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The Change in Retentive Values of Locator Attachments and Hader Clips over Time

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Abstract

Purpose: The aim of this study was to examine early changes in retentive values of implant overdenture attachments during multiple pulls.
Materials and Methods: Two implant attachment systems (Hader bar and clip, Locator system) were used in this study. The experimental groups were divided into yellow Hader clips, white Locator attachments, and green Locator attachments. Each group consisted of 21 matrix attachments. The attachments were placed into a custom-made acrylic resin block seated passively on another acrylic block containing a Hader bar or two Locator abutments with different angulations. Each attachment was subjected to 20 consecutive pulls using a universal testing machine. The peak load-to-dislodgement of the attachments after each pull was documented, and the percent reduction of the peak load-to-dislodgement was calculated. One-way ANOVA and Tukey's honestly significant difference test were used for data analyses. A $p \leq 0.05$ was considered significant.
Results: There was a significant difference in the percent reduction in peak load-to-dislodgement between the attachments after the first pull ($p = 0.005$) and after the final pull ($p = 0.0001$). The yellow Hader clips exhibited the least percent reduction in peak load-to-dislodgement ($6.50 \pm 3.59\%$) after the first pull, followed by the white Locator attachments ($8.60 \pm 4.42\%$); the green Locator attachments exhibited the greatest reduction ($11.05 \pm 4.94\%$).
Conclusion: The results of this in vitro study demonstrate that retentive values of the Locator attachments are reduced significantly after multiple pulls. Although this reduction might not be noticeable to the patient, it is recommended that the clinician place and remove the overdenture multiple times before delivery.

Similar to natural teeth, dental implants preserve the bone surrounding them and prevent further bone loss.[1-3] The anterior mandibular bone beneath an implant overdenture may resorb as little as 0.5 mm over a 5-year period, and long-term resorption may remain constant at 0.1 mm annually.[4-6] This is much less than the resorption reported for edentulous ridges[7] and very similar to the situation of overdentures supported by natural teeth.[8] The acceptance of mandibular implant-retained overdentures has become so overwhelming that according to the McGill consensus statement on overdentures,[3] a two-implant-supported overdenture should be the treatment of choice for the edentulous mandible.

Many attachments are now available for use in implant-supported overdentures. The choice of attachment is dependent upon the retention required, jaw morphology and anatomy, function, and patient compliance for recall.[9] In addition, the angulation of the implants can be an important factor when choosing attachments. Implants with poor angulation are often splinted with a bar and connected to the overdenture with attachments. An example of such a system is the Hader bar and clips.

In a study that evaluated the effect of simulated function on the retention of the Hader bar-clip retained overdenture, Breeding et al[10] observed that after the initial removal of a single yellow Hader clip from the Hader bar, there was a 30% drop in load-to-dislodgement (retention) from a mean of 2.57 kg to a mean of 1.79 kg for the subsequent removal. The reduction in retention reached a plateau by the 12th removal. The authors

Table 1 Implant overdenture attachments tested

Type of attachment	Number of specimens	Number of pulls	Implant angulation	Manufacturer
Plastic yellow Hader clip	21	20	0°	APM-Sterngold, Attleboro, MA
White Locator attachment	21	20	0°	Zest Anchors, Escondido, CA
Green Locator attachment	21	20	20°	Zest Anchors, Escondido, CA

recommended that yellow Hader clips be placed and removed 12 to 15 times before the actual insertion of the overdenture so that clinicians can evaluate if the retention of the clips is adequate for that patient. Williams et al[11] studied the effect of design, location, and alignment of overdenture attachments on their retentive values. This study had five overdenture attachment designs: (1) four plastic Hader-type clips with EDS bar (Attachments International, San Mateo, CA); (2) two plastic anterior Hader clips with an identical EDS bar; (3) two Hader clips with two posterior ERA attachments (APM-Sterngold, Attelboro, MA); (4) three Zaag attachments on a bar (Zest Anchors, Escondido, CA); and (5) four Zaag attachments without a bar. They demonstrated that an increased number of Hader clips did not have a significant effect on the retention. Further, this study showed that in all five overdenture attachment designs, the lowest retention was recorded when two or four Hader clips were used.

