

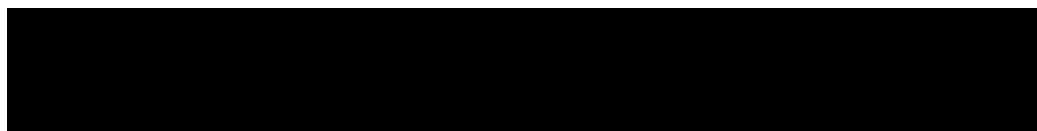
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“Effect of metal framework incorporation and Locator processing technique on initial and long term overdenture retention”

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Effect of metal framework incorporation and Locator processing technique on initial and long term overdenture retention.

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ABSTRACT

Statement of the problem. The indirect technique of processing overdenture Locator housings can cause inaccuracy in their positioning, leading to decreased overdenture retention and more rapid wear of the male retention element.

Purpose. The purpose of this in vitro study was to assess initial overdenture retention and change in retention over three months of simulated use in overdentures fabricated with direct processing of Locator housings, indirect processing without a metal framework, and indirect processing with a metal framework.

Material and Methods. Forty-five overdentures were fabricated from Microfit VR-90 acrylic denture resin. Fifteen overdentures utilized direct processing of Locator housings (Group DP), 15 overdentures utilized indirect processing of Locator housings without a metal framework (Group IP), and 15 overdentures utilized indirect processing of Locator housings with a metal framework (Group M). Samples were then subjected to 270 removal-insertion cycles on a titanium model with 2 locator abutments, simulating 3 months of use, assuming three daily removals and insertions of the overdenture for hygiene purposes. The mean initial work needed to dislodge each group was calculated, followed by calculations of linear regression of change in work needed to dislodge overdentures over 270 cycles. Data were analyzed using the Shapiro-Wilk and ANOVA tests ($\alpha=.05$).

Results. All three groups of overdentures were found to have statistically insignificant differences in initial work required for overdenture removal ($p>.05$). Average initial work required to remove group M was 37.147 J, group DP was 44.581 J, and group IP was 43.175 J. The rate of change in work required to dislodge the overdentures over three months of service was not significantly different amongst the three overdenture groups ($p<.05$).

Conclusions. Incorporation of a metal framework and Locator incorporation technique do not have an effect on initial overdenture retention or rate of wear of the Locator components.

Clinical Implications

Potential effects of different Locator incorporation techniques and prosthetic design on both initial overdenture retention and changes in retention over time could help dentists choose between the indirect and direct techniques for Locator processing. Ultimately, this could improve patient long term success with overdentures and reduce complication rates associated with overdenture loss of retention.

Mandibular dentures often have compromised retention and stability when compared to maxillary dentures. Endosseous implants have allowed for the development of implant-retained overdentures, which is defined as “any removable dental prosthesis that covers and rests on one or more...dental implants.”¹ Compared to conventional dentures, studies have determined that both implant-supported and implant-retained mandibular overdentures provide patients with improved chewing ability, fit and retention, function, and quality of life.² Many authors support the two-implant overdenture as the first choice treatment for the mandibular overdenture.³

There are different attachment systems available for implant-retained overdentures, to include magnetic, telescopic, ball, and stud attachments.⁴ Each of these systems offers its own unique limitations and advantages. Numerous factors can influence system selection, including amount of restorative space, patient features, and provider experience.

The Locator attachment system (Zest Dental Solutions, Carlsbad, CA) is a popular option for implant-retained overdentures. It consists of a low profile titanium abutment that connects to the implant, acting as the matrix component of the system.⁵ With its 3.17 mm height, it is an

excellent option for patients with limited prosthetic space. The second half of this system is a metal housing that is permanently fixed within the intaglio surface of the denture. A nylon retentive patrix fits within the metal housing and engages the matrix within the titanium abutment upon intraoral seating of the denture. The patrix has the added ability to pivot within the housing before fully engaging the abutment, accommodating up to 20 degrees of inter-implant misangulation, but causing more rapid wear of the attachment system.^{6,7} Wear of the nylon retentive component over time is inevitable, however, making it the most common mechanical problem associated with overdentures.⁸ One study found that a two implant overdenture with Locators had retention values reduce from 108.9 to 63.7 N after 500 cycles with 0° implant angulation.⁹ Normal overdenture maintenance is considered to include a maximum of two replacements of the patrix or matrix during the first year and up to five replacements in a 5-year period.¹⁰

