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RESEARCH ARTICLE

Effect of Accelerating Aging on Retention and the Release Period of Clips in a Bar Retained Maxillary Implant Overdenture

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ABSTRACT
Objectives: This study was made to detect the effect of accelerating aging on retention and measuring the release period of clips in a 2 and 3 bar retained maxillary implant overdenture. **Materials and Methods:** Four implants were placed in two maxillary edentulous epoxy models. One model had two bar attachments with two clips overdenture while the other model had three bar attachments with three clips in the overdenture. Retention and release period of the clips were checked before applying insertion removal cycles. Retention was measured using universal testing machine after 540 cycles (6 months) and 1080 cycles (1 year) of insertion removal on a chewing simulator. **Results and Conclusions:** There was a significant difference in retention and release period between two bars and three bars implant retained maxillary overdentures. A significant difference was also seen in each group after accelerated aging. Therefore, the three bar implant retained overdenture had higher retention values than two bar. Retention loss occurred in both groups after the insertion removal cycles. Release period value was lower in two bar overdenture than three bar overdenture.

KEYWORDS: Bar Attachment; Clips; Retention; Release Period; Implant.

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INTRODUCTION

Implants in the maxillary arch are distributed according to the size, curvature and shape of the ridges which may influence their survival due to forces acting on the prosthesis in the maxilla[1]. In Slot et al.[2] the best design observed for about a one year period for the maxillary overdenture is four implants with equal distance, and in case of compromised bone six implants were recommended. Implants that are splinted by a bar attachment are even more acceptable as they provide load distribution by sharing the occlusal load between the implants[3].

When anterior maxillary implants are connected when there is a sagittal discrepancy of the maxillo-mandibular relation, the connecting bar engages the palatal space and leads to problems during speech [4,5]. Therefore placement of two separate bars are recommended for such anatomical situations. Meanwhile, in bar retained implant maxillary overdenture absence of anterior bar provides a better anterior aesthetics and better oral hygiene of the patient [6].

Removal of the palate in a complete maxillary denture will jeopardize the denture retention therefore dental implants with attachments can be used to improve the retention. [7, 8].Retention is one of the most important principles in removable prosthodontics[9]. During insertion and removal of removable dentures and during minimal movement under functional load, wear of materials at the attachment surface occurs as a result of friction between the female and male elements, which leads to decrease in retention [10]. A parameter that has an obvious clinical implication in the retention and stability of the prosthesis during function is the release period, which is the time required for the attachment system to lose retention or disengage from the abutment during forced separation. Under excessive loads, an attachment system that readily disengages may protect the implants and the bone–implant inter face from potentially harmful forces. Thus, the release period acts as a safety mechanism for the attachment [11].

It has been proven that as the number of attachment increases, so does the retention. Breeding et al.[10] demonstrated a higher retentive value for two clips than for one clip in a direct vertical pull test of clips from a single bar unit. While in Savabi et al.[12] and William et al.[13] study, increased numbers of Hader clips did not significantly increase retention. It is noteworthy that in all research mentioned, the testing methods were extremely simple when compared to the intraoral conditions. However, few studies are available concerning the retention of maxillary implant assisted overdenture using bar clip attachment system.

Documents showing the retention of maxillary implant overdenture with bar attachments can be affected by simulated function are lacking in review. The aim of this study was to detect the effect of accelerating aging on retention and the release period of clips, in a two bar and three bar retained maxillary implant overdenture. The null hypothesis is that there will be no change in retention after accelerating aging and there will be no difference in release period between the two and three bar retained maxillary overdenture.

MATERIALS AND METHODS

This study was a comparative laboratory study, in which two epoxy resin (Ramsis medical products factory, Alex, Egypt) completely edentulous maxillary models covered by a 2mm resilient material resembling the oral mucosa were used. **(Fig 1)** Virtual setting of the teeth was made to determine the location of the canine and 2nd premolar. A clear acrylic guiding stent for implant placement was fabricated. A 3.8 mm twist drill attached to a vertical milling machine (Milling and Drilling machine, RF-Sakkary,Taiwan) was used to drill four vertical holes in the model using the guiding stent, through the cingulum of canine and mid fossa of 2nd premolar bilaterally.**(Fig 2)** The drilling for implant sites were done by using the manufacturer drills starting with the pilot drill and ending with the final drill. Four dummy implants (Dentium Co,Seaul,Korea) 4mm x 10mm were placed in each model with a hand wrench so that the top margins of the implant fixtures were 2 mm below the resilient material. **(Fig 3)** Plastic abutments were connected to each dummy implant and attached to a readymade plastic bar (Bredent VSP-gs bar,Germany) according to the following steps:

Group I: two bars were used bilaterally, each bar connecting from canine to second premolar abutments. (**Fig 4a)**

Group II: three bars were used, one bar between the two canines and two bilateral bars each connecting from canine to second premolar abutments**. (Fig 4b)**.

