



THE EFFECT OF ULTRA-SUCTION SYSTEM ON THE RETENTION OF MANDIBULAR COMPLETE DENTURE

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ABSTRACT

Aim of the study: To investigate the effect of the ultrasuction system on the retention of mandibular complete dentures. **Material and methods:** This study was conducted on seven completely edentulous patients. Each patient received a maxillary and two mandibular complete dentures, a conventional (set I) and an ultrasuction retained denture (set II). Patients were left to function with each denture set for a period of one month during which they were recalled to test the denture retention at time of denture delivery, one, two and four weeks later. In the retention test a specially designed retention testing device was used to pull the dentures from their geographic centers. The collected records were statistically analyzed using the paired t test. **Results:** The mean retention values for set I dentures were 157.96 ± 29.75 , 165.57 ± 29.21 , 170.77 ± 29.64 and 175.26 ± 29.03 at the baseline and after one, two and four weeks respectively, while for set II dentures the values were 187.80 ± 28.52 , 196.17 ± 29.18 , 201.51 ± 28.82 , 206.93 ± 28.56 at the baseline and after one, two and four weeks, respectively. Statistical analysis of these data revealed a significant increase in the retention after the application of the ultrasuction system and a significant increase in the retention of both sets of dentures by time ($p \leq 0.05$). **Conclusions:** The ultrasuction system increases the retention of mandibular complete dentures. However, further long term prospective clinical studies are recommended to investigate the biological effect of the system on the supporting tissues.

KEYWORDS: Retention, mandibular complete denture, ultrasuction device

INTRODUCTION

Although most patients express satisfaction with their conventional maxillary complete dentures, many struggle with the comfort and function of their mandibular complete dentures^{1,2}. This could be attributed to their smaller denture bearing area, unfavorable distribution of occlusal forces resulting

in increased rate of bone resorption, decreased stability and retention which in turn result in pain and patients' discomfort³. Besides, the seal area in the mandibular denture was not as readily located as in the maxillary denture and showed considerable movement during the ordinary functions of the mouth^{4, 5}.

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The use of endosseous dental implants to assist in the support, stability, and retention of removable prostheses is considered an effective treatment modality for edentulous patients^{6, 7}. However, there may be situations when it is impossible to provide implants or bone grafts on ground of medical, surgical or costs factors, especially in elderly patients⁸. In such cases a proper understanding, recognition and incorporation of certain mechanical, biological, physical and aiding factors becomes necessary to ensure optimal mandibular complete denture retention⁹.

Recently, a variety of retentive aids have been introduced to improve denture retention, the most common of which includes the use of soft liners and flexible denture bases to engage undercuts, denture adhesives, multiple suction cups and ultrasuction devices.

Denture adhesives merely reduce the amount of lateral movements that occur while dentures are in contact with basal tissues¹⁰. This benefit can mislead a patient into ignoring his or her need for professional help when dentures actually become ill-fitting. Besides, patient's response to the use of these materials is not totally positive because of the grainy or gritty texture of powder, the sensation of semidissolved adhesive materials that escape beneath the denture¹¹, the difficulties encountered in removing the adhesive from the denture and the oral tissues, the accompanying increase in the vertical dimension of occlusion¹² and the cost of the material. Denture adhesive products are frequently regarded as an obstacle to the dentist's ability to evaluate accurately the health of a patient's oral tissues^{13,14} and the true character of denture adaptation¹⁵. Relining of dentures with soft liners is, therefore, preferred over using a denture adhesive¹⁶. Unsealed soft liners, however, showed increased colonization of *Candida* compared with those sealed with an

acrylic varnish, implying that porosity and not the potential nature of soft liners may result in the amplified yeast loads¹⁷.

In an attempt to overcome many of the before mentioned problems suction cups incorporated into the intaglio surface of a denture were resurrected since their late introduction in 1885^{18,19}. Their recent use in patients unable or unwilling to undergo surgery to improve their denture foundation has shown a successful, economic and noninvasive way for enhancing denture retention^{xii}. Because the amount of retention provided by suction cup adhesion is proportionate to the area covered by the denture, mandibular dentures are subjected to a lower magnitude of adhesive retentive forces, a problem better solved by the ultrasuction system. The latter is a patented system that holds maxillary and/or mandibular dentures in place using suction chamber and a mounted valve that comprises a tiny unidirectional device imbedded into the denture base. As the patient bites firmly, the air trapped between the mucosa and the denture is expelled through the device, via two air passages. The lower pressure obtained beneath the denture tends to exert a pull and helps secure the denture against the ridge²⁰. In an attempt to reveal the effect of this system on enhancing the mandibular complete denture retention this study was conducted.