Another factor that may accelerate wear of Locator components is positional accuracy of the metal housing in the overdenture. There are two different techniques for processing Locator denture housings into overdentures—direct pickup and indirect processing. The direct pickup method involves intraoral pickup of attachment housings into the denture with autopolymerizing or light-cured acrylic resin after denture fabrication. The indirect processing method requires that the attachment housings be incorporated into the denture during denture base processing. Polymerization shrinkage of acrylic during denture processing may move the Locator housing, thereby reducing the accuracy of positioning. There has been only limited research on the impact of accuracy of different Locator housing processing techniques, however some studies suggest that the direct technique may be superior in terms of soft tissue ulceration, relining sessions, and need for attachment replacement in ball attachment overdentures.¹¹

A technique that may aid in stabilizing Locator housings during processing and increase accuracy of positioning is incorporation of a rigid substructure in the overdenture. Traditionally, reinforcement of overdentures has been utilized to increase fracture resistance and reduce strain on the acrylic.¹² El Ghazali et al reported that metal frameworks reduced the functional deformation of dentures and reduced trauma to the supporting tissue by improving denture tissue adaptation.¹³ Utilizing a metal framework will decrease the volume of acrylic used in denture fabrication, thereby reducing the total volume of polymerization shrinkage that occurs. In theory, this should help counteract the potential impact of polymerizing acrylic to change the position of Locator housings. The effect of metal reinforcement on the movement of Locator housings has not been previously tested in the literature, but offers the potential to improve the accuracy of the indirect processing technique. The purpose of this study is to examine the effect of metal frameworks on the accuracy of indirect processing of Locator housings in an overdenture. The null hypothesis is that metal frameworks has no effect on the accuracy of Locator housing positioning during the indirect processing technique.

MATERIAL AND METHODS

Overdenture Fabrication

A titanium model of an edentulous mandibular arch was fabricated with two recesses indexed for implant analogs with centers 15 mm apart in the mandibular canine regions. Zimmer Biomet 3i Certain 4.1 mm implant analogs (Zimmer Biomet Dental, Palm Beach Gardens, FL) were placed in the recesses in the mandibular model and soldered in place. Biomet 3I Certain 4.1 X 4 mm Locator abutments were seated on both implant analogs and torqued to 20 Ncm (Fig. 1). The titanium model was scanned and an overdenture framework was designed with 3D RDP design

software (3Shape, Copenhagen, Denmark) and 15 identical frameworks were fabricated with Sint-Tech (SINT-TECH Parc Européen d'Entreprises, Rue Richard Wagner 63200 Riom, France) chromium cobalt alloy (Fig. 2).

A total of 45 overdentures were fabricated via compression molding in acrylic denture resin (Microfit VR-90, Vynacron Dental Resins, Inc, Manapalan Township, NJ) according to the manufacturer's instructions. Samples were processed into the following groups: 15 overdentures with a framework and indirect processing of the Locator housings (Group M), 15 overdentures without the framework and with indirect processing of the Locator housings (Group IP), and 15 overdentures without the framework and without Locator housings (Group DP). Group DP had the Locator housings incorporated into the acrylic via the direct pick-up technique after denture processing using Chairside Attachment Processing Material (Zest Dental Solutions, Carlsbad, CA). Locator pink retention male components were placed in each housing.