Figure 1: Maxillary completely edentulous epoxy casts

Figure 2: Guiding Stent with Holes

Figure 3: Implants Placed in Epoxy Maxillary Cast

Figure 4a: 2 bars attached to plastic abutments

Figure 4b: 3 bars attached to plastic abutments

Bar attachments

The distance between two plastic abutments was measured and a plastic bar was cut into appropriate length using a thin diamond disc. A mandrel and surveyor were used to place the bar into position, 1 mm above the ridge.

The bar was attached on both sides to the plastic abutments using a resin luting agent. Wax was placed beneath the bar to avoid losing the space needed. The framework was reinforced by adding resin around the plastic abutments along with the bar peripheries and the

plastic abutments were reduced in height. Sprues were attached to the bar, then the framework was unscrewed. Investment, burn out, casting to Co-Cr, and finishing and polishing procedures were then carried out on the framework.

Metal housing

The metal superstructure was screwed to the implants on the epoxy cast and a clip (vsp-gs) was seated at the center of each bar. Tinfoil was placed around the metal superstructure to block out any undercuts. The metal superstructure and the clips were covered with a layer of wax. This layer of wax was then sprued and casted to cobalt chromium alloy to perform the metal housing. Clips were then placed into the metal housing.

Duplication of the epoxy cast with metal housing was made and poured into stone. On this model, an acrylic palateless denture base was made, the teeth were set, waxing up was performed, then flasking, curing and finally finishing and polishing.

The metal housing with the processing female part (clips) were picked up by the overdenture with auto polymerizing resin**.(Fig. 5)**

Figure 5: Overdentures with Metal Housing

A vertical rod was formed at the point of intersection of an anterior bar (which arise from the midline between two central incisors) and a horizontal bar lying above the molar teeth (right and left) to provide a method of fixation for the overdentures in the chewing simulator.

Measuring procedures

A- Pre-insertion removal cycles

Initial retention measurement

Retention was measured for each overdenture by using a Universal Testing Machine (Model 3345; Instron Industrial Products, Norwood, USA) with a loadcell of 5 kN. The device was subjected to a slowly increasing vertical load (50.8mm/min) until total dislodgment of the overdenture occurs. Three measurements for initial retention were made and the average was calculated. **(Fig. 6)**

Release Period

The computer software of the Universal Testing machine recorded the break and peak load. According to Petropoulos et al.[11] the release period was calculated by:

$$\text{Release Period} = \frac{(\text{break load} - \text{peak load})\ \text{displacement}}{50.8\ \text{mm / minute (constant cross–head speed)}}$$

Break load (tensile stress at maximum load): the force that causes separation of the component.

Peak load (maximum load): maximum force developed prior to separation of the attachment component.

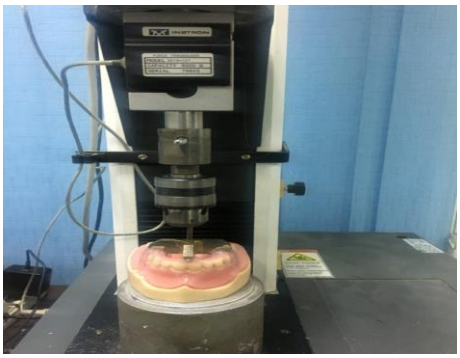

Figure 6: Universal Testing Machine

B-Insertion removal cycles

The overdentures along with their models were fixed into a teflon mold filled with artificial saliva in the chewing simulator, Robota (Model ACH-09075DC-T, AD-TECH Technology CO., LTD., Germany), to perform the insertion removal cycles by assuming three daily removals and insertions of the overdenture for the purpose of hygiene. Two groups were made for each overdenture according to the number of insertion removal cycles: **(Fig.7a,b)**

