

The Effect of Denture Cleansing Solutions on the Retention of Pink Locator Attachments: An in Vitro Study

Caroline Tram Nguyen, DMD, MS,¹ Radi Masri, BDS, MS, PhD,² Carl F. Driscoll, DMD,³ & Elaine Romberg, PhD⁴

¹ Former Resident, ASE Prosthodontics, University of Maryland Dental School, Baltimore, MD

² Assistant Professor, Department of Endodontics, Prosthodontics, and Restorative Dentistry, University of Maryland Dental School, Baltimore, MD

³ Professor, Director Postgraduate Prosthodontics Program, University of Maryland Dental School, Baltimore, MD

⁴ Professor, Division of General Dentistry, University of Maryland Dental School, Baltimore, MD

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Correspondence

Caroline Tram Nguyen, 3 Hermann Museum Circle Dr., Apt 2413, Houston, TX 77004.
E-mail: tramcaro@yahoo.ca

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Abstract

Purpose: To evaluate the changes in retention of pink Locator attachments after exposure to various denture cleansers.

Materials and Methods: Six groups (20 pairs each) of pink Locator attachments (3.0 lb. Light Retention replacement patrix attachments) were soaked for the equivalent of 6 months of clinical use in the following solutions: Water (control), Polident Regular, Efferdent, 6.15% sodium hypochlorite (NaOCl, 1:10 dilution), Polident Overnight, and Cool Mint Listerine mouthwash. A universal testing machine set at a crosshead speed of 2 in/min was used to perform one pull. The peak load-to-dislodgement was recorded to reflect changes in the retention of the Locator attachments after soaking. Data were analyzed by one-way ANOVA followed by Tukey's Honestly Significant Difference test. A $p \leq 0.05$ was considered significant.

Results: Denture cleansing solutions significantly affected the retentive values of pink Locator attachments ($F = 344.3$, $p \leq 0.0001$). Cool Mint Listerine mouthwash increased the retentive values of the attachments (51.10 ± 5.31 N) when compared to the control group (45.25 ± 3.49 N). There was no significant difference in the retentive values of attachments soaked in Polident Regular or Polident Overnight when compared to the control group. Efferdent caused a small reduction in the retentive values (40.81 ± 2.56 N) and most importantly, diluted NaOCl caused a large reduction in the retentive values (7.83 ± 2.50 N) of pink Locator attachments. In addition, Cool Mint Listerine mouthwash caused blue discoloration of the Locator attachments, and NaOCl caused whitening and softening of the pink Locator attachments.

Conclusion: Cool Mint Listerine and Efferdent's small effect on the retentive values of the Locators might be clinically unimportant; however, NaOCl caused a large reduction in the retentive values of the attachments. Because of their effect on retentive values and on the color of the Locator attachments, NaOCl and Cool Mint Listerine are not recommended. These results should be interpreted clinically with caution, realizing that different results may be obtained when fatigue stress during function and multiple pulls (in vivo) are combined with the chemical action of denture cleansers.

Gradual loss of teeth may eventually lead to complete edentulism and alveolar bone resorption.¹ For many years, the only available option was to treat patients with complete dentures, but now, changing a complete denture to an implant-retained overdenture can improve the stability of the dentures² and prevent bone loss.³ Implant-retained overdentures improve chewing function and significantly increase patients' satisfaction with their prostheses.² According to the McGill Consensus Statement on overdentures, two-implant overdentures should be the first choice of treatment for the edentulous mandible.³

Implant overdentures are retained using attachments, and several systems are available on the market. An increasingly popular attachment system is the Locator attachment system. It is used on non-splinted, free-standing implants, and according to the manufacturer (Zest Anchors, Escondido, CA), is classified as universal hinge, resilient overdenture attachments for endosseous implants. Locator attachments have a low-profile height of 2.5 mm, have a diameter of 4.1 mm at their seating surface, use a patrix and matrix configuration, and can compensate for angle corrections of up to 40°. They are indicated

in cases of tissue-supported removable overdentures on two to four implants, partially edentulous overdentures with one or more implants, and limited interarch distance.⁴

