



Comparative Study of Retention and Wear between Full and Partial Palatal Coverage of Bar Retained Maxillary Implant Overdenture

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Abstract

Objectives: This study was made to compare retention values and detect surface changes of clips in full and partial palatal coverage of bar retained maxillary implant overdenture at initial, 6 month and 1 year after insertion removal cycles.

Materials and Methods: Four implants were placed at the canine and 2nd premolar region in a maxillary edentulous epoxy model using a guiding stent. Three bar attachments along with their metal housing were performed, and the clips were inserted in the metal housing. Partial and full palatal coverage overdenture was prepared, each with 2 metal housing. Retention value and initial photo of the clips were recorded 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 and the clips were observed under the microscope using the scanning electron microscope.

Results and Conclusion: There was an insignificant difference in retention between full and partial palatal coverage of implant retained maxillary overdentures. A significant difference was seen in each group independently as retention decreases over time. No difference was detected between the 2 groups initially, after 6 month, and after 1 year. Surface changes and wear were detected when comparing the 6 month and 1 year photos with the initial.

Keywords: Bar attachment; Clips; Retention; Wear; Implant

Introduction

Palatal coverage may be beneficial to load transfer and reduction of stress to the supporting implants in many situations such as variation of implants width or length, reduced implant number, reduced implant support due to quality of integration, unfavorable implant positions and location. The clinical finding, revealed correlation value of palatal coverage with immediate or progressive protocol of loading. On the other hand, palatal coverage may not be possible or considered appropriate for patients with a hyperactive gag reflex, psychological or emotional problems and the presence of maxillary tori [1].

The reduction of palatal coverage gives more room for the tongue, exposes additional palatal tissue for better appreciation of food texture [2] and provides greater comfort for complete denture wearers. However removal of the palatal coverage reduces the area for tissue support and diminishes the retention of maxillary denture [3,4].

Overdentures without palatal coverage were declared to be less in weight, more comfortable, taste and temperature perception, as well as more effective during phonation, mastication and swallowing [5].

Removal of the palate reduces the chance of candida colonization [6]. Oral candidiasis rate often increases with main local predisposing factors as decreased saliva flow, smoking, mucosal lesions and decrease blood circulation in the mucosa [7,8]. Putting the oral mucosa in continuous contact with the base of the denture reduces the protective effect of the saliva and prevents proper oxygenation of the mucosa, thus creating a proper environment for the yeast to colonize on the acrylic surfaces [9].

Different factors have been proposed as causes for the deterioration of the attachments retention

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such as wear, design, clinical environment, inter implant distance, and implant angulation. However, daily wear, from prosthesis removal and insertion, as well as the oral microbiological environment, could result in a loss of prosthetic component function and consequent failure of the attachment system [10].

Wear is defined as “loss of material from a surface caused by mechanical action or through a combination of chemical and mechanical actions” [11]. Different in vitro studies using Scanning Electron Microscopy (SEM) indicated that attachments systems inevitably undergo wear. These events were reported to occur with attachments systems of varied materials and designs [12].

The wear of components of the attachments was found to be responsible for a decrease in the retention of the attachments, also deterioration, deformation, variations in the extent of wear patterns are seen with different attachment systems [13].

Documents showing retention between palate and palateless maxillary implant overdenture on 2 bar attachments are lacking in review. Therefore the aim of this study was to compare retention and wear between full and partial palatal coverage of bar retained maxillary implant overdenture. The null hypothesis is that there will be no change in retention or in wear between full and partial palatal coverage.

Materials and Methods

This study was a comparative laboratory study, in which a completely edentulous maxillary model (Ramsis medical products factory, Alex, Egypt) was used. The model was made of epoxy resin covered by a 2 mm resilient material resembling the oral mucosa (Figure 1). Dummy Implants (4 mm × 10 mm) were placed at the canine and 2nd premolar region on both sides of each model by using a maxillary denture as a stent (Figure 2, 3). Plastic abutments were fastened to each dummy implant and plastic bars were connected to



Figure 1: Showing maxillary edentulous model.



Figure 2: Showing a guiding stent.



Figure 3: 4 Implants placed at canine and 2nd premolar region.