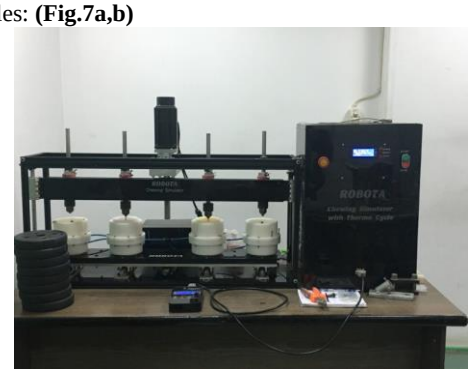

Figure 7a: Chewing Simulator

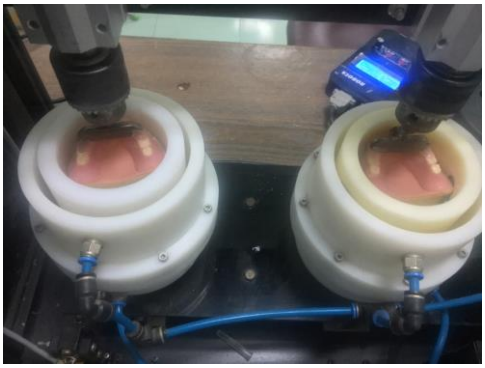

Figure 7b: Models along with their Overdentures Immersed in Artificial Salivae in the Chewing Simulator Machine.

Subgroup A (6 months)- 540 insertion removal cycles

Subgroup B (1 year)-1080 insertion removal cycles

C-Post-insertion removal cycles

After the insertion-removal cycles were applied, retention was re-measured 3 times and the average was calculated. The clips in each denture were then replaced by new ones and the procedure was repeated.

Data was collected tabulated and statistically analyzed with a statistical software package SPSS (statistical package for the social sciences) software version.22 package system using T-test and Anova. P values ≤ 0.05 were considered to be statistically significant in all tests.

RESULTS

A-Release Period

There was a significant difference between group I (2 bar attachment) and group II (3 bar attachment). The three bar attachment has a higher mean and standard deviation than two bar attachment. **(Table 1) (Fig.8).**

B- Retention

Three bar attachments has higher initial, 6 month and 1 year values than two bar attachments. There was a significant difference when comparing the initial and final values of retention in each subgroup individually using t-test. A siginificant difference was also seen when comparing the values of the differences of the four subgroups using Anova. Tukeys test showed a non significant difference between GIA & GIB and also between GIIA & GIIB **(Table 2) (Fig.9).**

Table 1: Comparison of the release period during vertical directed dislodging force for bar attachments of implant supported overdenture.

Release period	Groups		T-Test	
	Group I (2 bars)	Group II (3 bars)	t	P-value
Range	0.176-0.224	0.758-1.025	23.033	<0.001*
Mean ±SD	0.196±0.015	0.866±0.091		

* Statistical significant difference P ≤ 0.05

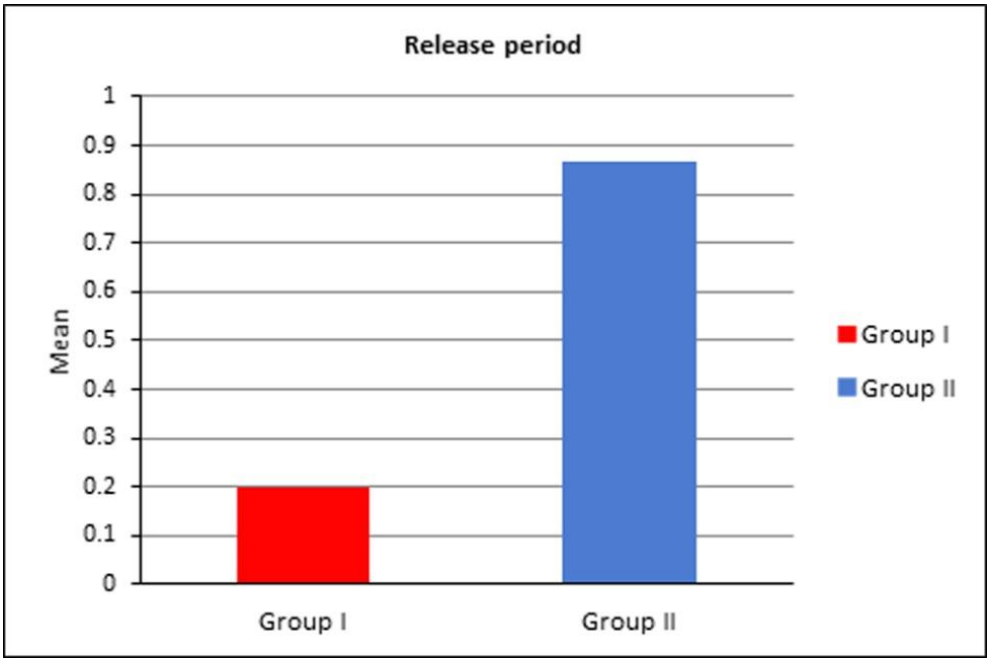

Figure 8: Comparison of Release Period between the groups.

