

# The Effect of Denture Cleansing Solutions on the Retention of Pink Locator Attachments after Multiple Pulls: An In Vitro Study

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## Keywords

Retention; dental hygiene; overdentures; Locators.

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## Abstract

**Purpose:** The effect of denture cleansing solutions and multiple pulls on the retention of pink Locator attachments was studied.

**Materials and Methods:** Five groups of pink Locator attachments (3.0 lb. Light Retention replacement patrix attachments; five in each group) were soaked for the equivalent of 6 months of clinical use in the following solutions: water (control), Efferdent, Polident Overnight, 6.15% sodium hypochlorite (NaOCl, 1:10 dilution), and Listerine mouthwash. A universal testing machine set at a 2 in/min crosshead speed was used to perform 548 pulls (548 cycles of insertion and removal). The reduction in load to dislodgement (retention) after the initial pull and the final pull and the percent reduction in retention after 6 months were compared between the groups using a one-way ANOVA followed by Tukey's Honestly Significant Difference (HSD) Test ( $\alpha = 0.05$ ).

**Results:** Denture cleansing solutions significantly reduced the retentive values of pink Locator attachments after the initial pull ( $F = 17.435, p < 0.0001$ ). The retentive values of Efferdent, Listerine, Polident Overnight, and water were significantly higher than the retentive value of the attachments soaked in NaOCl. After 6 months of simulated use (548 pulls), the four denture cleansing solutions had significant effects on the retentive values of pink Locator attachments ( $F = 5.855, p = 0.003$ ). The retentive values for attachments soaked in NaOCl ( $7.29 \pm 1.0$  N) were significantly lower than those of attachments soaked in Listerine ( $15.82 \pm 4.7$  N) and in Polident Overnight ( $14.41 \pm 3.6$  N). These cleansing solutions also had a significant effect on the percentage of retention lost ( $F = 3.271, p = 0.032$ ). The loss of retention in attachments soaked in Listerine ( $29 \pm 9\%$ ) was significantly lower than attachments soaked in water ( $53 \pm 12\%$ ). The loss of retention in attachments soaked in Efferdent was  $49 \pm 9\%$ ; in Polident Overnight,  $34 \pm 18\%$ ; and in NaOCl,  $42 \pm 11\%$ . There was no significant difference in the percentage of retention loss between water, Efferdent, NaOCl, and Polident Overnight. There was also no significant difference in the percentage of retention loss between Efferdent, NaOCl, Polident Overnight, and Listerine.

**Conclusion:** NaOCl significantly decreased the retentive value of Locators. Therefore, it should not be routinely recommended for use as a denture cleanser. Listerine significantly increased the retention of the Locator attachments; however, it is premature to recommend Listerine for use as a denture cleanser.

According to the McGill Consensus Statement on Overdentures, two-implant overdentures should be the treatment of choice for edentulous mandibles,<sup>1</sup> because dental implants, similar to natural teeth, preserve the surrounding bone,<sup>1-3</sup> pro-

vide stability for the denture by minimizing downward movement,<sup>4</sup> increase chewing ability,<sup>5</sup> and improve patient satisfaction.<sup>6</sup> Implant-retained overdentures, however, do require meticulous hygiene.<sup>7</sup> Most patients clean their dentures by

**Table 1** Denture cleansing solutions tested

Solution	Manufacturer information	Solution change interval (manufacturer's recommendations)	Total immersion time-6 months equivalent
Water	Baltimore, MD	8 hours	1440 hours
Efferdent	Johnson & Johnson, New Brunswick, NJ	15 minutes	2700 minutes
Polident Overnight	GlaxoSmithKline, Philadelphia, PA	8 hours	1440 hours
Sodium hypochlorite	Clorox, Oakland, CA	8 hours	1440 hours
Cool Mint Listerine	Johnson & Johnson, New Brunswick, NJ	8 hours	1440 hours

brushing, but brushing alone is not enough to control plaque.<sup>8</sup> Therefore, many patients use commercial denture cleansers (e.g., Efferdent and Polident Overnight) dissolved in tap water.<sup>9</sup> These cleansers have been shown to be more effective than water in reducing *Candida* and *Streptococcus mutans*. In all cases, the use of cleanser significantly reduced the amount of plaque, stain, and food on the dentures.<sup>10</sup> Another commonly used denture cleanser is sodium hypochlorite (NaOCl), which has been found to be the most effective immersion plaque removal agent.<sup>11,12</sup> Despite their efficacy, denture cleansers have been reported to cause deleterious effects on prosthetic materials used to rehabilitate edentulous patients.<sup>13,14</sup>