Overdenture Cycling

A universal testing machine (Instron, Instron Co, Norwood, MA) was used to perform cyclic loading of the overdentures. Overdentures were attached to steel frameworks with screws engaging the metal framework and overdenture bilaterally in the first molar sites (Fig. 3A and 3B). Overdentures were then placed on the titanium model, engaging the Locator abutments. The titanium model was attached to the lower compartment of the universal testing machine while a clamp was used to attach the steel framework in the overdenture to the universal testing machine (Fig. 4). The head of the universal testing machine was set at a constant crosshead speed of 50 mm/min and each overdenture was subjected to 10 removal-insertion cycles, then 250 cycles, followed by a final 10 cycles. Data for dislodgement force at distances of denture dislodgement

were recorded by the Instron. Work for each of the 270 cycles of overdenture removal-insertion was calculated for each overdenture using $W = F \cdot D$. The mean initial work for dislodgement of each overdenture was calculated as the average work for the ten initial dislodgement cycles.

The work required for dislodgement was used to assess retention of the prosthesis for each cycle of removal and seating. Microsoft Excel (Microsoft Corp, Redmond, WA) was used for statistical analysis, and the Shapiro-Wilk test was used to determine distribution normality. The work for each cycle of overdenture dislodgement was assessed with linear regression of energy needed to dislodge each overdenture through 270 cycles. The ANOVA test was used to compare initial work for overdenture dislodgement amongst overdenture groups ($\alpha = .05$). The ANOVA test was also used to compare the change in rate of work required for overdenture dislodgement over 270 insertion-removal cycles ($\alpha = .05$).

RESULTS

The average initial work for overdenture dislodgment was calculated by averaging the first 10 cycles (Table 1). The group of overdentures with Locator attachments incorporated directly (Group DP) had the highest initial retention at 44.6 J, followed by Group IP and Group M at 43.2 J and 37.1 J, respectively. ANOVA statistical testing (Table 2), however, revealed no significant difference amongst the initial work for dislodgement of the three overdenture groups ($F(2,42) = 1.56$, $p = 0.222$). After 270 insertion-removal cycles, the work for overdenture dislodgement showed minor changes in each group. One sample in each of the three groups was removed due to being an outlier. The average work for overdenture dislodgement slightly increased for groups DP and M, while for group IP there was a slight decrease (Table 3). Overall, however, the rate of

change in work over time was not statistically significant amongst the three groups ($F(2,36) = 0.617, p = 0.545$, Table 4).

DISCUSSION

The impact of the presence of a metal framework on movement of Locator housings during indirect processing and long term retention of overdentures has not yet been reported. This study examined the differences in initial load to dislodgement of overdentures and the change in energy needed for dislodgement over 3 months of cycling (270 insertion-removals) amongst the following overdenture groups—(1) Locator housings incorporated post-processing, (2) Locator housings incorporated indirectly during processing with a metal framework, and (3) Locator housings incorporated indirectly during processing without a metal framework.

Attachment retention loss is the most common complication of implant overdentures.¹⁴ Movement of the Locator housings during incorporation into the overdenture acrylic can cause slight positional discrepancies that can lead to more rapid wear of the retentive nylon components. Clinically, this can result in decreased patient satisfaction, increased cost, and increased prosthesis maintenance.¹⁵

The work required to dislodge overdentures from the implant model was used to quantify overdenture retention. Ultimately, no significant difference was found in the initial retention of the three different overdenture groups. This indicates that neither inclusion of a metal framework in the prosthetic design nor the technique used to process Locator housings into the overdenture did not impact initial overdenture retention. This contradicts the premise that having less volume of acrylic to incorporate the retention housings will lead to more accuracy in its positioning and, therefore, increased retention. Furthermore, all three overdenture groups had only small changes

in retention after cycling, with the IP and M groups even showing slight increases in the rate of change in work required for overdenture dislodgement. This is in agreement with previous studies that showed an initial increase in retention.^{16, 17} Kobayashi et al¹⁷ found Locator attachments did not show a decrease in retention below baseline until after 1000 cycles of dislodgement. In the present study all three groups had no significant differences in the rate of change in retention after the simulated insertion-removal cycles. Because the results showed that neither the processing technique nor the presence of a metal framework had an effect on both the initial and final retentiveness of Locator-retained implant overdentures, the null hypothesis was accepted.