MATERIAL AND METHODS

This study was carried out on seven completely edentulous co-operative patients selected from the Prosthodontic Department, Faculty of Oral and Dental Medicine, Cairo University. The age of the selected patients ranged from 45-65 years and all of them were selected to be free from systemic and oral diseases, especially those that might affect the

retention of the denture as neuromuscular disorders, diabetes mellitus and/ or xerostomia. Their residual ridges were covered by firm healthy mucosa and exhibited no unilateral or bilateral undercuts to eliminate the effect of the latter on the retention and to facilitate the performance of the retention test. Patients also had an Angle class I maxillo-mandibular relationship, normal tongue size and were free from any temporomandibular joint troubles. Before including the selected patients in the study an informed consent was obtained from each one of them because hyperplasia of the soft tissues covering the residual ridges was expected to occur after fitting the ultrasuction system.

For each patient one maxillary and two mandibular complete dentures were constructed, namely set I and II dentures.

1- Set I : It was represented by the conventional mandibular dentures

2- Set II : It was represented by the ultrasuction retained mandibular dentures.

Set I dentures were first delivered to the patients, who were left to function with these dentures for a period of one month during which they were recalled for alleviating any complaint, checking occlusion and testing denture retention. Set II dentures, however, were delivered after a resting period of about two weeks to one month during which the patients were left completely without the dentures. This period allowed for tissue rebound. Patients were then allowed to function with the new set of dentures for the same period as Set I, namely one month.

I- Construction of set I mandibular dentures

This set of dentures was constructed in the conventional way except that the mandibular secondary impression made in rubber base* was boxed and poured in dental stone** three times to obtain three master casts without affecting the accuracy of the poured impression^{21,22}. Boxing was an essential step to preserve the depth and width of the borders which had to be reproduced in set II. On the first two master casts namely cast (a and b) the first and the second set of dentures were processed, whereas the third cast namely cast (c) was used in determining the geographic center of the dentures and in checking that the extension of both sets (I and II) of dentures was not changed or jeopardized by excessive finishing and polishing procedures. Changes in the extension carried out during the delivery visit of set (I) dentures were transferred to cast (c) by an indelible pencil so that they could be reproduced in set (II) dentures.

Since the maxillary cast of each patient was mounted on a semiadjustable articulator*** using a maxillary face bow**** record, a face bow index was obtained after finishing the try in stage of set I dentures to aid in remounting the finished and polished maxillary denture.

II- Construction of set II mandibular dentures

In this set of dentures, the retention was assisted by an ultrasuction system. The latter is supplied in a kit consisting of; two ultra suction valves, a specially designed profiled bar (spacer) used to create a suction chamber at the ridge level, two processing caps, service key and spare diaphragms (*Fig. 1*).

* Monepren (addition silicone rubber), Kettenbach GmbH & Co. KG. Im. Heerfeld7, D-35713 Eschenburg

** Labstone, Miles dental products, Miles Inc., South Bend, USA

*** Hanau model H, Teledyne Buffalo, New York

**** Hanau, engineering company, Inc., Buffalo, New York

The specially designed profile bar was stabilized on the master cast (b) using 2-3 drops of cyanoacrylate (**Fig 2**). It stopped about 1 cm short of the end of the denture. After applying adequate amount of separating medium on both the cast and the bar, a mix of self cured acrylic resin was adapted on the cast to construct the trial denture base. Baseplate wax was then used to form the occlusion rim. The resulting occlusion block was used to record the centric and protrusive relations against the finished maxillary complete denture, which was remounted by the face bow index.

After processing of set II dentures, the bar was removed. Particular attention was given to prevent damage to the walls of the created suction chamber. In the lingual flange at the premolar –first molar area, two cavities were prepared in which the valves were lodged. The graded end of the service key was used to guide the width and depth of the valve (**Fig. 3**).

A processing cap was placed in each valve to protect the core from being filled with the self cured acrylic resin that was used to fix the valves (**Fig. 4**). The processing caps were then removed after polishing. Using a fissure bur (1mm in diameter) a communication channel between the valve and the high point of the suction chamber was created. A plastic diaphragm was placed in each valve and the perforated cover was closed with the key provided.

