Detection of the Effects of the Various Denture Cleansing Methods on Overdenture Retentive Attachments with a Scanning Electron Microscope

SUMMARY

Background/Aim: The purpose of this in vitro study was to evaluate the effect of mechanical and chemical denture cleansing methods on dental attachments of varying retention with a scanning electron microscope.

Material and Methods: An implant analog and a male part of a dental attachment were embedded into an acrylic block, and an abutment was screwed onto the analog. Different locator attachments with varying retention were tested using different denture cleansing methods and tap water for a time simulating 12 months of clinical use. A pull-out test was performed for each attachment, followed by analysis of the samples with a scanning electron microscope.

Results: For the blue attachment group, there was no statistically significant difference between the retention values of control and chemical and mechanical denture cleansing groups (p>0.05). The clear and pink attachments were affected by chemical and mechanical denture cleansing, and had significantly decreased retention values compared to the control group (p<0.05). For both types of attachments, the mechanical cleansing group exhibited the lowest retention loss value. Scanning electron microscopy results showed that surface irregularities, scratch lines, and deformations were detected in chemical and mechanical denture cleansing groups for all types of retentive attachments.

Conclusions: Both attachment systems with different retentions were influenced by the denture cleansing method. Considering the results, clinicians could recommend the most appropriate method to patients, one that does not adversely affect the properties of the retainer parts. Clinicians should not advise using mechanical and chemical denture cleansing methods to protect the long-term retention of pink and clear attachments.

Key words: Complete Denture, Dental Hygiene, Dental Implants, Overdenture

Introduction

With advances in oral implantology, dental implants are being used to increase mechanical retention and stability by supporting a removable prosthesis in the presence of a sufficient amount and quality of bone in edentulous jaws. According to the McGill consensus statements, two implant-retained overdentures have satisfactory outcomes, such as increased stability, bone preservation, and improved quality of life for the patient.

Different retainer attachment systems are used for overdentures, including locators, magnets, and clips. Appropriate attachment selection should be made according to the structure of the edentulous bone, the patient's expectations, the necessary retention and function, and ball and magnet attachments. Previous studies concluded that metal clip systems in bar, ball, and magnet holders wear during function. Hence, locator attachments that have a flexible, retentive, and wear-resistant system made by using different values of nylon retentive parts have been recently used.

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Cleaning and long-term care of both conventional and implant-supported prostheses should be provided by the patient. Inflammatory changes and malodor are caused by plaque buildup that occurs without adequate denture cleaning. According to a guide prepared by the American College of Prosthodontists (ACP)(Felton et al., 1991), the oral cavity and prosthesis surfaces must be cleaned daily to maintain oral health well-being.

Dentures can be cleaned using different methods, including mechanical and chemical cleaning, or a combination of both9. Cleaning of prostheses with toothpaste, toothbrush, and ultrasonic cleaners are considered mechanical denture cleansing methods10. The disadvantages of these methods include: use of a toothbrush alone is insufficient and ultrasonic agitation is comparatively expensive for cleaning. The chemical denture cleansing method involves soaking the prosthesis in water or other solutions with an effervescent tablet containing alkali peroxide, sodium sulfate, or sodium bicarbonate10. However, there is not enough information on whether any of the mechanical and chemical methods are more advantageous than the others.

For implant-supported overdenture prostheses, various abutments and attachments are available for use. Many studies in literature have investigated the effect of various chemical denture-cleansing solutions on the retention of different overdenture attachments4,11-14. However, no studies have been conducted on the effect of both mechanical and chemical denture cleansing methods on the retention of locator attachments. Therefore, the purpose of this study was to evaluate the effect of mechanical and chemical denture cleansing methods on overdenture attachments with different retentions. The hypothesis was that different denture cleansing methods would not affect attachments with various retention values.

**Material and Methods**

For the lower and upper parts of the test apparatus, two base plate waxes (Set Up Wax; Cavex) were melted and poured separately into pre-prepared 2 × 2 × 3 cm plastic boxes. An implant analog with dimensions of 4.0 × 11 mm (Astra Implant System) was placed in the lower wax with the implant collar 2 mm above the surface prior to complete cooling of the wax. The parallelism of the placed analog was achieved using a parallelometer. A metal loop was placed on the upper wax surface to perform a pull-out test. The plastic covers were removed and the waxes were embedded in a flask with a Hydrock Type 3 stone (Kerr, Orange, CA, USA). The flasks were filled out with a heat-polymerized acrylic resin (Methylid Heat Cure; Kulzer Inc.) according to the manufacturer’s instructions. Locator abutments (Zest Anchors, Escondido, CA) were screwed into an analog. The male part containing the preloaded black nylon attachment was inserted on top of the female part using autopolymerizing acrylic resin.