There were several limitations in this study. First of all, this study only evaluated overdenture retention over 270 insertion-removal cycles, replicating 3 months of overdenture use. This length of use may have been insufficient to cause significant wear of the overdenture retentive components. As previously discussed, more significant data could have been attained with more insertion-removal cycles. Future studies with longer duration of cycling may better assess differences in rate of change in overdenture retention associated with incorporation of a metal framework and Locator housing processing technique. A second limitation of this study was the use of a solid titanium model for the insertion-removal data collection. Although it provided repeatability in sample fabrication, it failed to accurately represent the intraoral conditions of resilient soft tissues, especially at the distal extensions of the denture base. Incorporating resiliency in the test model could have increased the rate of wear of the attachment system, and therefore provide more significant data, even at the low insertion-removal cycles chosen for this study.

CONCLUSIONS

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

1. Incorporation techniques for Locator housings, either direct or indirect, does not affect initial overdenture retention or rate of wear of Locator retentive components over 3 months of wear.
2. Incorporation of a metal framework into overdentures with direct processing of Locator housings does not affect initial overdenture retention or rate of wear of Locator retentive components over 3 months of wear, compared to overdentures with direct processing without a metal framework.

Disclaimer:

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Tables

Table 1: Mean \pm SD initial work for dislodgement of overdenture groups

Overdenture Group	Mean Work (J)
M	37.1 \pm 11.3
IP	43.2 \pm 15.2
DP	44.6 \pm 9.5

Table 2: ANOVA results for initial work for dislodgement of overdenture groups

Source	<i>df</i>	Mean Square	<i>F</i>	<i>P</i>
Between groups	2	233.95	1.56	0.222
Within groups	42	149.81		

Table 3: Mean \pm SD rate of change in work for overdenture dislodgment through 270 overdenture insertion-removal cycles

Overdenture Group	Mean Work (J)
M	0.0137 \pm 0.016
IP	-0.0004 \pm 0.021
DP	0.0730 \pm 0.039

Table 4: ANOVA results for rate of change in work for overdenture dislodgment through 270 overdenture insertion-removal cycles

Source	<i>df</i>	Mean Square	<i>F</i>	<i>P</i>
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Between groups	2	0.0198	0.617	0.545
Within groups	36	0.0320		