Varghese et al<sup>15</sup> demonstrated that denture cleansers significantly affect the retentive value of yellow Hader clips. Specifically, attachments soaked in a diluted NaOCl solution for a time equivalent of 6-month use exhibited an increase in retentive value. There was no significant difference between the average retentive value of Hader clips soaked in Polident Regular, Polident Overnight, and Efferdent. In another study, Nguyen et al<sup>16</sup> investigated the effect of denture cleansers on the retention of pink Locator attachments (3.0 lb. Light Retention replacement patrix attachments); Efferdent and diluted NaOCl produced a significant reduction in retention while Listerine increased the retentive value of pink Locator attachments.<sup>16</sup> The authors postulated that loading and unloading soaked Locators may produce different results and unmask the detrimental effects of Listerine and other cleansers.<sup>16</sup> This research project addressed these issues and tested the null hypothesis that after the initial pull and after 6 months simulated use, there was no significant difference in the retention of pink Locator patrices soaked in the following denture cleansers: tap water, Efferdent, Polident Overnight, sodium hypochlorite, or Cool Mint Listerine.

## Materials and methods

This research project implemented methods similar to those described by Nguyen et al.<sup>16</sup> Tru Wax baseplate wax (Heraeus

Kulzer Inc., Armonk, NY) was melted and poured into a hollow plastic cylinder (diameter 1.0", height 3", Home Depot, Baltimore, MD). The wax was left to cool before being separated from the plastic cylinder. One implant, OSSEOTITE Certain 4.1 mm platform (Biomet 3i, Palm Beach Gardens, FL) with a wax guide pin (Biomet 3i) inserted in it, was embedded into the wax cylinder. The implant was positioned perpendicular to the floor and in the middle of the cylinder, established using a surveyor (J.M. Ney Co., Bloomfield, CT). The top of the implant was placed at least 3 mm above the surface. The cylinder containing the implant was invested in a flask (Whip Mix Co., Louisville, KY) with Type III stone (Kerr Lab, Orange, CA) and placed in the boil-out tank (Nevin Laboratories Inc., Chicago, IL) 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 packed in the doughy stage. The flask was trial packed three times at 1500 psi and final packed at 3000 psi. The acrylic was heat polymerized at 165°F for 9 hours. Once the cycle was completed, the flask was left to bench cool. The cylinder was divested, finished, and polished.

After processing and polishing this first cylinder, baseplate wax (Heraeus Kulzer Inc.) was used to form another cylinder of wax on top of the acrylic cylinder with the implant. The assembly was invested, boiled out, packed with clear acrylic resin, and heat polymerized in the same manner described above. Then one Locator abutment (Zest Anchors, Escondido, CA) was inserted into the implant, and a metal housing containing the processing sleeve was placed on top of it. The second cylinder was used to pick up the metal housing.

The denture cleansing solutions used in this study and their manufacturers are listed in Table 1. They were: Polident Overnight, Efferdent, 6.15% sodium hypochlorite (diluted 1:10 in tap water, NaOCl), and Listerine. Tap water was used as the control. Five pink Locator attachments (3.0 lb. Light Retention replacement patrix attachments) were soaked in each of the cleansing solutions. They were placed in a small-perforated plastic bag, and 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 for the entire soaking period. The bags were immersed in a beaker (Plasutil, Bauru, Brazil) containing 125 mL of each solution, according to manufacturer's instructions, for the time equivalent of 6 months (Table 1). The solutions were changed on a simulated daily basis. For example, Efferdent required 15 minutes of soaking per day; thus, the solution was changed every 15 minutes. At that time, the attachments within the perforated bag were rinsed with tap water for 15 seconds and then immersed in 50 mL of tap water. The next tablet was then inserted into the same beaker. The solutions were changed every 8 hours for the Locator attachments soaked in NaOCl, Polident Overnight, Listerine, and tap water.

At a minimum, it is estimated that a patient places/removes the overdenture at least three times a day, once for each meal. Therefore, during 6 months of use, a patient removes and replaces the denture at least 548 times. Based on this assumption, the attachments were tested for loss of retention after being subjected to 548 cycles of removal and insertion.