Table 2: Comparison of retentive forces between subgroups using anova, Paired T-test used in each individual group.

Retention							
Subgroups		Initial		Final		Differences	Paired T-test
		Range	Mean ±SD	Range	Mean ±SD		Range
Group IA (2 bars-540 cycles)		15.297-19.645	17.184±1.440	13.268-18.903	15.353±1.707	1.830±1.559	0.005*
Group IB (2 bars-1080 cycles)		14.720-18.719	16.773±1.535	11.590-15.877	13.334±1.269	3.439±2.078	0.001*
Group IIA (3 bars-540 cycles)		29.693-36.423	33.213±1.994	24.626-29.933	27.908±1.483	5.305±3.138	<0.001*
Group IIB (3 bars-1080 cycles)		28.574-35.61	32.546±2.204	22.618-27.651	24.255±1.574	8.290±1.300	<0.001*
Anova	F					16.835	
	P-value					<0.001	
Tukeys test							
		IA&IB	IA&IIA	IA&IIB	IB&IIA	IB&IIB	IIA&IIB
Initial		0.958	<0.001*	<0.001*	<0.001*	<0.001*	0.845
Final		0.025	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*

* Statistical significant difference P ≤ 0.05

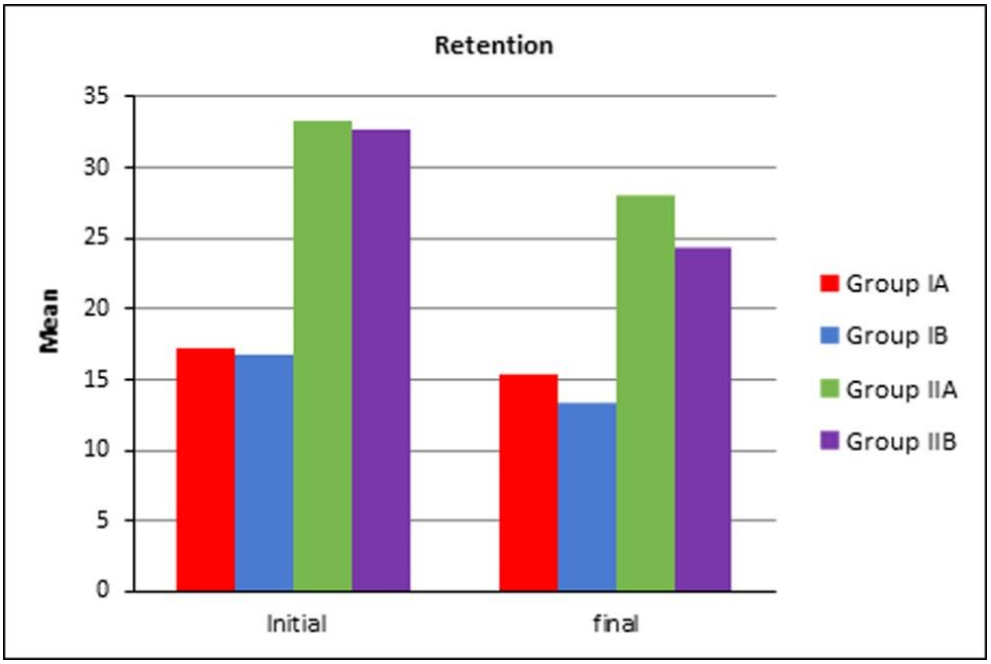

Figure 9: Comparison of Retentive Forces Between Subgroups

DISCUSSION

A significant difference was seen between the release period of Group I (0.196± 0.015 minutes) and Group II (0.866± 0.091 minutes). Group I shows a faster release period than Group II providing less stress on the abutments during dislodging force. The values of the release period at the present study differ from that of Petropoulos et al.[11] who evaluated the release period of Nobel Biocare bar and clip (1.86×10^{-3} minutes). This difference in value may be explained by the fact that different bar and clip material and number were used. In Petropoulos study, one round gold bar attached to two implants was used with a single metal clip that was activated by the operator, while in the current study two types of CoCr round bar designs supported on four implants were used with different number of plastic clips.