The Locator attachment system (Zest Anchors) is an attachment system that does not use the splinting of implants. This attachment is self-aligning and has dual retention (inner and outer). Its design features the benefits of the minimal height requirement (3.7 mm) and greater cross-section for strength. Locator attachments come in different colors and each has a different retention value. The white attachment has standard retention, the pink has light retention, and the blue has extra-light retention. Additional features are the extended range attachments, which can be used to correct implant angulation up to 20°. These attachments do not have the inner retention feature. They are offered in green, which has standard retention, and red, which has extra-light retention. There is very little information in the literature concerning the Locator attachments. Chung et al[12] compared the retention characteristics of pink and white Locator attachments with the Hader bar and metal clip (APM-Sterngold), Spheroflex ball (Preat Corp., San Mateo, CA), Shiner SR magnet (Preat Corp.), Maxi 2 magnet (Golden Dental Products, Inc., Savannah, GA), Magneidisc 800 magnet (Aichi Steel Corp., Aichi-ken, Japan), and white ERA and gray ERA attachments (APM-Sterngold). The results suggested that the gray ERA showed the highest retention with a peak load-to-dislodgement of 3.59 ± 0.2 kg, followed by the white Locator with a peak load-to-dislodgement of 2.95 ± 0.08 kg.

To date, the change in retention values of the Locator attachments after multiple removals has not been tested. It is also not known whether the Locator attachments exhibit a loss of retentive value after initial placement and removal similar to that reported for the yellow Hader clips.

Materials and methods

This study was conducted in vitro using three sets of acrylic testing blocks, one for each of the groups tested (Table 1). Two implant analogs (3i, Palm Beach Gardens, FL) were embedded 10 mm apart in a 1 × 1 × 2 in^3 block of type III stone (Whip Mix Corp., Louisville, KY) (Fig 1A). The parallelism of the analogs was established using a surveyor (J.M. Ney Co., Bloomfield, CT). UCLA abutments (3i) were screwed into

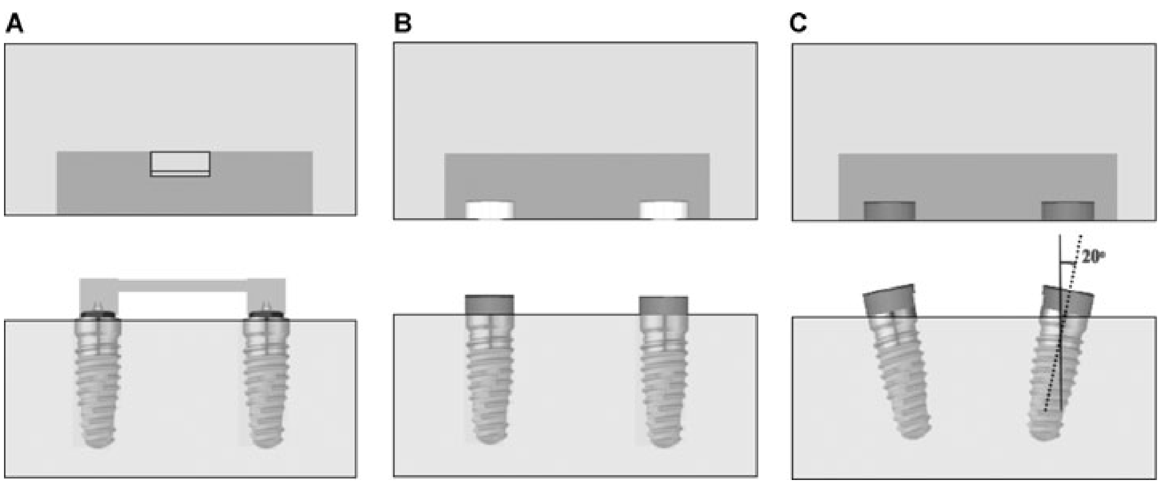

Figure 1 (A) Diagram of assembly used to test yellow Hader clips. (B) Diagram of assembly used to test white Locator attachments. (C) Diagram of assembly used to test green Locator attachments.

the lab analogs with lab screws (3i). A plastic Hader bar pattern (APM-Sterngold) was used to cast a bar in type III Gold (Firmilay, Jelenko, Heraeus Kulzer Inc., Armonk, NY), which connected the two implant analogs.

