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RESEARCH AND EDUCATION

Effect of denture cleansing solutions on different retentive attachments

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ABSTRACT

Statement of problem. Various Locator abutments and attachments are available commercially for use in overdenture patients. Patients are advised to use cleansing agents to keep their overdentures clean. The effect of different cleansing agents on attachments with different retention is not known.

Purpose. The purpose of this in vitro study was to evaluate the retention of 3 Locator abutment attachments after they were soaked in 3 different cleansing solutions.

Material and methods. An implant analog with a diameter of 4.1 mm was embedded into acrylic resin, and 1 Locator abutment was placed onto the analog. Seven specimens of clear, pink, and blue Locator attachments (n=7) were soaked in 3 different denture-cleansing solutions (NaOCl, sodium perborate, sodium perborate-sodium bicarbonate) for a time simulating 6 months of clinical use. The control group was soaked in tap water. A testing machine was used to test the attachments' retention. The retention of the attachments after they were soaked in denture cleansers was compared among the groups with repeated-measures analysis of variance followed by the Tukey HSD test (α=.05).

Results. The retention of the clear attachments was significantly less after they had been soaked in sodium bicarbonate-containing denture cleanser (P=.001). The retention of the pink Locator attachments was no different after they had been soaked in the different solutions, and the retention of the blue Locator attachments decreased significantly after they had been soaked in the NaOCl and sodium bicarbonate cleansing agents (P=.002).

Conclusions. Attachments of different colors and retention were affected differently by cleansing agents. (J Prosthet Dent 2016;115:606-610)

According to the McGill consensus statement, the 2-implant-retained overdenture prosthesis should be the first option[1] for the treatment of the edentulous mandible because implants preserve bone, provide stability, increase masticatory ability, and improve patient satisfaction.[2,3] The retention of the implant overdentures is provided by using attachments, and many attachment systems are available.

Regardless of the attachment system, hygiene and cleansing procedures should be recommended to the patient. The effective and regular cleaning of the dentures is important for maintaining oral health and the prostheses. However, previous studies have reported that most of the edentulous patients wearing complete dentures are unaware of how to maintain them.[4,5]

Dentures can be cleaned using different methods such as mechanical cleaning, chemical cleaning, or a combination of both.[6,7] Most patients with edentulism use brushing (mechanical method) to cleanse their prostheses. Toothpaste is inexpensive, easy to use, and easily available. However, with an improper brushing technique, abrasives in the toothpaste may damage the denture.[4] Brushing alone has been reported to be insufficient in removing plaque.[2] Ultrasonic agitation is also available for cleansing; however, the equipment is relatively expensive. The chemical method of cleansing is commonly used by patients. Patients immerse their dentures in water, sodium hypochlorite, or other

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Clinical Implications

Clinicians should recommend cleansing agents containing sodium perborate-sodium bicarbonate for patients using Locator abutments with clear or blue attachments to prevent a potential decrease in retention.

solutions with effervescent tablets.[8,9] Although chemical methods are simple to use, their higher cost and their potential for metal corrosion or bleaching are disadvantages.[8,10,11] Although sodium hypochlorite (NaOCl) is bactericidal and fungicidal and removes stains by dissolving organic substances that accumulate on the denture, it bleaches acrylic resin.[12] The combination of oxidation with a strong alkaline solution has detrimental effects on the esthetics of a denture.[13]

Lack of retention is one of the most common problems, especially with mandibular complete dentures. Dislodgement of the denture during function affects patient acceptance of the prostheses.[14] Mandibular complete dentures tend to move during function and may not restore function adequately. Implant overdentures emerged as a way of improving function and patient satisfaction. However, a decrease in attachment retention with time and the necessity for maintenance/repair are the most frequent complications with overdenture therapy.[15] The overdenture wear mechanism can be abrasive or corrosive and can cause surface fatigue.[16] A patient removes and replaces the denture at least 4 times a day, including after meals and before going to sleep.[2] While all these removal and replacements may wear the attachments, at nighttime, the denture cleansers may have corrosive effects on the dentures.