Mechanical and chemical denture cleaning methods were applied to seven specimens in each group, including clear, pink, and blue attachments (Locator; Zest Anchors) (n=7). Tap water was used for the control group (C). The denture cleansing groups, their immersion times, and cleaning schedules are shown in Table 1.

**Table 1. Denture-cleansing groups and their immersion time and cleaning schedule**

<table>
<thead>
<tr>
<th>Cleansing-group</th>
<th>Time per day</th>
<th>Total immersion time (12 months)</th>
<th>Lot no</th>
<th>Manufacturer</th>
<th>Group Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aktident Tablet</td>
<td>15 min</td>
<td>540 min</td>
<td>014038</td>
<td>Aktif Dis Ticaret, Istanbul</td>
<td>T</td>
</tr>
<tr>
<td>Aktident Jel</td>
<td>4 min</td>
<td>144 min</td>
<td>8104401</td>
<td>Aktif Dis Ticaret, Istanbul</td>
<td>J</td>
</tr>
<tr>
<td>Tap water</td>
<td>8 h</td>
<td>1140 min</td>
<td></td>
<td></td>
<td>C</td>
</tr>
</tbody>
</table>

The specimens in the chemical denture cleansing group (T) were soaked in an effervescent tablet solution (Aktident, Aktif Dis Ticaret, İstanbul). The denture cleansing solution was freshly prepared each time according to the manufacturer’s recommendations to mimic daily use. In the mechanical denture cleansing group (J), the specimens were cleaned with a moist denture brush (Aktif Dis Ticaret, İstanbul) using one drop of denture cleansing gel (Aktident, Aktif Dis Ticaret, İstanbul) followed by rinsing with tap water.

After an investigation time equivalent to 12 months, a universal testing machine (SHIMADZU AG-X) was used to test the retention alterations of the attachments (Figure 1). Pull-out tests were performed at a crosshead speed of 50 mm/min until the male and female parts were completely separated from each other. This insertion and removal process was repeated 10 times for each insert within the group, and the mean values were recorded. The attachments were inserted and removed using a removal vehicle (LOCATOR core tool; Zest Anchors). After the pull-out test, the specimens were coated with gold and evaluated using a scanning electron microscope (SEM).

Data were analyzed using repeated-measures analysis of variance (SPSS 21.0.) The data of the retentive changes
of each locator attachment according to the denture cleansing methods were analyzed using a one-way ANOVA followed by Tukey’s HSD test; p ≤ 0.05 was regarded as significant.

![Figure 1. Surface changes of the blue, pink and clear retentive attachments in control (C), chemical denture cleansing solution (T) and mechanical denture cleansing solution (J), respectively.](image)

### Results

According to the pull-out test results, it was observed that the attachments were affected differently by denture cleansing methods. The interaction between denture cleansing methods and attachment type was significant. The mean (±SD) retentive values for attachments in the control groups were as follows: clear attachments 30.43 N (±1.11 N), pink 26.22 N (±0.85 N), and blue 22.27 N (±0.73 N). In the chemical denture cleansing group (T), the retentive values were as follows: clear attachments 23.19 N (±0.66 N), pink 20.10 N (±1.10 N), and blue 18.20 N (±0.66 N). The mean retentive values (±SD) for attachments in the mechanical denture cleansing group (J) were as follows: clear attachments 21.10 N (±0.63 N), pink 20.14 N (±0.57 N), and blue 17.17 N (±1.10 N) (Table 2).