Tru Wax baseplate wax (Heraeus Kulzer Inc., South Bend, IL) was shaped into a $2 \times 1 \times 1$ in^3 rectangular box. The Hader bar was screwed into the lab analogs (3i) and embedded into the block of baseplate wax (Dentsply, York, PA) while being parallel to the floor (Fig 1A). The alignment was confirmed using a surveyor. The top of the analog was exposed at least 1 to 2 mm above the block of wax. The bar was removed, and a wax guide pin was inserted into each lab analog. On each side of the block of baseplate wax, a rectangular notch was carved. The notch was 4 mm in width and 4 mm in length. The block was invested and processed with heat-processed Clear Jet Acrylic (Lang, Wheeling, IL) according to the manufacturer's instructions. The block was then finished using a model trimmer (Whip Mix Corp.). The final polishing was accomplished using coarse, medium, and fine pumice/water mix and a lathe polishing wheel. The Hader bar was reinserted into the lab analogs and completely blocked out with type II stone, except for the processing clip and the metal housing (APM-Sterngold), which were placed onto the center of the bar. Boxing wax (Heraeus Kulzer, Armonk, NY) was placed around the block of acrylic resin to be used as a matrix for flowing baseplate wax (Dentsply) into it. The assembly was invested, boiled out, packed with clear acrylic resin, heat processed, finished, and polished as described earlier. The two blocks of acrylic resin were used for testing procedures (Fig 1A). The first acrylic resin block had two lab analogs embedded in it, which retained the bar, as well as four notches on each side. The second acrylic resin block had raised areas on each edge to complement the notches in the first acrylic resin block. This aided in the verification of complete passive seating during testing procedures and ensured consistent pulls. The intaglio of the second block also had the metal housing with the clip to be tested. To remove the clip, a bard parker knife with no. 11 blade (Becton Dickinson, Franklin Lakes, NJ) was used to make a cut in the old clip, and a new clip was inserted in its place using the Hader clip tool (APM-Sterngold) throughout 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 procedure. This ensured that the values obtained represented the retentive value of the clip only.

The procedures described above were used to fabricate the white Locator testing blocks with the following modification. During the fabrication of the first block, the Hader bar was omitted and instead, wax guide pins were attached to the lab analogs. The wax guide pins attached to a surveyor were used to check the parallelism of the two analogs, as well as during processing as described above in the fabrication of the acrylic resin block with implant lab analogs and Hader bar. After processing and polishing the first block, two Locator abutments were inserted into the lab analogs and blocked out with type II stone, except for the metal housing, which contained the black processing patrix component. The remainder of the processing of this block was performed as described above. After polishing the second block, the Locator set-up with the white patrix component was ready for the testing procedure (Fig 1B).

The green Locator testing blocks were fabricated as described above with the modification that the analogs were placed at 20° to the vertical axis (Fig 1C). The remainder of the processing of the blocks was as previously described.

Twenty-one specimens each of the yellow Hader clips and white and green Locator attachments were tested for peak load-to-dislodgment on the universal testing machine (Satec Material Testing Equipment, T Series, Scottsdale, AZ). The Satec machine was used at a crosshead speed of 2 in/min.[11] First, the acrylic resin block with the bar embedded into it was clamped down and stabilized to the lower member of the Satec machine. The acrylic resin block with the metal housing embedded in it was clamped to the upper part of the Satec Testing machine. The Satec Testing machine allowed a tensile force to be applied to the testing specimen until the Hader clip/Locator separated from the bar/implants and the peak load-to-dislodgment value was recorded. This testing procedure was repeated 20 times for each Hader clip/Locator set-up (Table 1).

The same procedure was used to test the parallel Locator attachment set-up as well as the 20° divergent one. After each separation of the blocks, the measured peak load-to-dislodgment value was recorded. The first value was labeled as the maximum peak load-to-dislodgment, and the other values were normalized to it by calculating the percent reduction, to standardize the results and to compare the Hader bar and clip with the Locator attachment retentive values.

Using a large effect size, a p of ≤ 0.05, and a sample size of 21, the power equaled 0.80. One-way ANOVA and Tukey honestly significant difference tests were used to test for significant differences. A $p \leq 0.05$ was considered significant.

Results

The load-to-dislodgment behavior of the yellow Hader clips and the white and green Locator attachments over 20 pulls is illustrated in Figure 2A. In general, the peak load-to-dislodgment values declined from beginning to end for the three types of attachments. The green Locator attachments exhibited the highest mean peak load-to-dislodgement (8.25 ± 1.61 kg), followed by the white Locator attachments (7.05 ± 1.66 kg). Hader clips exhibited the lowest mean peak load-to-dislodgement (1.44 ± 0.30 kg). The percent reduction in load-to-dislodgement over 20 pulls was calculated to compare the three types of attachments (Fig 2B). Each point on this graph represents a mean of the peak load-to-dislodgment of 21 specimens. The green Locator attachments consistently exhibited the greatest percent reduction in peak load-to-dislodgement, followed by the white Locator attachments and Hader clips.

There was a significant difference in the mean percent reduction of peak load-to-dislodgement values after the first pull ($F = 5.730$, $p = 0.005$, Fig 3A). Hader clips exhibited the lowest amount of reduction ($6.50 \pm 3.59\%$), which was not significantly different from the amount of reduction for white Locators ($8.60 \pm 4.42\%$). The green Locator attachments exhibited the greatest reduction ($11.05 \pm 4.94\%$), and this was significantly greater than that for the Hader clips, but not the white Locators.