**Figure 1** The acrylic resin cylinders used for testing pink Locator attachments. The first acrylic resin cylinder has a metal housing with a Locator matrix embedded within. The second acrylic cylinder has a Locator patrix abutment attached to implant.

Pink Locator attachments were tested because they are the most commonly used attachments in practice (personal communication with manufacturer). The attachments were tested for changes in load-to-dislodgement (retention) on a Universal Testing Machine (Model 5581, Instron Corp, Norwood, MA). The acrylic cylinders (Fig 1) were attached to the two members of the Universal Testing Machine. Each attachment was subjected to 548 cycles of insertion and removal. A reversible load cell was used to apply a perpendicular tensile force at a 2 in/min crosshead speed.<sup>17</sup> After each test (548 cycles), the removal end of a Locator Core tool (Zest Anchors) was used to remove the old attachment, and the seating end of this same tool was used to place a new attachment into the metal housing within the acrylic cylinder, and testing was repeated.

Using means from five of the six experimental groups in Nguyen *et al*,<sup>16</sup> a power analysis was performed. The result showed that with an  $n$  of 5 in each group, a  $p \leq 0.05$ , an effect size of 15.43, and a two-tailed test, power was equal to 1.00. Therefore five specimens in each group were used.

The reduction in retention after the initial pull and the final pull and the percentage of retention loss after 6 months of simulated use and soaking in denture cleansers were compared

between the groups, using a one-way ANOVA followed by Tukey's HSD Test. A  $p \leq 0.05$  was considered significant.

## Results

Denture cleansing solutions had significant effects on the retentive values of pink Locator attachments after the initial pull ( $F = 17.4$ ,  $p < 0.0001$ ). The retentive value for the attachments soaked in NaOCl was  $12.6 \pm 1.5$  N. The retention of attachments soaked in Listerine was  $22.3 \pm 3.1$  N, in water was  $22.2 \pm 2.3$  N, in Polident Overnight was  $21.8 \pm 2.4$  N, and in Efferdent was  $21.5 \pm 1.5$  N. There was no significant difference between these four cleansers. All four values were significantly higher than the retentive value of the attachments soaked in NaOCl (Fig 2).

After 6 months of simulated use, the denture cleansing solutions had significant effects on the retentive value of pink Locator attachments ( $F = 5.9$ ,  $p = 0.003$ ). The retentive value for attachments soaked in NaOCl ( $7.3 \pm 1.0$  N) was significantly lower than that of attachments soaked in Listerine ( $15.8 \pm 4.7$  N) and in Polident Overnight ( $14.41 \pm 3.6$  N). The retentive value for attachments soaked in Efferdent were  $11.0 \pm 2.2$  N, and in water was  $10.5 \pm 2.9$  N. There was no significant difference in retentive values between Listerine, Polident Overnight, Efferdent, and water. There was also no significant difference between Efferdent, water, and NaOCl (Fig 3).

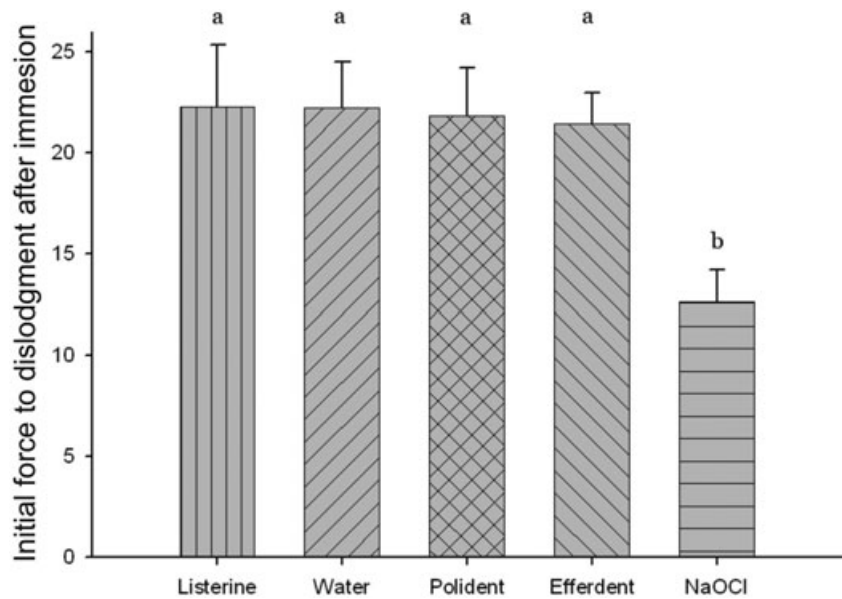
The denture cleansing solutions also had a significant effect on the percentage of retention lost ( $F = 3.271$ ,  $p = 0.032$ ). This percentage was calculated by using the average retention after the initial pull minus the average retention after the 548th pull, divided by the mean retention of the initial pull. The reduction in retentive value for attachments soaked in Listerine ( $29 \pm 9\%$ ) was significantly lower than that of attachments soaked in water ( $53 \pm 12\%$ ). The loss in retention for attachments soaked in Efferdent was  $49 \pm 9\%$ , in Polident Overnight was  $34 \pm 18\%$ , and in NaOCl was  $42 \pm 11\%$ . There was no significant difference in the percentage of retention loss between water, Efferdent, NaOCl, and Polident Overnight. There was also no significant difference in retention loss between Efferdent, NaOCl, Polident Overnight, and Listerine (Fig 4).