<table>
<thead>
<tr>
<th>Type of attachment</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Between Groups</td>
<td>176.048</td>
<td>2</td>
<td>88.024</td>
<td>13.003</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>101.543</td>
<td>15</td>
<td>6.770</td>
<td></td>
</tr>
<tr>
<td>Pink</td>
<td>Between Groups</td>
<td>70.507</td>
<td>2</td>
<td>35.254</td>
<td>10.837</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>48.795</td>
<td>15</td>
<td>3.253</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>Between Groups</td>
<td>12.338</td>
<td>2</td>
<td>6.169</td>
<td>1.404</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>65.906</td>
<td>15</td>
<td>4.394</td>
<td></td>
</tr>
</tbody>
</table>

For the blue attachment group, there was no statistically significant difference between the retention values of the control (C), chemical denture cleansing (T), and mechanical denture cleansing groups (p = .276). The clear and pink attachments were affected by chemical and mechanical denture cleansing, and the retention values were significantly lower than those of the control group (p = .001). For both types of attachments, the mechanical cleansing group (J) presented the lowest retention loss value. Clear attachments were the most affected type in terms of loss of retention in both denture cleansing methods.

According to the SEM images, minor surface irregularities and scratch lines were observed in the control group (tap water) for all types of retentive attachments. In the T group, severe surface roughness, surface laceration, and deformation were detected in the blue, clear, and pink attachments. In the T group, in addition to the severe surface roughness, diffuse denture cleaning gel material adhered to the surface appeared on all types of attachment surfaces (Figure 1).
of different attachments\textsuperscript{4,14,17}. In the present study, the effects of both chemical and mechanical denture cleansing solutions were examined. The results of this study demonstrated that clear and pink attachments were affected by chemical and mechanical denture cleansing, and that the mechanical cleansing group showed less retention loss from the chemical cleansing group. When comparing the clear, blue, and pink attachments, clear attachments were the most affected type in terms of loss of retention in both denture cleansing methods. Retention loss in the blue locator attachment group showed no statistically significant differences between the denture cleansing methods. In contrast with other studies\textsuperscript{4,13}, the results of the present study showed that blue attachments were not affected by the solutions.

A tensile force at a 50 mm/min crosshead speed was applied because patients were found to remove overdentures from their locator attachments at that speed\textsuperscript{4,13,14,17,18}. Evtimovska et al.\textsuperscript{7} in their study presented that a significant loss of retention occurred after the first removal of the locator attachments from the abutments. Thus, in the present study, each attachment was subjected to 10 consecutive pulls. In a study by Kurkcuoglu et al.\textsuperscript{4} each attachment underwent 12 insertion and removal cycles, after which the peak dislodgement values were recorded. The main difference in the present study is that the mean dislodgement values were recorded because the first pull showed the highest value, followed by a decrease after each pull. The other is that, according to the general recommendations of other similar studies, a total immersion time of 12 months was selected for this study\textsuperscript{11,13,14}.

In the literature, chemical denture cleansing methods are varying. Alkaline peroxides, alkaline hypochlorites, diluted acids, disinfectants and enzymes are generally used for chemical cleaning\textsuperscript{10,20}. The use of sodium hypochlorite with different concentration is most effective cleaning method but it has some disadvantages\textsuperscript{31}. Evidence-based guidelines recommended that dentures should not be soaked in Sodium hypochlorite longer than 10 minutes per day to avoid denture damage\textsuperscript{22}. Chlorhexidine is other widely used cleaning agent for dentures. In a study, chlorhexidine gluconate significantly increased the retention of the attachments, the increased retention was thought be due to some texture change on the nylon surfaces and it was concluded that sodium hypochlorite significantly decreased the retention of pink nylon attachment, thus it should not be recommended as a routine denture cleanser\textsuperscript{23}. Denture cleaning tablets which are produced for antimicrobial cleaning of dentures provide efficient cleaning and do not contain any abrasive. In the present study, sodium bicarbonate-containing cleaning agent is used for both mechanical and chemical cleaning. In many studies denture cleaning tablets showed no significant effect on the retention of pink locator\textsuperscript{13,14,23}.

This in vitro study had several limitations. The locator attachments were not tested in clinical conditions. The effects of masticatory cycles and thermal changes may have altered the retention value of attachments during daily use. Therefore, further research considering thermocycling and clinical conditions in this context is required.

Conclusions

The present study showed that both the denture cleansing method solutions reduced the retentive ability of clear, pink, and blue attachments, and adversely affected the surface structure at 12 simulated months; the blue attachments were least affected by both denture cleansing methods in terms of retention loss. The mechanical denture cleansing method showed insignificantly lower retentive values than the chemical denture cleansing method for all types of attachments. The chemical and mechanical denture cleansing method should not be recommended for routine cleansing locator-retained overdentures.

References


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