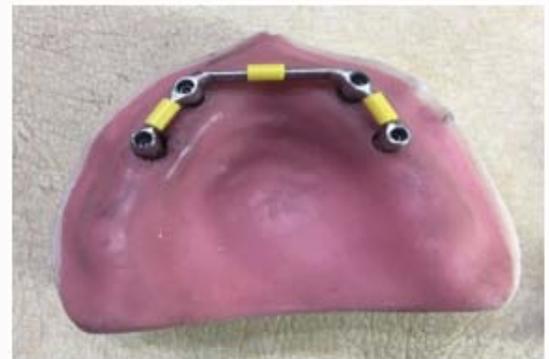


Figure 4: Clips placed on the co-cr bar.

the implants so that 3 bars were available on each model. Each bar was attached to the abutment placed in the canine region at one end and to the 2nd premolar abutment at the other end by using a resin luting agent.

The complexes of plastic abutments and bar attachments were sprued and casted into co-cr alloy (Figure 4). The complexes were polished and screwed back onto the model. Clips were seated at the center of each bar and tinfoil was placed around the bar to block out any undercut. The metal and the clips were covered by a layer of wax. This layer of wax was then sprued and casted to cobalt chromium to perform the metal housing. This step was repeated to obtain 2 metal housing for each overdenture. Clips were then placed into the metal housing.

The epoxy model with metal housing was duplicated and poured into stone. Two dentures were made on the model, palateless acrylic denture base and a denture with palate. Teeth were set and waxing up was performed, and then flasking curing and finally finishing and polishing (Figure 5, 6). The clips and the metal housing were picked up by the overdenture with auto polymerizing resin.

Two bars were made on each overdenture: A horizontal bar lying above the molar teeth and an anterior bar was arising from the midline between the 2 central incisors to determine the center position of the denture. At the point of intersection between these 2 bars (center point) a vertical rod was formed for vertical dislodging of the denture.

Measuring procedures

Study groups (Table 1).

Initial retention for each overdenture was measured by using a Universal Testing Machine with a load cell of 5 KN. The device was



Figure 5: Shows partial palatal coverage overdenture.

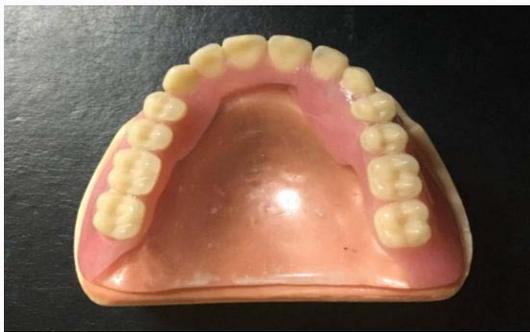


Figure 6: Shows full palatal coverage overdenture.



Figure 7: Denture placed in the scanning electron microscope.

subjected to a slowly increasing vertical load of 50.8 mm/min until total dislodgement of the overdenture occurs. The average was taken for 3 initial measurements.

Using SEM attached with EDX Unit (Energy Dispersive X-ray Analyses) (Model Quanta 250, Field Emission Gun), with accelerating voltage 30 KV, magnification 14x up to 1000000x. Clips placed in the overdenture were examined under the microscope with a magnification of 500x (Figure 7).

The overdentures along with their models were fixed into a Teflon mold filled with artificial saliva in the chewing simulator (Figure 8). 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.

The artificial saliva was prepared at the Faculty of Science, Tanta

Table 1: Study groups.

Groups	Duration	Insertion removal cycles	Number
Full palate	Initial	0	10
	6 month	540	10
	1 year	1080	10
Partial Palate	Initial	0	10
	6 month	540	10
	1 year	1080	10

University according to the following:

- 1.5 mol/L Calcium Chloride (CaCl₂)
- 3.0 mol/L Potassium di Hydrogen Phosphate (KH₂PO₄)
- 20 mol/L Sodium bicarbonate (NAHCO₃)

pH 7.0 at room temperature.

After insertion removal cycle's retention was remeasured and the average was taken. The clips were then re-examined under the scanning electron microscope to detect changes in each clip. 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. 26 package system using independent t-test and ANOVA. P values ≤ 0.05 were considered to be statistically significant in all tests.