## Discussion

This *in vitro* study investigated the effect of denture cleansing solutions on the retention of pink Locator attachments. The results of this study rejected the null hypothesis that after the initial pull and the final pull there would be no significant difference in the retention of pink Locator attachments no matter which denture cleanser was used. The results of this study demonstrated that soaking pink Locator attachments in denture cleansers for a simulated period of 6 months significantly affected retention.

After the first pull, the loss of retention in Locator attachments soaked in NaOCl was significantly greater than all other cleansers. This result is in agreement with Nguyen *et al*'s findings,<sup>16</sup> which showed that pink Locator attachments soaked in NaOCl exhibited the lowest retention. There was no significant difference in retention between groups soaked in Listerine, Polident Overnight, Efferent, and water (control), while

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

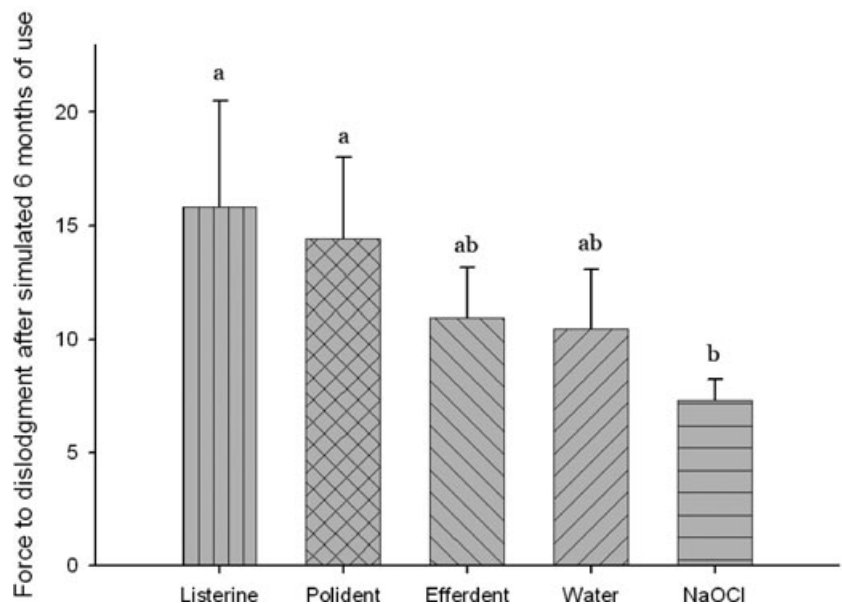


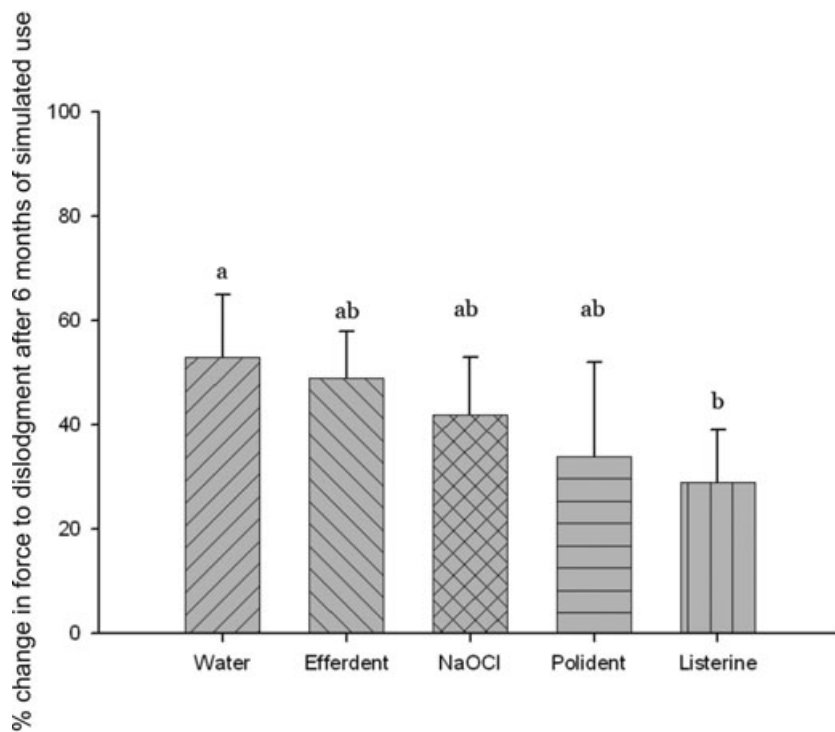
Nguyen et al<sup>16</sup> found significant differences between Locators soaked in water and Locators soaked in Polident Overnight and Efferdent. The difference in these findings may be due to the different methods employed. Nguyen et al<sup>16</sup> used a simulated model containing two implants and tested the retention provided by two attachments (n = 20 in each group); however, in this study, only one implant was used, and only one attachment was tested at a time (n = 5 in each group). This project involved testing Locators during successive removal and insertion cycles. Using one implant/Locator assembly helped to ensure that the attachments seated on the abutment every time.

After 6 months of simulated use, the retentive values of Locator attachments were also significantly reduced. NaOCl caused the greatest loss of retention. Clinically, if the patient soaks the dentures in NaOCl, the Locators will most likely need to be replaced more frequently. Consistent with recommendations from previous studies, NaOCl as a denture cleanser should be avoided when Locator attachments are used.<sup>15,16</sup>

To investigate the effect of multiple pulls on the retention of soaked attachments, the percent loss of retention was calculated. The results of this research showed that attachments soaked in Listerine were least affected by multiple pulls. This result was not in agreement with a prediction arising from an

