The effect of denture cleansing solutions on the retention of Pink Locator® attachment: 1 year simulation

Pijitra Watcharapichat1, Chatchai Kunavisarut2, Piyapanna Pittayachawan3, Tassanee Tengrangsan4

1 M.Sc. (Implant Dentistry), Implant Center, Faculty of Dentistry, Mahidol University.
2 M.Sc. (Prosthodontics), Advanced General Dentistry Department, Faculty of Dentistry, Mahidol University.
3 Ph.D. (Dental Ceramics), Advanced General Dentistry Department, Faculty of Dentistry, Mahidol University.
4 M.Sc. (Endodontics), Advanced General Dentistry Department, Faculty of Dentistry, Mahidol University.

Abstract

Objective: To evaluate the effect of various denture cleansing solutions on retention of pink Locator® attachments after 1 year

Materials and methods: Thirty-five pink Locator® attachments (3.0 lbs. Light Retention) were divided into five groups (seven specimens in each group) and soaked in different denture cleansers for 1 year. They were Polident® 5 minutes, Fittydent®, 0.12% Chlorhexidine gluconate, 1% sodium hypochlorite and tap water as control. The pink Locator® attachment was tested for load-to-dislodgement (retentive force; Newton) on a Universal Testing Machine (Model 5566, Instron Corp, Norwood, MA) in separate soaking time (before soaking, after simulated soaking for 1 month, 6 months and 1 year). The percentage of retention loss after soaking in the denture cleansers for 1 month, 6 months and 1 year were compared by groups using the Kruskal-Wallis Test and then followed by the Mann-Whitney U Test to indicate which pairs of denture cleansers were different. A p-value ≤ 0.05 was considered significant.

Results: After 1 month soaking time, there was no significant difference among the cleansers (p-value > 0.05). After 6-month soaking time, the retention for attachments soaked in Fittydent® (median of % retention loss: -33.49%) and Chlorhexidine gluconate (-27.05%) were significantly higher than that soaked in tap water (3.81%). There was no significant difference among tap water, Polident® 5 minutes (-8%) and Sodium hypochlorite (-9.57%). After 1-year soaking time, the retention for attachments soaked in Sodium hypochlorite (42.58%) was significantly lower than that soaked in other solutions. The retention for attachments soaked in Fittydent® (-36.04%) and Chlorhexidine gluconate (-29.03%) were significantly higher than that soaked in tap water (-10.15%). There was no significant difference between tap water and Polident® 5 minutes (-12.41%).

Conclusion: Polident® 5 minutes had no significant effect on the retention of pink Locator®. Fittydent® and Chlorhexidine gluconate significantly increased the retention of the attachments. Sodium hypochlorite significantly decreased the retention, thus it should not be recommended as a routine denture cleanser.

Key words: dental implants, denture cleansing solutions, Locator® attachment, overdenture, Retention.

Introduction

Implant retained overdenture is an effective treatment option for edentulous patients. It can improve the retention and stability of the dentures, oral function and significantly increase patients’ satisfaction with their prostheses. There are various types of attachment systems that can be applied for implant retained overdentures and the most commonly used attachment system is Locator® attachment.

Locator® attachment (Zest Anchors, Inc, homepage, Escondido, CA, USA) is an individual mechanical attachment roughly similar in size and function to a ball attachment. Locator® attachment consists of Locator® abutment screwed on the implant and metal housing with Locator® nylon (Dupont Zytel 101L NC-10 Nylon, Zest Anchors Inc.) inserted into the denture base. These nylon components are provided in different colors with different retentive values including blue, pink, clear, red, orange and green color.

Implant retained overdenture needs rigorous hygienic care. Adequate denture hygiene can treat and prevent infection in edentulous patients. Failure to properly clean the accumulated biofilm from the dentures is related with an increased incidence of localized denture stomatitis. Most patients clean their denture by brushing; however elderly patients tend to have compromised ability to manually clean their dentures effectively. Moreover, American college of Prosthodontists (ACP) has recommended cleaning the dentures daily by soaking and brushing with an effective, nonabrasive denture cleanser. There are several denture cleansers available in Thailand market such as Polident®, Steradent® and Fittydent®. Nevertheless, denture cleansing solutions may cause negative effect on prosthetic materials including Locator® nylon component. Additionally, various types of denture cleansing solutions may have different effects on retention of Locator® nylon component. Previous studies showed that only 6.15% Sodium hypochlorite significantly reduced the retention of Locator® nylon significantly, but other denture cleansing solutions had no effect on retention. However, the simulated soaking time of those studies were only 6 months and also the soaking time of Sodium hypochlorite was more than the ACP recommendation.