Results

Retention

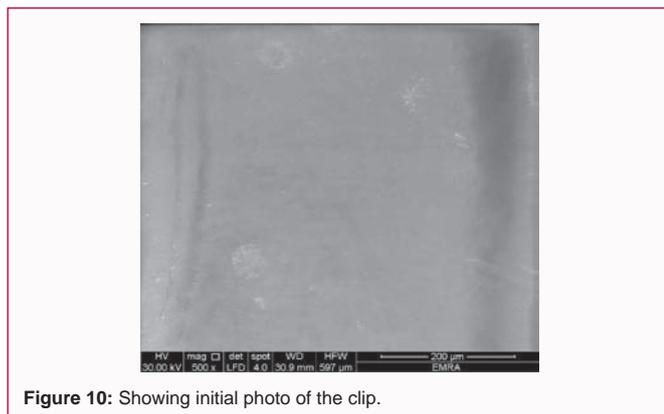
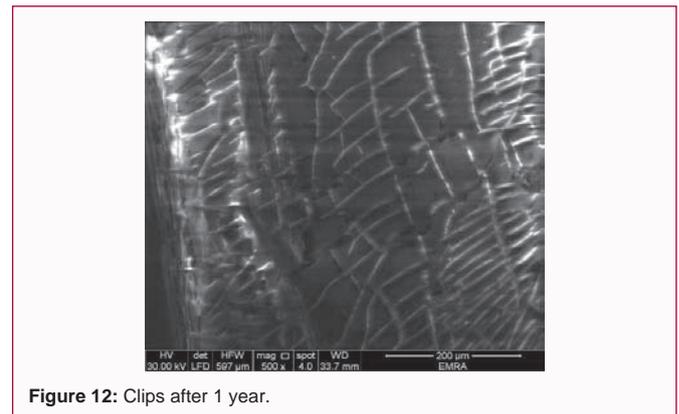
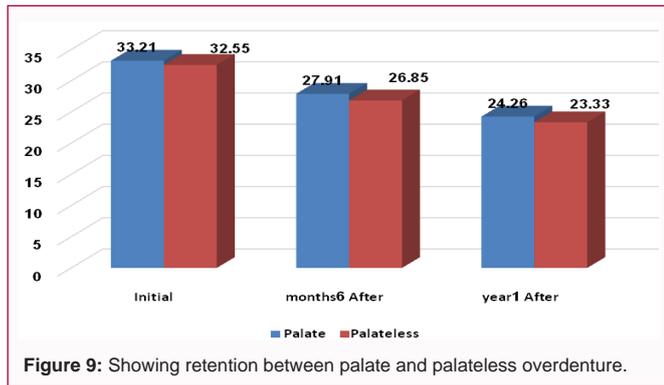
Table 2 shows that there was non-significant difference between the palate and palateless overdenture using independent t test in the initial, 6 month and 1 year values of the 2 different groups. ANOVA



Figure 8: Overdentures and models are placed in a teflon filled with artificial saliva at the chewing simulator.

Table 2: Comparison of retentive forces between palatal and palateless overdentures using independent T-test, and ANOVA was used between the durations in each group individually.

Durations	Palate	Palateless	t	p-value
Initial	33.21 ± 1.99	32.55 ± 2.20	0.704	0.491
6 months	27.91 ± 1.48	26.85 ± 1.87	1.406	0.177
1 year	24.26 ± 1.57	23.33 ± 1.27	1.456	0.163
F	57.02	151.044	-----	
p-value	0.000 ^{**}	0.000 ^{**}	-----	



after 1 year (Figure 12).

Discussion

Epoxy resin maxillary model was used as it has an elastic modulus resembling bone analog material (approximately 20 Gpa) [14]. A silicone soft lining resilient material with a thickness of 1.5 mm to 2 mm was used to simulate masticatory mucosa on all edentulous areas. The silicone material had a nominal elastic modulus on the order of 2 MPa, which is the same order of magnitude as the approximate elastic moduli reported in uniaxial tensile tests of soft tissues [15].

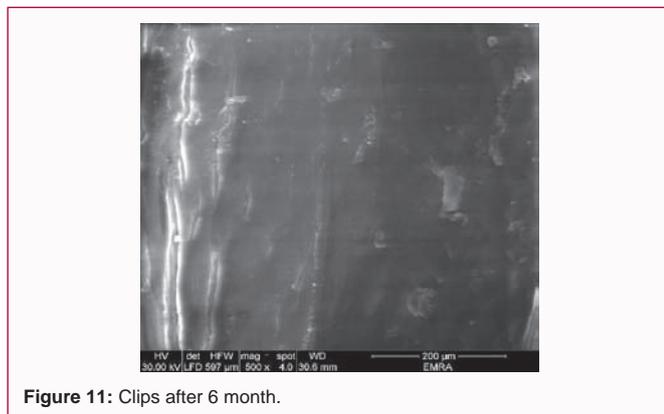
A clear guiding stent fabricated on a model with the ideal set-up was made to ensure proper implant placement at the position of the canine and 2nd premolar on the maxillary edentulous cast [16].