**Figure 3** After 6 months of simulated use, mean peak load-to-dislodgment for each denture cleansing solution tested. Error bars represent standard deviation (SD). Polident = Polident Overnight; NaOCl = diluted sodium hypochlorite. \*Groups with the same letter are not significantly different.





**Figure 4** Percent change in force to dislodgment after 6 months simulated use. Error bars represent standard deviation (SD). Polident = Polident Overnight; NaOCl = diluted sodium hypochlorite. \*Groups with the same letter are not significantly different.

earlier study<sup>16</sup> stating that even though Listerine increased the initial load-to-dislodgment of Locator attachments, these effects may not be desirable, because Listerine might affect the retention of the attachments over time. These findings, however, remain inconclusive, and more testing for longer periods of time is necessary.

The finding that multiple pulls had little effect on percent loss of load-to-dislodgment of Locators soaked in NaOCl must be interpreted with caution. This is because Locators soaked in NaOCl exhibited very low initial retentive values. Successive pulls and insertions may not have been able to reduce retention values any further.

Locator attachments are made of nylon (Dupont Zytel 101L NC-10 Nylon, Zest Anchors Inc). Cornelius *et al*<sup>18</sup> showed that NaOCl affected nylon by changing the surface morphology and by creating porosities and cracks at the SEM level. Nylon soaked in NaOCl for a long time may exhibit structural changes undermining the integrity of the material.

This *in vitro* study has several limitations. Patients may remove and insert the denture more than three times a day. Therefore, the actual retention of attachments will deteriorate faster than reported in this study. Further, the attachments were soaked continuously in the cleansers for a simulated period of 6 months, and then simulated function was performed. This is different than in clinical situations, where periods of soaking are interrupted with periods of use, as the patients wear the dentures during the day and then soak them in denture cleansing solutions during the night. In addition, a 2 in/min crosshead speed was used to pull the attachments, because it is the speed with which patients remove implant overdentures from the locator abutments.<sup>17</sup> However, patients may remove their dentures at

different rates, which in turn will affect the retention. Further, in this study, the attachments were soaked for 6 months of simulated use. Testing for longer periods is necessary, as a recent study demonstrated that Locator attachments can last up to 1.8 years.<sup>19</sup>

## Conclusions

Within the limitations of this *in vitro* study, the following conclusions were drawn:

- (1) The retention of pink Locator attachments used in implant overdentures was not affected when soaked in Efferdent and Polident Overnight.
- (2) Listerine significantly increased the retention over time of the Locator attachment; however, it is premature to recommend Listerine for use as a denture cleanser.
- (3) NaOCl significantly decreased the retentive value of Locators compared to other groups, and therefore, it should not be recommended routinely for use as a denture cleanser.