Therefore, this study evaluated the effect of several denture cleansers including Polident®, Fittydent®, 0.12% Chlorhexidine gluconate and 1% Sodium hypochlorite on the retention of pink Locator® after 1 year.

Materials and methods

Acrylic resin blocks were fabricated and divided into five groups according to types of denture cleansers. One acrylic resin block was used to house the implant analog attached with Locator abutment (block A), while the other 35 blocks (block B) were used to house the metal housings with pink Locator® nylons (7 block B for each group) (Figure 1).

Block A

The rectangular plastic molds with internal dimensions of 1.5 x 3.5 x 2 cm were fabricated. Self-polymerized pink acrylic resin (SPD, Mulazzano, Italy) was mixed and poured into the plastic mold and left until polymerization was completed to form acrylic resin block A.

Block B

Figure 1 The acrylic resin blocks
After polishing block A, one round hole (6 mm in diameter x 3 mm in depth) was fabricated into the top part of the block A at a distance of 7 mm from the center of the hole to the edge of the block in order to form the index for block B. Another round hole (10 mm in diameter x 13 mm in depth) was fabricated at the center of the block in order to prepare the space for implant analog. One implant analog (RN 4.1 mm, 10 mm in length, Institute Straumann AG, Waldenburg, Switzerland) was attached to a surveyor (Degussa, VG1) by using implant mounting and mounting adaptor. Then, an implant analog was positioned in the prepared hole perpendicular to the horizontal plane. The platform of the implant was placed 1 mm above the surface of the acrylic resin block. Self-polymerized acrylic resin was mixed again and poured into the hole and left until polymerization was completed. One Locator® abutment (Zest Anchors, Escondido, CA) was torqued to 20 Ncm on the implant analog.

**Block B**

The separating media was applied on the top surface of block A. A block-out spacer and a metal housing containing the processing cap were placed over the abutment. Another plastic mold was placed on top of the block A. Self-polymerized acrylic resin was mixed and poured into the hole in block B in the same method as block A. Then, a screw hook was embedded into the top part of block B. Eventually, block B contained metal housing and a key to match the hole in the block A. This index aided in anti-rotation and verification of complete seating during testing procedures. The axial walls of the hole in block A were slightly relieved to reduce any friction produced between these walls during the testing procedure.

The black processing cap was replaced by pink Locator® nylon by using Locator® core tool. If there was excess acrylic resin at the margin of the black processing cap, it would be removed before taking the processing cap out of the metal housing.

The pink Locator® attachment was tested for load-to-dislodgement (retentive force; Newton) on a Universal Testing Machine (Model 5566, Instron Corp, Norwood, MA). The testing machine was calibrated before testing each specimen. The acrylic block A was clamped down and stabilized on the lower member. A screw hook of block B was gripped to the upper member of the machine. A tensile force at a 2 in/min crosshead speed was applied to the specimen until the Locator® attachment was separated from the abutment.

The retention of each specimen was measured as followed: before soaking in denture cleanser, after simulated 1-month soaking time, after simulated 6-month soaking time, and after simulated 1-year soaking time. Each specimen was pulled 10 times and mean retentive value (Newton) was calculated (Figure 2). To allow proper recovery of the nylon components and to prevent potential heating between the attachment parts, a period of 10 seconds between each pull was employed.

The denture cleansing solutions used in this study were Polident® 5 minutes (Glaxo Smith Kline, Philadelphia, PA), Fittydent® (Fittydent International GMBL, A-7423 Pinkafeld, Austria), 0.12% Chlorhexidine gluconate (M Dent, Faculty of Dentistry, Mahidol university, Thailand) and 1% Sodium hypochlorite (M Dent, Faculty of Dentistry, Mahidol university, Thailand). Tap water was used as the control. Five block B with pink Locator® attachments (3 lbs. or 13.35 N) were immersed in each of the cleansing solution according to manufacturer’s instructions for the time equivalent of 1 year. (Table 1)
The solutions were changed on a simulated method. For example, Polident® required 5 minutes of soaking per day, hence, the solution was changed every 5 minutes. Between each immersion, the pink Locator® attachments within the block B were rinsed with tap water for 60 seconds.

The pink Locator® attachment was tested for retentive force at the period of before soaking, after soaking for 1 month, 6 months and 1 year. The percentage of retention loss after soaking in the denture cleansers for 1 month, 6 months and 1 year were compared among the groups by the Kruskal-Wallis Test followed by the Mann-Whitney U Test to indicate which pairs of denture cleansers were different. A p-value ≤ 0.05 was considered significant.