Overdentures are retained by precision attachments, magnets, or clips. The attachment selection depends on the required retention, mandibular anatomy, function, and patient demands. Metal clips are reported to cause wear on the bars or ball attachments.[3] As an alternative, nylon clips are used to support the overdentures; they can be readily replaced, can provide sufficient retention, and can protect bars and attachments from wear.[17] Manufacturers provide different attachments with different retentive values.

Many studies of denture cleaning and the effect of denture cleansing agents on attachments have focused on Hader bars and clips or Locator attachments.[2,10,17] Few studies have compared the effect of denture cleansing solutions on the retention of different attachments. The purpose of this study was to evaluate the effects of different denture cleansing solutions on attachments with varying retention. The hypothesis was that different cleansing solutions would have different effects on attachments with different levels of retention.

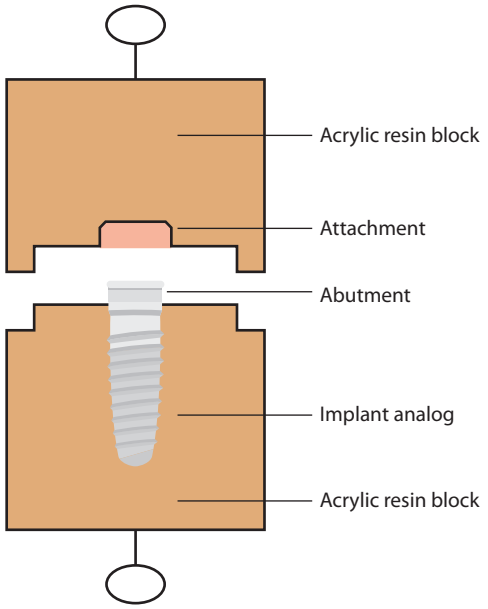

Figure 1. Test assembly.

MATERIAL AND METHODS

An implant analog (BEGO Implant Systems) with a diameter of 4.1 mm was placed inside a 2×2×3 cm plastic box. The analog's parallel alignment was established with a computer-aided design and computer-aided manufacturing fabricated holder. A baseplate wax (Setup Wax; Cavex) was melted and poured into the box, leaving the implant collar 2 mm above the wax surface.[2,10,18] After the wax cooled, the plastic box was opened, and a loop for the pull-out test was inserted inside the block. The wax pattern was invested in a flask with Type III dental stone (Durguix; Protechno). The flask was placed in a boil-out tank for 5 minutes to melt and remove the wax, then left to cool down. A heat-polymerized acrylic resin (Meliodent Heat Cure; Heraeus Kulzer Inc) was prepared following the manufacturer's instructions and placed into the flask, which was left under pressure at 10 MPa. The acrylic resin was polymerized at 100°C for 40 minutes and then finish polished. Two 2×2×2 mm notches were prepared to verify complete seating of the top block to be prepared. The top block was fabricated from wax and evaluated for proper closure on the bottom block, and all procedures were repeated. After the acrylic resin blocks containing the analog and housing were finished, an abutment (Locator; Zest Anchors) was placed onto the analog (Fig. 1).

Seven specimens of clear (2268 g), pink (1361 g), and blue (680 g) attachments (Locator; Zest anchors) (Table 1) were soaked in denture cleansing solutions

Table 1. Attachments tested

Attachment Type	Manufacturer	Lot No.	n	No. of Pulls
Blue	Zest Anchors	008908	7	12
Pink	Zest Anchors	008909	7	12
Clear	Zest Anchors	008910	7	12

Table 3. Tests of between-subjects effects

Source	Type III Sum of Squares	*df*	Mean Square	F	*P*
Intercept	612621.528	1	612621.528	1549.973	<.001
Solution (A)	13035.036	3	4345.012	10.993	<.001
Attachment (B)	67955.800	2	33977.900	85.966	<.001
A×B	8594.708	6	1432.451	3.624	<.003
Error	28457.762	72	395.247		

P<.05 indicates significant difference.