Regardless of the attachment system employed, standard hygiene procedures are routinely recommended for patients wearing implant-retained overdentures. These include mechanical and chemical denture cleansing options.⁵⁻⁸ Mechanical denture cleansing techniques are brushing with or without pastes and ultrasonic agitation. Chemical means of cleaning dentures include alcohol-based disinfectants and denture cleansers made of alkaline hypochlorites, alkaline peroxides, enzymes, and diluted organic or inorganic acids.⁵ Soft debris, bacterial plaque, and dental calculus are often found on denture surfaces,⁹ and brushing alone is insufficient for controlling plaque on dentures.¹⁰ Because of this, many authors prefer the use of chemical denture cleansers.^{5,10-13}

Denture cleansers may have detrimental effects on overdentures, and they can lead to deterioration of the denture base material, such as bleaching of acrylic resin, corrosion of metal, and deterioration of temporary and soft lining materials if used incorrectly.^{5,14-16} Varghese *et al* performed an *in vitro* study to test the effect of denture cleansing solutions on the retention of yellow Hader clips. The cleansing solutions tested were Polident Regular, Polident Overnight, Efferdent, sodium hypochlorite (NaOCl) diluted 1:10 in tap water, and tap water. Using a one-pull test, they showed that denture cleansers affect the retentive value of yellow Hader clips, specifically those soaked in diluted NaOCl solution.¹⁷ In the present study, the effect of various denture cleansers on pink Locator attachments (3.0 lb. Light Retention replacement patrix attachments) was tested to evaluate change in retention in a one-pull test.

Materials and methods

Fabrication of the testing acrylic block with implant lab analogs

This research project adopted similar methods to those described previously in Varghese *et al*.¹⁷ Tru Wax baseplate wax (Heraeus Kulzer Inc., Armonk, NY) was shaped into a rectangular box (2" × 1" × 1") to fabricate an acrylic resin block that housed the dental implants. A rectangular notch was carved on each side of the block of the baseplate wax. The notch was 4 mm in length, depth, and height (Fig 1). The block was invested in a flask with Type II stone (Kerr Lab, Orange, CA) and was placed in the boil-out tank for 7 minutes. The flasks were separated and bench cooled. Two layers of Modern Foil Separating Medium (Heraeus Kulzer Inc.) were applied. Heat-polymerized clear Jet Acrylic (Lang, Wheeling, IL) was mixed according to manufacturer's instructions and was packed in the doughy stage. The flask was trial packed three times at 1500 psi and final packed at 3000 psi. The flask was heat-polymerized at 165°F for 9 hours. Once the cycle was completed, the block was divested, finished, and polished.

Two implants (3i Implant Innovations, Palm Beach Gardens, FL) with wax guide pins were embedded into the block of baseplate wax. The pins were perpendicular to the floor, and their parallel alignment was confirmed by attaching the wax guide pins to a Ney surveyor (Dentsply, Bloomfield, CT). The top of

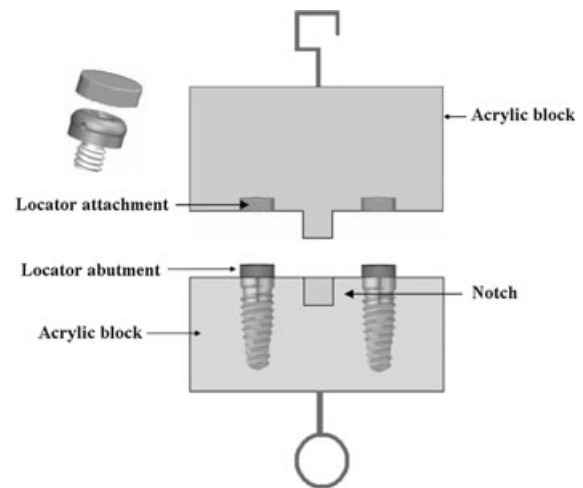


Figure 1 The acrylic resin blocks used for testing pink Locator attachments. The first acrylic resin block (upper part) has two metal housings with a Locator matrix attachment embedded within each. The second acrylic resin block (lower part) has two Locator patrix abutments attached to two implants.

the implants were exposed at least 1–2 mm above the block of wax. This implant assembly was processed in the same manner, as described above. After processing and polishing, two Locator abutments (Zest Anchors, Escondido, CA) were inserted into the implants and blocked out with Type II stone, except for the metal housings, which contained the black processing patrix components. Baseplate wax was used to form another block of wax on top of the acrylic block with the implants. The assembly was invested, boiled out, packed with clear acrylic resin, and heat-polymerized in the same manner described above.