A minimum of four implants is recommended to support maxillary overdentures [17], so four implants were placed at the canine and 2nd premolar region to provide a quadrilateral support compared to linear designs. 3 bars were used as El Naggar D et al. [18] showed that there was a significant difference in retention between the use of 2 and 3 bar retained overdenture.

Retention in Palatal group shows a value of 33.21 ± 1.99 N initially, 27.91 ± 1.48 after 6 month and 24.26 ± 1.57 after 1 year, while that of palateless group shows a value of 32.55 ± 2.20 N initially, 26.85 ± 1.87 after 6 month and 23.33 ± 1.27 after 1 year. The palatal group has higher retentive force values than palateless group. When comparing both groups using independent t test, these values have proved to be insignificant as p value was greater than 0.001. The removal of the palatal coverage reduces physical retention and the area for tissue support thus decreases the retention of the maxillary denture [3,4].

540 cycles of repeated insertion and removal cycles were performed to simulate 6 months of clinical function of the overdenture. This number was estimated assuming three daily removals and insertions of the overdenture for the purpose of hygiene [19]. Under normal circumstances a patient places/removes an overdenture prosthesis 3 times each day, in the morning, after lunch, and after dinner [20]. Based on this assumption, time was calculated by the equation: Days = Number of cycles/3 [21]. That was the way our cycles were calculated in the present study. The attachments included in the current study were tested for loss of retention after being subjected to 540 cycles (6 months) and 1080 cycles (1 year).

In our current study, ANOVA test was used to detect a highly significant difference between the duration (initial, 6 month and 1 year) of the same group as retention decreases with time. This study coincided with the results of Uludag and Polat [19], El Syad et al. [22]



was used between the durations of the same group and there was a highly significant difference between them as P value <0.001 (Figure 9).

Wear

Each clip was observed under the SEM at a magnification of 500x to reveal surface characteristics of the clips before and after the insertion removal cycles. Initial photo (Figure 10) revealed smooth inner surface of the clips.

Minimal surface changes and roughness were seen after 540 cycles (6 months) in the center of the clips, no changes were spotted on the peripheries (Figure 11). Surface irregularities and few cracks were noted when compared to the initial photo (Figure 13).

Numerous oblique, horizontal and vertical scratches (Figure 15) were detected on the clips under the scanning electron microscope after 1080 cycles (1 year). No difference was seen in the clips under the scanning electron microscope between initially, after 6 month and

and Bayer et al. [23] Hammas et al. [24] who measured decrease in retention values over time.

Studies have indicated that attachment systems undergo wear-induced structural changes, leading to a reduction or total loss of their retention. Previous studies indicated that the plastic clips and not the bar were responsible of the decrease in retention [23]. SEM was used in this study to detect structural changes in the clips.

There is a shortage of reports illustrating plastic clips under the SEM initially, 540 cycles and after 1080 cycles. Silva et al. [25] and Walton and Ruse [26] detected the appearance of erosion zones after 5500 cycles using a stereoscope. Saito et al. [27] used an energy dispersive X-ray analyzer to detect the amount of wear debris adhering to the inside of the clip after 7200 removal cycles.

The surface change that was visible on the clips correlate with the changes that happened in retention. After 540 cycles (6 months) few cracks were detected under the SEM in comparison to the initial photo, and the retention of the clips decreased. After 1080 cycles (1 year) more cracks were seen under the SEM and the retention loss that occurred was greater than the 540 cycles (6 months). This indicates that the retention of clips decreases with more cracks and surface irregularities on the inside surface of the clips. El garba et al. [28] has examined the plastic clips using SEM but after immersion in different cleansing solutions with different storage temperatures.

Conclusion

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

- There is insignificant difference between full and partial palatal coverage in a bar retained maxillary overdenture.
- Retention loss occurred in both groups over time.
- Surface changes of the clips were clearly seen under the SEM between the initially, 6 months and 1 year results in both groups.

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