Initial retention in Group I shows a range of (14.720-19.645N) while that of Group II shows a range of (28.574-36.423N). Group II has higher retentive force values than Group I, this means that increasing the number of clips increases the retention. This result co-incides with Breeding et al.[10] who demonstrated a higher retentive value for two clips than one clip, while it disagrees with Savabi et al.[12] and William et al.[13] who found no change in retention values when increasing the number of clips. This difference in result may be due to cantilever bar design used in their studies.

Uludag and Polat[14] stated that with bar and clip attachment, bar with two distal locator attachments, and a bar with locator attachments, after 6 months of clinical function, there was a decrease in the retention from the initial testing to the final pull out test. That result was gained also in our current study.

The retentive force provided by an attachment system should be high enough to prevent displacement of the overdenture. According to Lehmann and Arnim[15], attachment retention forces from 5 to 7 N should be sufficient to stabilize overdentures during function. Group I and Group II are categorized as high or medium retention according to the classification of Chung et al.[16], who classified the attachment system into four categories, from high to very low retention.

Initial retention force values of Group II (32.879±2.074) N is similar to the results of, Van Kampen et al.[17],Savabi et al.[12] and Botega et al.[18], who reached high retention values greater than 30N using either plastic or metal clips on bars. Meanwhile Walton and Ruse[19] and William et al.[13], showed lower values of medium retention using metal clips (10.2 to 19.3N) and plastic clips(11.0. 15.6N) similar to the results found in Group I (16.978±1.463)N. Bayer et al.[20] had a low initial retention value of about 7 N using an SFI (stress free instant) bar with POM (polyoxymethylene) and PEEK (polyether ether ketone) clips. It has been reported that difference in values may be due to different diameter and thickness of the clips. Increase in thickness leads to increase in material hardness and decrease in its flexibility. A greater contact area between bar and clip due to increase in diameter, leads to greater friction and retention[18].

However regardless of the high retention values recorded at the beginning of the present study, bar attachments showed decrease in retention over time which is in agreement with Uludag and Polat[14], El Syad et al. [21] and Bayer et al.[20] who measured retention invitro at baseline and after 6 months. Hammas et al.[22] has recorded decrease in retention values from baseline to 3,6,9 and 12 months.

Conversely to the present study, many reports have demonstrated that retention force values can increase or show no change with time instead of decreasing. Setz et al.[23] measured retention values at baseline and after 15,000 cycles for six bars of different manufacturer, he concluded that three bars (Cendreax Metaux, Straumann dolder gold bar with gold clips, and Straumann dolder gold bar with titanium clips) showed increase in retention, two bars (Friatec/IMZ and Nobel biocare)

provided no change in retention and loss of retention was only seen in one bar (Straumann dolder titanium bar with titanium clips) . Increase in retention was also seen in Botega et al.[18] who reported that after 5500 cycles the Conexao and Lifecore Bar-clip there was an increase in retention. It has been suggested that this increase is due to deformation of plastic components that results in their hardening [24]or to an increase in surface roughness after initial usage[23]

In Naert et al.[25] study retention force was measured clinically on a patient at baseline, after 1st year and after 5 years, increase in retention was seen after the first year while decrease in retention occurred after 5 years. Van Kampen et al.[17] was an invivo study in which no significant difference in retention was seen at baseline and after 3 month..

CONCLUSION

Within the limitations of this study, the results showed the following:

- The use of two bar design seems to be safer than three bar design.
- The three bar design had a significantly higher initial retention than the two bar design.

Retention loss occurred in both groups, at 6 months and after 1 year.

DECLARATIONS

Ethics approval and consent to participate

Approval for this research was obtained from the Research Ethics Committee,Faculty of Dentistry,Tanta University. The design and the procedures of the present study were accomplished according to the research guidelines published by the Research Ethics Committee, Faculty of Dentistry, Tanta University.

Consent for publication

Not applicable

Competing Interest

This manuscript has not been previously published in part or full and is not under consideration for publication elsewhere. All authors state that there is no conflict of interest.

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Authors Contribution

All authors read and approved the final manuscript and contributed in this research work.

Conflict of interest

The authors declare that they have no conflict of interest.

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