(n=3) (Table 2). Tap water was used for the control group. The specimens were placed in plastic cages with glass ballast to ensure the immersion of the attachment during the soaking period. The cages were immersed in a beaker (Plasutil) with 250 mL of each solution and prepared according to the manufacturer's instructions for the time equivalent to 6 months.[10] The specimens were placed in freshly prepared solutions on a simulated daily basis. The attachments were rinsed under running tap water for 15 seconds when the solutions were changed.

One abutment was used per attachment group. Abutments were tightened onto the analogs. The attachments were tested for changes in retention on a Universal Testing Machine (LRX; Lloyd Instruments). The testing machine applied a tensile force until the attachment was separated from the abutment. A perpendicular tensile force at a 50 mm/min crosshead speed was applied using a reversible load cell. Each attachment underwent an insertion and removal cycle 12 times. The peak dislodgment values were recorded. After each cycle, the used attachment was removed with an attachment removal instrument (Locator core tool; Zest Anchors), and a new attachment was placed into the metal housing within the acrylic resin cylinder. This procedure was repeated for each attachment. The retention of attachments after 6 months of simulated soaking in denture cleansers was compared among the groups by using a repeated-measures analysis of variance (ANOVA) and the Tukey HSD test (α=.05).

RESULTS

According to the ANOVA results, the attachments were significantly affected by the denture cleansing solutions and attachment types (*P*=.001). Also, the solution and attachment type interactions were significant (*P*=.003) (Table 3). The mean (±SD) retentive values for attachments soaked in water were for pink attachments 27.33 N (±2.21 N), clear 36.71 N (±4.04 N), and blue 22.11 N (±1.23 N). In NaOCl, the retentive values for pink attachments was 29.23 N (±3.33 N), clear 38.34 N (±1.8 N), and blue 10.42 N (±3.57 N). The mean retentive values (±SD) for attachments soaked in Protefix Active Cleanser (PAC) were for pink attachments 27.57 N (±1.63 N), clear 33.64 N (±2.67 N), and blue 13.77 N (±1.49 N). For attachments soaked in Aktident (AKT) the mean retentive values were for pink attachments 25.45 N (±1.51 N), clear 23.5 N (±2.45 N), and blue 7.71 N (±2.2 N).

Table 2. Denture cleansers tested

Cleanser	Manufacturer	Lot No.
Protefix Active Cleanser (PAC) (sodium bicarbonate-sodium perborate)	Queisser Pharma	019123E
Aktident (AKT) (sodium bicarbonate)	Aktif Dis Ticaret	014123
Sodium hypochlorite (NaOCl)	ACE, Procter & Gamble	4112729
Tap water	-	-

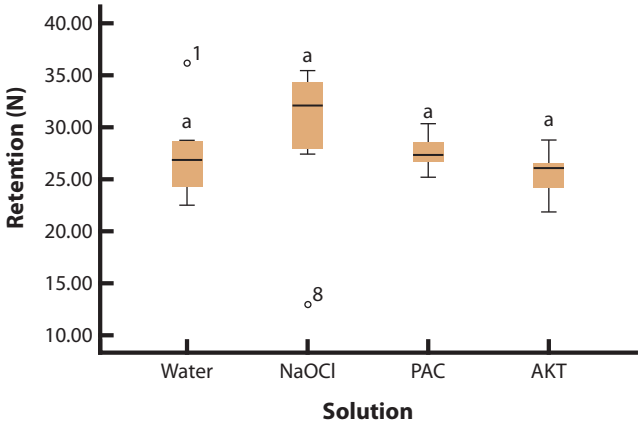

Figure 2. Pink attachments' retention values with different cleansing agents. *Different letters indicate significant differences (*P*<.05).