The two blocks of acrylic were used for testing procedures. The first acrylic resin block had two implants embedded in it. The second acrylic resin block had raised areas on each edge to complement the notches in the first acrylic resin block. These aided in the verification of complete seating during testing procedures and ensured consistent pulls. The second block contained two metal housings (Zest Anchors) with the Locator attachments tested embedded in its intaglio surface, thereby allowing ease of replacement with other Locator attachments during the testing procedure. The axial walls of the notches on the acrylic resin block were slightly relieved to remove any friction produced between these walls during the testing procedures. This ensured that the values obtained represented the retentive value of the attachments only (Fig 1).

Testing procedure

The denture cleansing solutions used in this study were: Polident Regular, Efferdent, 6.15% NaOCl diluted 1:10 in tap water,⁶ Polident Overnight, and Cool Mint Listerine. Tap water was used as control (Table 1). As pink Locator attachments are the most widely used by dentists (personal communication with the sales department of the manufacturer), these were the ones tested in this experiment. Locator attachments were placed in a small, perforated plastic bag (Ziploc, S.C. Johnson &

Table 1 Denture cleansers tested

Denture cleanser	Manufacturer info
Cool Mint Listerine	Johnson & Johnson, New Brunswick, NJ
Polident Regular	GlaxoSmithKline, Philadelphia, PA
Polident Overnight	GlaxoSmithKline, Philadelphia, PA
Efferdent	Johnson & Johnson, New Brunswick, NJ
Bleach	Clorox, Oakland, CA

Son, Racine, WI). A second bag containing a small marble was placed within the first bag to prevent the attachments from floating to the top of the solution. This ensured that the attachments were immersed throughout the time period. The bags were immersed in a beaker (Plasutil, Bauru, Brazil) containing 125 ml of each solution for the time equivalent of 6 months according to manufacturer's instructions. The solutions were changed on a "daily" basis. For example, Polident Regular required 3 minutes of soaking per day according to manufacturer's instructions. Every 3 minutes, using a timer (Timex, Middlebury, CT), the solution was changed. At that time, the attachments within the mesh bag were rinsed with tap water for 15 seconds, and were then immersed in 50 ml of tap water. Then the next tablet was inserted into the same beaker. Efferdent required 15 minutes of soaking per day; thus the solution was changed every 15 minutes. Another group of Locator attachments was soaked in NaOCl for 8 hours a day,¹⁸ and the solutions were changed every 8 hours. Finally, patients who would soak their dentures either in Polident Overnight, Cool Mint Listerine, or tap water would soak them overnight, so these groups required 8 hours of soaking per day, and the solutions were changed every 8 hours (Table 2). Each group consisted of twenty pairs of pink Locator attachments.

Pink Locator attachments were tested in pairs of two for their retention on a universal testing machine (Satec Material Testing Equipment, T Series, Scottsdale, AZ). A reversible load cell was used and set at a crosshead speed of 2 in/min.¹⁹ The acrylic block with the Locator patrices embedded in it (Fig 1) was clamped down and stabilized on the lower member of the Satec machine. A screw hook was embedded into the top part of the upper acrylic resin block, which in turn was clamped into a pneumatic grip of the upper member of the Satec machine. A tensile force was applied to the specimen until the Locator attachments separated from the abutments. The peak load-to-dislodgement was recorded. Each attachment

Table 2 Experimental design and soaking periods

Denture cleansing solution	Solution change interval (manufacturer's recommendations)	Immersion time (6-month equivalent)
Tap Water (Control)	8 hours	1440 hours
Polident Regular	3 minutes	9 hours
Efferdent	15 minutes	45 hours
Sodium Hypochlorite	8 hours	1440 hours
Polident Overnight	8 hours	1440 hours
Cool Mint Listerine	8 hours	1440 hours

Table 3 Differences in retention of various cleansers

Group	N	MEAN (peak load, N)		F	p
		Mean	SD		
Cool Mint Listerine	20	51.10 ^a	5.31	344.323	0.0001
Water	20	45.25 ^b	3.49		
Polident Overnight	20	44.99 ^b	5.21		
Polident Regular	20	44.95 ^b	2.33		
Efferdent	20	40.81 ^c	2.56		
Sodium Hypochlorite	20	7.83 ^d	2.50		

Groups with the same letter are not significantly different.

was removed from the metal housing in the acrylic resin block using the removal end of a Locator Core tool (Zest Anchors). The seating end of this same tool was used to place a new attachment into the metal housing within the acrylic block.

