachment used (P<0.05). While there were no statistical differences between the other groups (Tantum Verde, Efferdent and water) whatever the color of locator attachment used. (P>0.05). **Table (3).**

TABLE (3): Two-Way ANOVA and Post-hoc Tukey Tests results for mean ± SD of retention values before and after soaking and percentage of retention loss of the three Locator attachments in three cleansing agents beside water.

Changes %						
	Water	Efferdent	Naocl	Tantum		
Pink	2.98	12.33	43.99	12.48		
White	2.20	7.81	35.38	7.14		
Purple	2.14	2.56	22.41	5.12		
Two Way ANOVA For (%)						
Rows	Columns		Cells			
3.06	3.88		8.03			
Tukey's Test For Rows						
	Water Vs Efferdent	Water Vs Naocl	Water Vs Tantum	Efferdent Vs Naocl	Efferdent Vs Tantum	Naocl Vs Tantum
Pink	0.220	<.0001*	0.065	<.0001*	0.220	0.000559*
White	0.163	<.0001*	0.073	0.000323*	0.312	0.001208*
Purple	0.347	<.0001*	0.096	<.0001*	0.383	0.000372*
Tukey's Test For Columns						
	Pink Vs White		Pink Vs Purple		White Vs Purple	
Water	0.109339		0.001006*		0.001213*	
Efferdent	0.466242		0.000450*		0.005551	
Naocl	0.044866*		0.001018*		0.038320*	
Tantum	0.107351		0.000684*		0.015238*	

*Significant, (P<0.05).

DISCUSSION

This *in vitro* study investigated the effect of three denture cleansing solutions on the retention of different Locator attachments. The solutions used in this study were Efferdent®, Sodium hypochlorite and Tantum Verde mouthwash (benzylamine HCl).

Effervescent tablets that are used as denture cleansers generally have the similar major components: Sodium bicarbonate, sodium perborate, Potassium monopersulphate and detergent. When dissolved these tablets in water, an alkaline peroxide solution composes. This peroxide solution mechanically kills candida albicans by releasing oxygen. Despite their efficacy, denture cleansers have been reported to have deleterious effect on resin denture bases.^(14,15)

Sodium hypochlorite is documented alternative for disinfection of acrylic resin dentures. However, evidence based guidelines from the American college of Prosthodontists (ACP) recommended that dentures should not be soaked in Sodium hypochlorite longer than 10 minutes per day to avoid denture damage.⁽⁷⁾

Tantum Verde mouthwash with benzylamine HCl as an active ingredient was used in this study as a denture cleanser following the characteristics of an ideal denture cleanser which were recommended by Fleton and coworkers⁽⁷⁾ as it should, at a minimum, demonstrate antibiofilm activity, antibacterial and antifungal, compatible with denture materials, nontoxic, do not roughen the denture surface, short acting (≤ 8 hours) and cheap.

In this study; every locator attachment sample was pulled ten times and their mean was calculated, this is because in an earlier study⁽¹⁶⁾ it was shown that there was a significant loss of retention after the first pull of the Locator attachments from the abutments, and every additional time the Locator attachments were removed from the abutments, an additional decrease in retention occurred until retention plateaued after the tenth pull. A period of

10 seconds between each pull was made to allow proper recovery of the nylon components and to prevent potential heating between the attachment parts.⁽¹³⁾

Williams and coworkers have declared that tensile force applied by patients removing their dentures was approximately 2 inch/ minutes; so, the pull test was done at that speed.⁽¹⁷⁾

The results of this study matches previous reports^(11,12,18) that Sodium Hypochlorite cleansing agent has statistically significant lowering effect on the retention values of Locator attachments more than any other cleanser solution tested in this study; although locator attachments tested were representing different level of retention; they were all affected and decreased in retention values. This can be explained that they are all manufactured from the same material (Nylon) and were expected to behave as each other⁽¹²⁾ and Sodium Hypochlorite affected nylon by changing the surface morphology⁽¹⁹⁾ of nylon creates porosities and cracks at the SEM level⁽²⁰⁾ and exhibits structural changes undermining the integrity of the material.

On the contrary of the results of the current study and explanations; previous reports stated that although all attachments are made of the same material, the composition of material may differ to achieve different elasticity and retention force. Because as the composition differs, the effect of cleansing agents on the attachments may change.^(10,11) These statements was supported by the results of Varghese et al, which had shown that soaking nylon Hader clips in Sodium Hypochlorite increased single-pull retention of clips tested. But this difference in results could be due to the different chemical composition and design specifications of Locator attachments Vs. Hader clips.⁽²¹⁾

In this study, the three Locator attachments soaked in Tantum Verde mouthwash were less affected than those soaked in Sodium Hypochlorite and gave non statistical significant results. These results were in agreement with earlier study that

used another on-shelf mouthwash,⁽¹¹⁾ and not in agreement with a conclusion arising from an earlier study⁽¹²⁾ declaring that the mouthwash increased the retentive values of Locator attachments. These findings, although support using Tantum Verde mouthwash as an alternative denture cleansing agent, remain inconclusive and more testing is necessary.

Efferdent samples resulted in non-statistical significant differences between different attachments with the least effect on the purple attachments (2.7Kg). These results matches earlier reports^(11,12) and following the recommendations of a previous study⁽¹⁰⁾ that clinicians should recommend cleansing agents containing sodium perborate-sodium bicarbonate for patients using Locator attachments having higher retentive values to prevent gross reduction in their retention, especially that, in a previous study, Al-Ghaffi et al; demonstrated that Locator attachments can last up to 1.8 years.⁽²²⁾

CONCLUSIONS

Within the limitations of this in-vitro study it can be concluded that:

1. Sodium hypochlorite decreased the retention value of all types of Locators significantly compared to other cleansing agents, so it should be avoided when Locator attachments are used.
2. The retention of purple (2.7 Kg) nylon insert was the least affected Locator attachments when soaked in Efferdent, and this reduction of retention can be considered not important clinically.
3. Efferdent and Tantum Verde mouthwash did not significantly affect the retention values of the Locator attachments; however, it still need more research work to assure Tantum Verde's antimicrobial and physical effect before recommending it as a denture cleanser.

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