For the pink attachment, the difference in retention after soaking in 3 solutions was not statistically significant (Fig. 2). Clear attachments were affected by AKT denture cleanser (*P*=.001), and the retention values decreased; the differences between water, NaOCl, and PAC were not statistically significant (Fig. 3). Blue attachments were significantly affected by the NaOCl and AKT cleansing agents and showed decreases in retention values (*P*=.002) (Figs. 4, 5).

DISCUSSION

In this study, 3 types of attachments were evaluated with 3 types of denture cleansing agents. The hypothesis of this study was accepted because different solutions and types of attachments affected the retention values of the attachments used for overdentures.

In previous studies, pink attachments, which have a retention value of 13.34 N, were tested mainly because the market sales were the highest. However, blue attachments, which have a lower retention value (6.67 N)

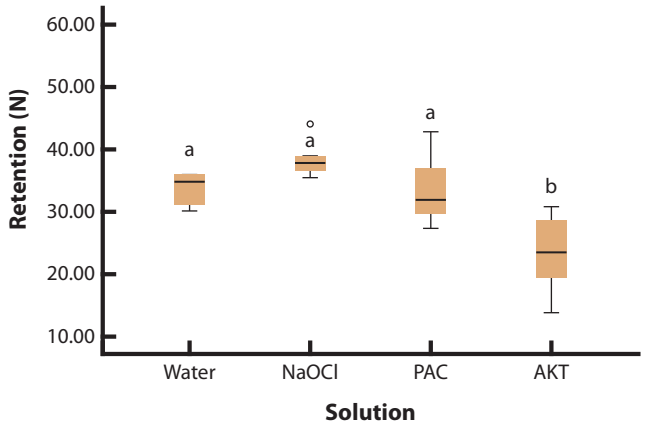

Figure 3. Clear attachments' retention values with different cleansing agents. Different letters indicate significant differences ($P<.05$).

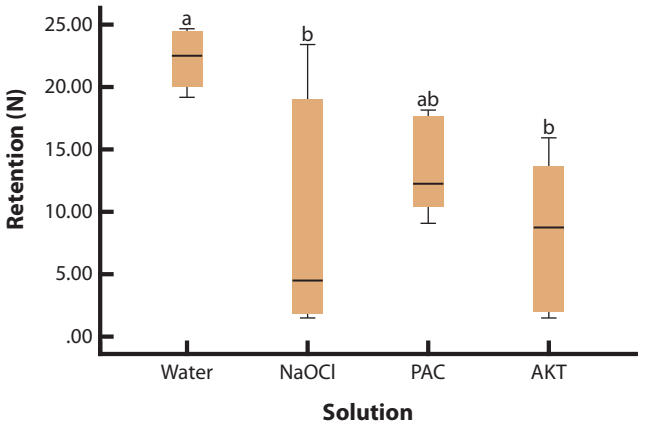

Figure 4. Blue attachments' retention values in different cleansing agents. Different letters indicate significant differences ($P<.05$).

and clear attachments, which have a higher retention value (22.24 N), are also available in the market. The authors of previous studies stated that Locator attachments are made of nylon and that the effect of NaOCl on different nylon attachments would be the same.[2,10] Although all attachments are made of the same material, the composition of material may differ to achieve different elasticity and retention force. As the composition changes, the effect of cleansing solutions on the attachments may change. The present study results showed that blue attachments were affected by the solutions more than the other attachment types and that their retention values decreased, possibly requiring more frequent replacements of these types of attachments. Nguyen et al[9] also reported similar results for blue attachments.