Peak load-to-dislodgement value for each pair of locators was collected, and statistical analysis was completed using one-way ANOVA followed by Tukey's Honestly Significant Difference (HSD) test ($p \leq 0.05$ considered significant). Data are reported as mean \pm SD.

Results

Denture cleansing solutions had significant effects on the retentive values of pink Locator attachments ($F = 344.3$, $p < 0.0001$, ANOVA, Table 3). The retentive values ranged from 7.83 ± 2.50 N for Locator attachments soaked in NaOCl, to 51.10 ± 5.31 N for Locator attachments soaked in Listerine 8 hours. The retention of the attachments soaked in Listerine for 8 hours per day was significantly higher than the retentive values for all other Locator attachments, including the water group (control). The Locators soaked in NaOCl exhibited the lowest peak load-to-dislodgement. This represents a large reduction of 82.70% in retention compared to the control group. Locator attachments soaked in Efferdent had significantly lower peak load-to-dislodgement than the water control group and

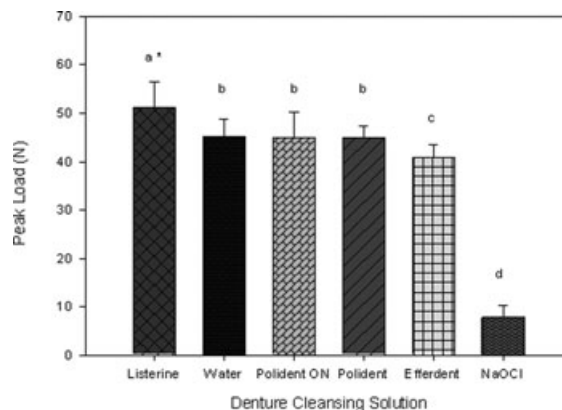


Figure 2 Mean peak load-to-dislodgement (N) for each denture cleansing solution tested. Error bars represent standard deviation (SD). Polident ON = Polident Overnight, NaOCl = diluted sodium hypochlorite. *Groups modified with the same letter are not significantly different.

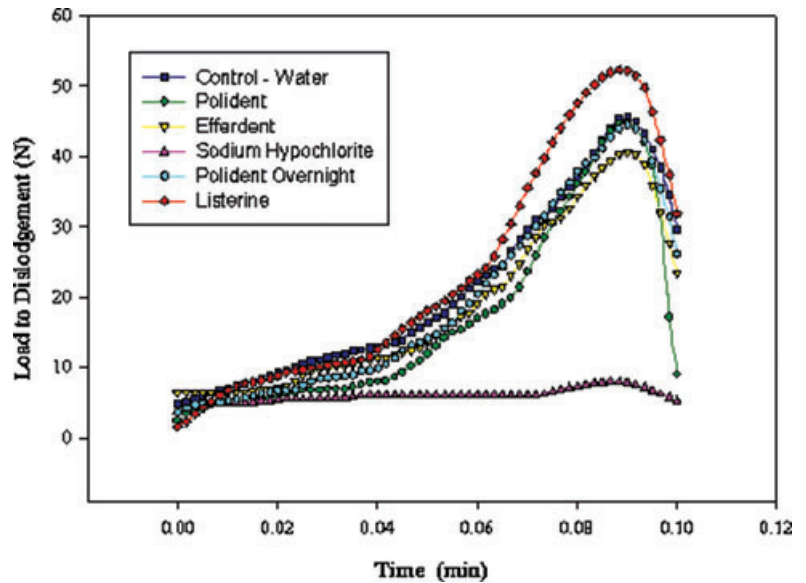


Figure 3 Representative examples of a single pull from each of the tested attachments. In each of the test groups, the load was documented in a continuous fashion during the pull until the attachment was dislodged.

Polident Regular for 3 minutes per day and Polident Overnight for 8 hours per day. Polident Regular and Polident Overnight showed no statistical difference in peak load-to-dislodgement when compared to the control group but were significantly lower than the Listerine group (Table 3, Fig 2).

Representative examples of the behavior of the Locator attachments from each group in response to dislodging forces over time are presented in Figure 3. This shows the change in tensile force for a pair of attachments during the first pull for each of the cleansers. The highest point of each line in the graph represents the peak load-to-dislodgement. Immediately after that point in time, the Locator attachments were dislodged from the Locator abutments.