Figures

Fig. 1 Titanium Model of Mandibular Arch



Fig. 2 Chromium Cobalt Alloy Framework



Fig. 3A Overdenture Attached to Steel Framework

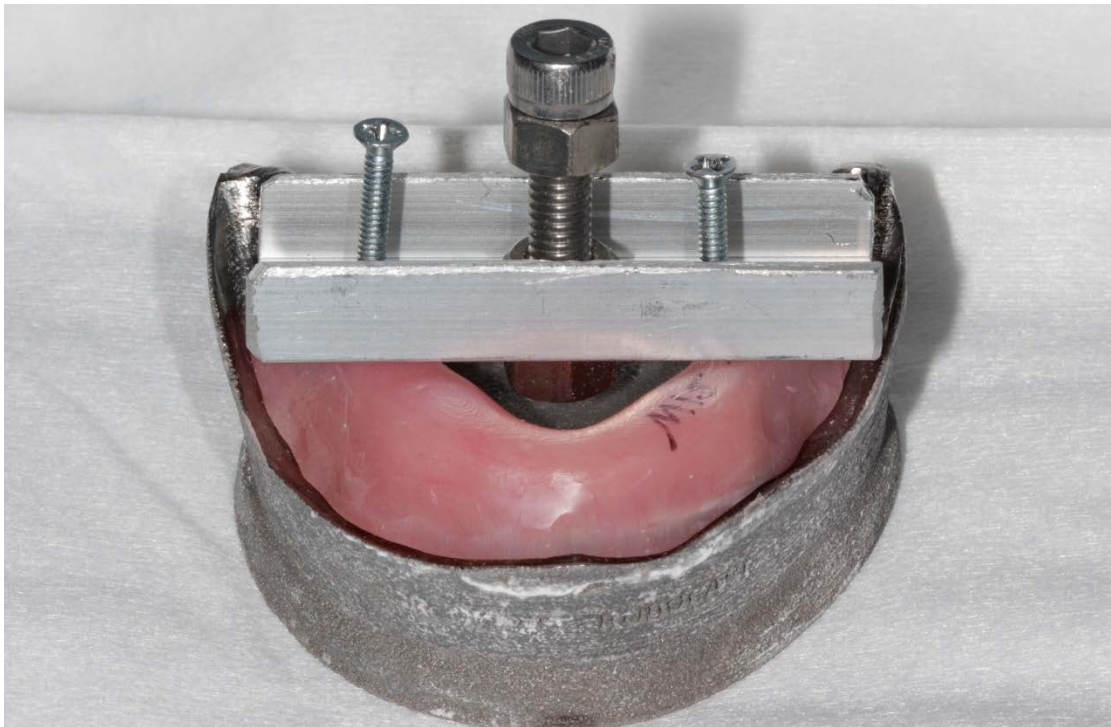


Fig. 3B Overdenture Attached to Steel Framework

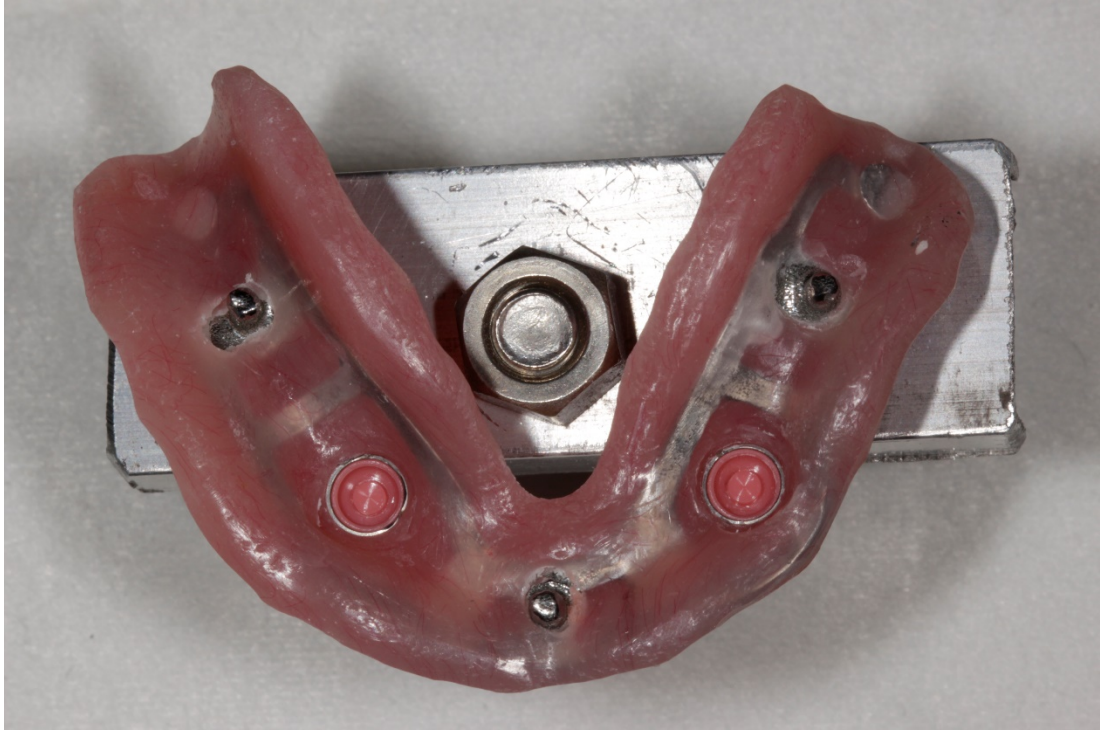


Fig. 4 Instron, Universal Testing Machine