## References

1. Feine JS, Carlsson GE, Awad MA, *et al*: The McGill consensus statement on overdentures. Mandibular two-implant overdentures as first choice standard of care for edentulous patients. Montreal, Quebec, May 24-25, 2002. *Int J Oral Maxillofac Implants* 2002;17:601-602
2. Adell R, Eriksson B, Lekholm U, *et al*: Long-term follow-up study of osseointegrated implants in the treatment of totally

- edentulous jaws. *Int J Oral Maxillofac Implants* 1990;5:347-359
3. Lindquist LW, Carlsson GE, Glantz PO: Rehabilitation of the edentulous mandible with tissue-borne fixed denture. Six-year longitudinal study. *Quintessenz* 1988;39:599-613
  4. Fenton AH: The decade of overdentures: 1970–1980. *J Prosthet Dent* 1998;79:31-36
  5. Jemt T, Stalblad PA: The effect of chewing movements on changing mandibular complete dentures to osseointegrated overdentures. *J Prosthet Dent* 1986;55:357-361
  6. Burns DR, Unger JW, Elswick RK, Jr., et al: Prospective clinical evaluation of mandibular implant overdentures: Part II—Patient satisfaction and preference. *J Prosthet Dent* 1995;73:364-369
  7. den Dunnen AC, Slagter AP, de Baat C, et al: Professional hygiene care, adjustments and complications of mandibular implant-retained overdentures: a three-year retrospective study. *J Prosthet Dent* 1997;78:387-390
  8. Dills SS, Olshan AM, Goldner S, et al: Comparison of the antimicrobial capability of an abrasive paste and chemical-soak denture cleaners. *J Prosthet Dent* 1988;60:467-470
  9. Shay K: Denture hygiene: a review and update. *J Contemp Dent Pract* 2000;1:28-41
  10. Gornitsky M, Paradis II, Landaverde G, et al: A clinical and microbiological evaluation of denture cleansers for geriatric patients in long-term care institutions. *J Can Dent Assoc* 2002;68:39-45
  11. Watkinson AC, McCreight MC, Warnock DW: Prevalence and persistence of different strains of *Candida albicans* in treatment of denture stomatitis. *J Prosthet Dent* 1985;53:365-366
  12. Kulak Y, Arikan A, Albak S, et al: Scanning electron microscopic examination of different cleaners: surface contaminant removal from dentures. *J Oral Rehabil* 1997;24:209-215
  13. Budtz-Jorgensen E: Materials and methods for cleaning dentures. *J Prosthet Dent* 1979;42:619-623
  14. Harrison A, Jagger DC: An in vitro investigation of the abrasive qualities of a selection of denture-cleaning pastes on poly(methyl methacrylate) denture base material. *Prim Dent Care* 1997;4:21-24
  15. Varghese RM, Masri R, Driscoll CF, et al: The effect of denture cleansing solutions on the retention of yellow Hader clips: an in vitro study. *J Prosthodont* 2007;16:165-171
  16. Nguyen CT, Masri R, Driscoll CF, et al: The effect of denture cleansing solutions on the retention of pink Locator attachments: an in vitro study. *J Prosthodont* 2010;9:226-230
  17. Williams BH, Ochiai KT, Hojo S, et al: Retention of maxillary implant overdenture bars of different designs. *J Prosthet Dent* 2001;86:603-607
  18. Cornelius RM, McClung WG, Barre P, et al: Effects of reuse and bleach/formaldehyde reprocessing on polysulfone and polyamide hemodialyzers. *ASAIO J* 2002;48:300-311
  19. Al-Ghaffi SA, Michalakis KX, Hirayama H, et al: The in vitro effect of different implant angulations and cyclic dislodgement on the retentive properties of an overdenture attachment system. *J Prosthet Dent* 2009;102:140-147

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