Denture cleansing solutions also caused discoloration of the Locator attachments tested. Soaking the pink Locator attachments in Cool Mint Listerine turned their color to blue, while soaking them in NaOCl whitened and softened the attachments (Fig 4). The other denture cleansers had no effect on the color of Locators as determined visually.

Discussion

In this research project, efforts were focused on testing the pink Locators, because Zest Anchors reports that these are the most popular in the market, followed by the 1.5 lb. Extra-Light Retention replacement patrix Blue Locators. A crosshead speed of 2 in/min was used because it is the speed at which patients remove implant overdentures from their fixtures.¹⁹ A one-pull test was performed because in a study of the change in retentive values of Locator attachments and Hader Clips over time, Evtimovska et al showed that a significant loss of retention occurs after the first removal of the Locator attachments from the abutments.²⁰ Furthermore, their study showed that each additional time the Locator attachments were removed from the abutments, an additional decrease in retention occurred until retention plateaued after the sixteenth pull. By using a one-pull

test, this variable was eliminated, enabling us to test changes in retentive value caused only by denture cleansing solutions.

The retention of pink Locator attachments soaked in Listerine for 8 hours per day showed a slight increase in retentive value compared to the control group (+12.93%), while attachments soaked in Efferdent had a slight decrease in retentive value (-9.81%). Attachments soaked in Polident Regular and Polident Overnight showed no difference in peak load-to-dislodgement from the control group in the one-pull test during a 6-month soaking simulation.

1. Water / Control
2. Polident Regular
3. Efferdent
4. Sodium Hypochlorite
5. Polident Overnight
6. Listerine



Figure 4 Examples of Locator attachments after soaking in their respective solutions and testing on the universal testing machine.

The results of this study showed that NaOCl solution significantly affected the retentive values of Locator attachments—more so than any other cleanser tested. The effect of NaOCl manifested as a considerable reduction (82.70% reduction from the water control group) in the retentive value of the Locator attachments. This is in apparent disagreement with results obtained earlier by Varghese *et al*,¹⁷ which had shown that soaking nylon Hader clips in NaOCl slightly increased single-pull retention of clips tested. This difference in results could be due to the different chemical composition and design specifications of Locator attachments vs. Hader clips, and the longer soaking time in this study (8 hours vs. 15 minutes per day).

The present study only evaluated the effect of denture cleansers on the retentive values of pink Locator attachments. Locator attachments are available on the market in different colors representing different designs offering various levels of retention. Because they are all manufactured from the same material (DuPont Zytel 101L NC-10 Nylon, Zest Anchors Inc), we expect that NaOCl will affect them similarly.

There were several limitations to this study. The Locator attachments were only tested for a maximum simulated time of 6 months; their retentive value may only be affected after exposure to the denture cleansing solution for more than 6 months of soaking as well as use. Further research is needed to address this issue. In addition, the attachments were continuously soaked, which is different from clinical situations where dentures are only kept in a solution for a certain amount of time and then taken out for several hours. Furthermore, the attachments were not tested under fatigue stress to mimic normal occlusal function, there was no thermal cycling, and only a one-pull test was performed, whereas in normal clinical conditions, implant overdentures would be removed from their fixtures several times over 6 months. The attachments are subjected to occlusal forces during function in the mouth. Therefore, the retentive values of Locator attachments may deteriorate even more in clinical situations and, if anything, the results of this study may underestimate the true effects.

Conclusion

This *in vitro* study demonstrated that the retention of pink Locator attachments used in implant overdentures is unaffected when soaked in Polident Regular and Polident Overnight for 6 simulated months. Cool Mint Listerine and Efferdent slightly affected the retentive values of the Locators, an effect that might be unimportant clinically; however, diluted NaOCl significantly decreased the retentive values of the attachments and is not recommended for cleansing Locator-retained overdentures. Other effects observed were blue discoloration of attachments soaked in Cool Mint Listerine mouthwash and whitening and softening of attachments soaked in NaOCl. Therefore, clinicians may want to additionally avoid the use of Listerine for cleaning dentures. These results should be interpreted clinically with caution, even for solutions that did not significantly affect the retentive value of the Locator attachments, realizing that different results may be obtained when fatigue stress during function (*in vivo*) is combined with the chemical action of denture cleansers.

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