The surface texture of pink Locator® attachments were assessed under Scanning Electron Microscope (SEM) after simulated 1-year soaking time in order to identify the effects caused by denture cleansers. The surface texture was blindly evaluated by one operator.

**Results**

The results of this study accepted the alternative hypothesis that denture cleansing solutions on the retention of Pink Locator® attachment: 1 year simulation
solutions had significant effects on the retention of pink Locator® nylon after 1-year simulated immersion time.

After 1 month of simulated soaking time, there was no significant difference among the cleansers (p-value > 0.05). The median of percentage of retention loss after soaking in tap water for 1 month was -4.64% (negative values meant increased retention while positive values meant decrease retention), in Polident® 5 minutes was 3.25%, in Fittydent® was 0.27%, in Sodium hypochlorite was -6.81% and in Chlorhexidine gluconate was -11.81%. Denture cleansing solutions had no significant effects on retention of attachments after soaking for 1 month (Figure 3).

After simulated 6-month soaking time, the results showed that some denture cleansers had significant effects on retentive values of the attachments. The median of percentage of retention loss in tap water was 3.81%, in Polident® 5 minutes was -8%, in Fittydent® was -33.49%, in Sodium hypochlorite was -9.57% and in Chlorhexidine gluconate was -27.05%. The retention for attachments soaked in Fittydent® and Chlorhexidine gluconate were significantly higher than that soaked in tap water (p-value = 0.001 and 0.026 respectively). There was no significant difference between tap water, Polident® 5 minutes and Sodium hypochlorite (p-value > 0.05) (Figure 4).

After 1-year soaking time, some denture cleansers had significant effects on retentive values of the attachments. The median of percentage of retention loss in tap water was -10.15%, in Polident® 5 minutes was -12.41%, in Fittydent® was -36.04%, in Sodium hypochlorite was 42.58% and in Chlorhexidine gluconate was -29.03%. The retention for attachments soaked in Fittydent® and Chlorhexidine gluconate were significantly higher than that soaked in tap water (p-value = 0.011 and 0.026 respectively). Additionally, the retention for attachments soaked in Fittydent® was significantly higher than that soaked in Polident® 5 minutes (p-value = 0.026). The retention for attachments soaked in Sodium hypochlorite was significantly lower than that soaked in other solutions (p-value < 0.05). There was no significant difference between tap water and Polident® 5

Figure 3 Percentage of retention loss of each sample in 5 cleansers after 1-month soaking.
minutes (p-value = 0.805) (Figure 5).

Table 2 showed mean and standard deviation (Newton) of retentive values in different cleansers at each period of time. Some denture cleansers caused discoloration of the pink nylons and the pink acrylic resin. Sodium hypochlorite eventually softened the pink nylons, whitened the pink nylons and acrylic resin. Fittydent® also whitened the pink nylon and acrylic resin. The

**Figure 4** Percentage of retention loss of each sample in 5 cleansers after 6-month soaking. Groups with the same letter are not significantly different.

**Figure 5** Percentage of retention loss of each sample in 5 cleansers after 12-month soaking. Groups with the same letter are not significantly different.
others did not affect the colour visually (Figure 6).

According to microscopic visualization of the nylon surfaces after 1 year soaking, Polident® group had no surface change compared to control group. Fittydent®, Sodium hypochlorite and Chlorhexidine gluconate groups had rougher surface. Sodium hypochlorite group had much more surface change than other groups (Figure 7).

Discussion

This study emphasized on testing the Locator® attachment because it is one of the most popular attachment systems. It provides several advantages, which are low-profile height, resiliency, self-aligning, durability, dual retention, easy replacement and repair, angulation correction and long-term stability. A tensile force at a 2 in/min crosshead speed was applied because it was the speed which patients removed overdentures from their Locator® abutments. The retention of each specimen was measured for 4 periods (before soaking in denture cleanser, after simulated 1-month soaking time, after simulated 6-month soaking time, and after simulated 1-year soaking time) in order to investigate only the effects of denture cleansers on retention at each period of time. However, there were other factors that can influence retentive value of nylon component of Locator® including denture removal-insertion, occlusal function, implant angulation and numbers of implants, etc.