NaOCl, one of the cleaning solutions used in this study, is a powerful disinfectant that is active against microorganisms and is nontoxic to humans in low concentrations. The antimicrobial efficiency of NaOCl occurs by the action of hydroxyl ions and high pH. Effervescent tablets that are used as denture cleansers generally contain sodium perborate and sodium bicarbonate. By dissolving these tablets in water, an alkaline peroxide solution forms, and sodium perborate in the structure decomposes. This peroxide solution mechanically removes debris by releasing oxygen.[6,12] In the present study, the AKT cleansing tablets used contained sodium bicarbonate, and the PAC tablets contained both sodium bicarbonate and sodium perborate.

In the current study, no statistically significant increase in the retentive values of pink and clear attachments were found for NaOCl. However, Varghese et al[14] reported an increase in the retentive value of the Hader Bar with NaOCl immersion. Evtimovska et al[17] reported that NaOCl decreased the retentive values of the attachments. Cornelius et al[18] stated that NaOCl changed the surface morphology of nylon, and porosities and cracks were

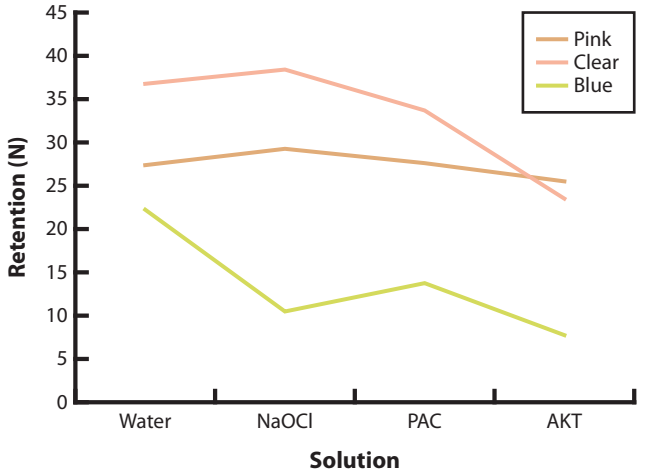

Figure 5. Retention of attachments after being soaked in different solutions.

observed at the scanning electron microscopy level. To our knowledge, no information is available regarding the potential chemical reactions that may occur between tested cleansing agents and attachments. However, a nylon manufacturer (Kelco) claims a deteriorating effect of NaOCl and no effect of sodium bicarbonate on their nylon product. A thorough chemical analysis of the effect of cleansing agents and whether they deteriorate attachments is needed. Physical changes in the abutments and attachments during testing may affect the retention values of attachments. According to previous studies, Locator abutments have decreased retention and are less sensitive to wear after 2000 cycles. Also, wear-induced retention losses are based on the wear of plastic matrices, while metallic matrices are not affected.[18] In the present study, the attachments were used on the abutments only 10 times, which lowers potential attachment and/or abutment wear as a result of repeated use.

In the present study, a crosshead speed of 50 mm/min was used because it approximates the speed of implant

overdenture removal.[2,10,11] Multiple pulls were performed to observe the decrease in retention value after the first pull, while many other researchers preferred 1 pull.[10,16,19] Only 1 analog and 1 attachment was tested at a time. This helped ensure the attachment abutment seating.[2]

An implant analog was used in this study to perform the dislodgement tests. The purpose of the present study was only to test the retention between the female and male parts of attachments. Therefore, the use of an analog-abutment complex instead of an abutment-implant connection may be of the least concern. Future studies where actual implants are used to evaluate the retention of attachments should be performed.

CONCLUSIONS

Within the limitations of this in vitro study, the following can be concluded:

1. Attachments of different colors are affected differently by cleansing agents.
2. The retention of blue attachments decreased significantly with tablets containing sodium bicarbonate and with the NaOCl cleansing agent.
3. The retention of pink attachments was not affected by any test solutions.
4. Using tablets containing sodium bicarbonate (AKT) resulted in significantly lower retentive values for clear attachments ($P<.05$).
5. Tablets containing sodium bicarbonate-sodium perborate (PAC) did not affect the retention of the attachments tested.

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