There was a significant difference in the mean percent reduction of peak load-to-dislodgement values of the attachments

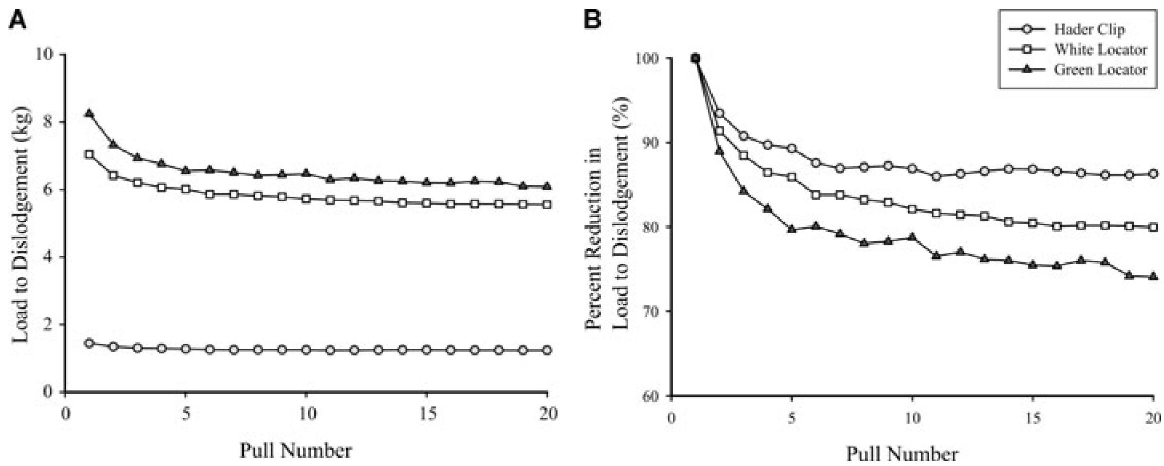

Figure 2 (A) Load-to-dislodgement of attachments over 20 pulls. (B) Percent reduction in load-to-dislodgment over 20 pulls (mean of 21 specimens calculated for each pull).

after the final pull ($F = 16.053$, $p = 0.0001$, Fig 3B). The green Locator attachments exhibited the greatest reduction (25.91 ± 6.65%), but there was no significant difference in the percent reduction of peak load-to-dislodgment between the white Locators (21.07 ± 8.96%) and green Locators after the final pull. Hader clips (13.70 ± 4.89%) exhibited the lowest amount of reduction. The reduction for white and green Locators was significantly greater than that for Hader clips.

Discussion

The retentive values of the yellow Hader clips and the white and green Locator attachments were tested over 20 pulls on a universal testing machine. A crosshead speed of 2 in/min was used, because it is the speed at which patients remove the implant overdenture from the Hader bar.[11] Results showed that there were differences in the peak load-to-dislodgement of the three types of attachments.

In the present study, only one Hader clip was used, and the mean value for the initial tensile removal (1.44 ± 0.30 kg) was lower than that reported by Breeding et al[10] (2.57 ± 0.50 kg). Williams et al[11] showed that the average retentive value for the two Hader clips was 2.30 ± 0.30 kg. Due to the difference in the number of clips used and the differences in experimental design, it is difficult to compare the results of those studies with the present study.

The initial peak load-to-dislodgment recorded for the white Locator attachments (7.05 ± 1.66 kg) was greater than that previously reported by Chung et al[12] (2.95 ± 0.08 kg), or those advertised by the manufacturer for a single white Locator attachment (2.27 kg). Testing conditions, apparatus, and speed of pull are different from those used by Chung et al.[12] The manufacturer does not disclose the method by which the retentive value of the Locator attachments was calculated.

This in vitro study had several limitations. One limitation was the lack of simulation of oral cavity conditions. The presence of saliva and constant occlusal load may affect the rate