The solutions used in this study were Polident® 5 minutes, Fittydent®, Chlorhexidine gluconate and Sodium hypochlorite. Polident®

<table>
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<tr>
<th>Period</th>
<th>Retention: Mean±SD (Newton)</th>
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<tbody>
<tr>
<td></td>
<td>Water</td>
</tr>
<tr>
<td>Before soaking</td>
<td>19.02±2.07</td>
</tr>
<tr>
<td>1-month soaking</td>
<td>19±1.95</td>
</tr>
<tr>
<td>6-month soaking</td>
<td>18.71±1.94</td>
</tr>
<tr>
<td>1-year soaking</td>
<td>20.79±2.07</td>
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Table 2: Retention of each cleanser at different soaking time

Figure 6  Examples of pink Locator® attachments and a part of pink acrylic resin after soaking for 1 year. (1) tap water. (2) Polident® 5 minutes. (3) Fittydent®. (4) Sodium hypochlorite. (5) Chlorhexidine gluconate.
and Fittydent® were able to reduce dental biofilm including Candida species effectively. They have similar major components, which are Sodium bicarbonate, Potassium monopersulphate and detergent. Sodium hypochlorite is another denture cleanser, which is superior to all other types of commercially available denture cleansers. Francine et al. reported that 1% sodium hypochlorite is a valid alternative for disinfection of acrylic resin. However, guideline 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.

Chlorhexidine gluconate is a broad spectrum antiseptic agent. It can inhibit Candida albicans and other common non-albican yeast species. Chlorhexidine is one of the most widely used agents and has been used as an adjunctive treatment of oral candidiasis since the 1970s. Andrade et al. indicated that 0.12% chlorhexidine solution had an ability to remove denture biofilm and had no adverse effect or stains on dentures and none of the participants complained about the bad taste associated with the Chlorhexidine.

After a simulated period of 1 year, Polident® 5 minutes had no significant effect on the retention of pink Locator®, which is in agreement with the studies of You et al. and...
Nguyen et al.\textsuperscript{14} and had no effect to the surface texture. Thus, it can be an alternative routine denture cleanser. Furthermore, it has short soaking time which is easy for the patient to use. Fittydent® significantly increased the retention of the attachments and also whitened the pink nylon and acrylic resin despite their major components are similar to Polident® 5 minutes. This might be due to the product recommended soaking time of Fittydent®, which is longer than Polident® 5 minutes. Furthermore, microscopic visualization showed the rougher surface compared to the control and Polident® groups. Chlorhexidine gluconate significantly increased the retention of the attachments and did not affect the colour visually, which is in agreement with the study of Andrade et al.\textsuperscript{9} Thus, it can be used as an alternative routine denture cleanser including the cleanser for oral candidiasis patient. Moreover, the cost compared to other commercial denture cleansers is lower. The increased retention might be due to some texture change on the nylon surfaces. However, the effect of surface texture change in longer soaking time should be evaluated in future studies. Although the soaking time of Sodium hypochlorite in this study was limited to 10 minutes per day which was less than previous studies\textsuperscript{13,14} (8 hours); however, the retention of nylon was still decreased after 1 year. After 1 and 6-month soaking, the increased retention might be due to the abundant surface change of the nylons. The texture change caused the surface getting rougher and had more friction. However, after continuing soaking for 1 year, there might be material degradation that caused the nylon to be softened. Finally, the retention was dropped drastically even if the soaking time did not exceed 10 minutes per day. Thus, it should not be recommended as a routine denture cleanser, which is in agreement with the studies of You et al.\textsuperscript{13} and Nguyễn et al.\textsuperscript{14}. Furthermore, Sodium hypochlorite had several detrimental effects to denture materials, which are metal corrosion, irritant effect on the skin and other cells and unpleasant residual odor and taste.\textsuperscript{9,35,36}

This in vitro study had some limitations. The pink nylons were soaked continuously in the denture cleansers for a simulated 1 year. This is different from the clinical situation, which periods of soaking and periods of use are alternate. The attachments were not tested under mimic normal oral environment and occlusal function. These conditions may conceal the effect from denture cleansers. Thus, the solutions that increased the retention of pink Locator® should be interpreted with caution because different results may be obtained when normal oral environment and occlusal function are combined. In addition, the data were not normally distributed. This might be due to the small sample size. However, the results from the study were clear and the surface textures under microscopic visualization were consistent with the results. Within the limitations of this study, the authors concluded that Polident® 5 minutes had no significant effect on the retention of pink Locator®.

Fittydent® and Chlorhexidine gluconate significantly increased the retention of the attachments. However, Fittydent® also whitened the pink nylon and acrylic resin. Sodium hypochlorite eventually significantly decreased the retention and softened and whitened the pink nylon and acrylic resin, thus it should not be recommended as a routine denture cleanser.

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