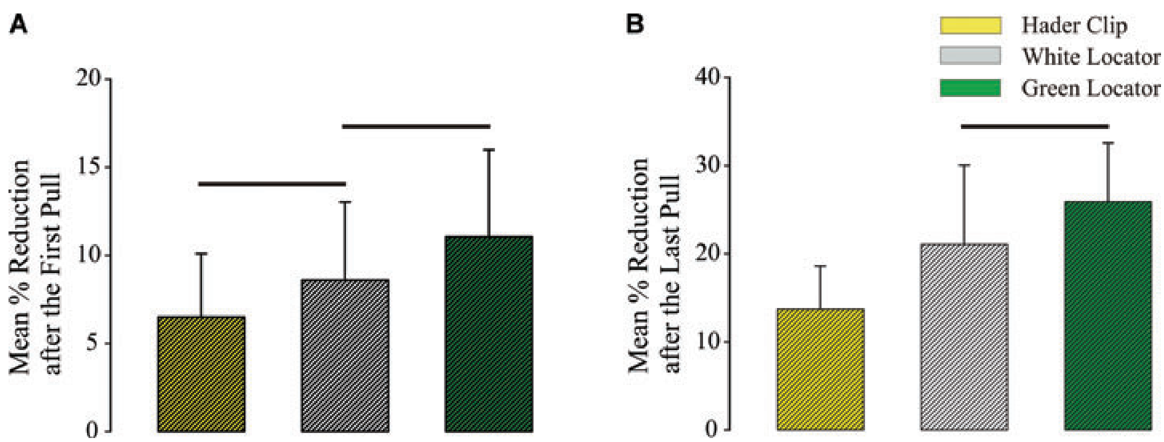

Figure 3 (A) Mean percent reduction in peak load-to-dislodgment after the first pull. In this figure, groups connected with the same bar are not significantly different, $p = 0.005$. Error bars indicate standard deviations. (B) Mean percent reduction in peak load-to-dislodgment after the last pull.

of wear of the attachments. Further, the design of the research model did not simulate a complete overdenture set-up. In the oral cavity, the soft tissues upon which the overdenture rests are resilient. The resiliency of the soft tissue may increase the load on the attachments and therefore can affect their retentive values. The attachments were not tested under simulated function, and thermal cycling was not performed. These are the two factors that may influence the changes in retentive values of the attachments. The present study did not take into consideration the effect that regular cleansing has on the attachments. Varghese et al[13] showed that sodium hypochlorite affects the retentive value of the yellow Hader clips. Further, the variability of the rate at which each individual may remove the prosthesis is probably different each time. Therefore, it would be difficult to simulate such variability in an in vitro study model.

The green Locator attachment, in comparison to the other two attachments used in this study, exhibited the greatest percent reduction in retentive values after the first pull. This was significantly greater than the percent reduction for the Hader clips but not for the white Locator attachments. This observation could be attributed to the implant angulation. It is conceivable that the 20° divergence increased the rate of wear of the green Locator attachments upon removal from the abutments.

Breeding et al[10] showed that after the initial removal of a single Hader clip from the Hader bar there was a significant drop in retention (30% reduction in peak load-to-dislodgement). The results of the present study showed less reduction after the first pull from the bar assembly (6.5 ± 3.59%). The difference in the rate at which the tensile pulls were performed in the Breeding et al study[10] (0.02 in/min) as opposed to this study (2 in/min) could account for this variation in the results. It has been estimated that the actual speed of pull by patients is 2 in/min.[11] Therefore, the present study may simulate the clinical setting more closely.

Breeding et al[10] also showed that after the final removal (15th) of the yellow Hader clips, the reduction in peak load-to-dislodgement was even greater (66%) than that after the initial pull. The percent reduction after the final pull for the yellow Hader clips was much smaller in this study (13.70% ± 4.89). As mentioned in the introduction, it is recommended that the Hader clip-retained overdentures be removed 12 to 15 times to enable the clinician to clinically evaluate the retention of the attachments before delivery to the patient.[10] The results of this study do not support this recommendation.

For the green Locator attachment, the peak load-to-dislodgment dropped about 11% after the first pull, while the white Locator showed a drop of 8.6% after the first pull. These values are not high and are not likely to affect the perception of retention. In the case of Hader clips, their retentive values dropped 6.5% after the first pull. These values are also too small for the patient to perceive any changes in retention.

For the green Locator, the peak load-to-dislodgment dropped from 8.25 ± 1.61 kg after the first pull to 6.08 ± 0.78 kg after the last pull, which represents a reduction of 25.9%. The white Locator showed slightly less reduction—21% (7.05 ± 1.66 kg after the first pull and 5.48 ± 1.04 kg after the last pull). Although this reduction might not be noticeable to the patient, it is recommended that the clinician place and remove the overdenture multiple times before delivery.

Conclusion

The results of this in vitro study demonstrate that Locator attachments have higher retentive values than yellow Hader clips, and they should be used when greater retention is needed. The reduction in retentive values is not as large as previously reported for Hader clips[10] and is relatively small for the Locators. The reduction in peak load-to-dislodgement for the Locator attachments is more apparent when they are used for nonparallel implants. Further research is necessary to examine the long-term behavior of these attachments.

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