Once the patient received set II denture, he was instructed to run water through the visible orifices of the suction chamber on a daily basis, otherwise the valves would be blocked and would lose their efficiency.



Fig. (1): The ultrasuction system components: (a) A specially designed profiled bar (b) two ultra suction valves, (c) two processing caps, (d) service key, (e) spare diaphragms.



Fig. (2): The profile bar stabilized on the master cast.



Fig. (3): The service key guiding the width and depth of the cavities prepared at the premolar –first molar area.

III- Determining the geographic center of the lower dentures

When both sets were finished, the dentures were prepared for the retention tests. It has been documented that the measurement of complete denture retention was best attempted by pulling the denture from its geographic center²³. Hence, it was essential to locate this center for both sets of dentures. This procedure was carried out on cast (c) as explained below.

Three lines were drawn on the cast and extended to the cast base to aid in determining the geographic center of the lower denture, point (a) as seen in *fig. 5*. At this point a trough was drilled in the cast base by the aid of a surgical round bur. The bur was then maintained in the trough leaving 20 mm of it projecting from the cast. This was the most appropriate length from which the application of force took place without endangering the upper jaw or being interfered by the tongue. The denture was then placed on cast (c) and was prepared for the retention test as described below.

IV- Preparing the denture for the retention test

Three orthodontic brackets were attached to lingual aspect of the denture, one at its midline and two posteriorly where line (4) (*Fig. 5*) passed through them. Three metallic wires 18 gauge in diameter, as advocated by Burns et al²⁴, were engaged by the three lingual brackets and extended upwards to meet in the geographic center of the denture, which was easily identified by the surgical bur projecting from the cast base. A metallic loop was then used to join the three wires on the top of the bur.

V- Measuring the retention of set I and II lower dentures:

The retention measurement test was performed for each set of dentures at time of insertion, one week, two weeks and one month after delivery. During the retention test each patient was asked to keep his chin firmly on a chin support and to wear the upper denture to prevent palatal injury while pulling off the denture. The test began only after the patient was allowed to bite on his dentures to expel any air trapped beneath the denture base.



Fig. (4) Valves fixed at the premolar –first molar area

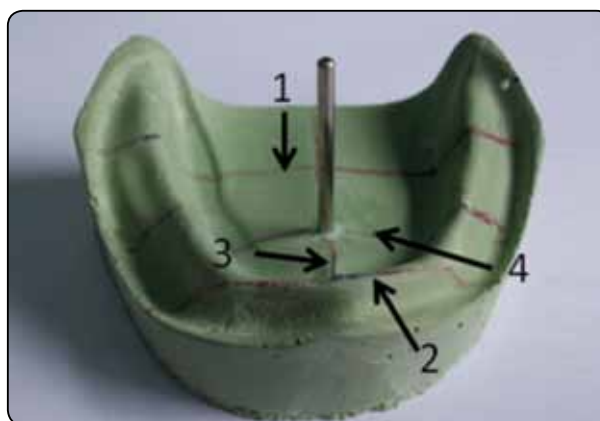


Fig. (5) Lines drawn on the cast to aid in determining the geographic center of the cast; line (1) connecting two points at the apices of the retromolar pads of both sides of the arch, line (2) passing through the crest of the anterior ridge and parallel to the line (1), line (3) passing through the mid line of the cast and perpendicular to both lines (1) and (2), (point a) the midpoint between line (1) and (2) drawn on line (3), line (4) passing through point (a) and running parallel to lines (1) and (2).



Fig. (6): The retention testing device

The retention was measured by a specially designed retention testing device (*Fig. 6*). The device is digital and can apply forces in upward and downward directions. It has a minimum reading of 20 and a maximum reading of 5000 grams with a good to a very good (0.778-0.998) reliability. It consists of a metallic probe connected to a base by an electric wire. The metallic probe constitutes the part of the device that applies the force. The base, on the other hand, has a digital screen which gives positive and negative readings according to the direction of force application. The device applied a vertical pull off load on the metallic loop joining the wires. Values at which the denture was dislodged were recorded.

The pull off procedure was repeated 10 times to obtain 10 records for each, the mean of which was calculated.

VI- Statistical analysis of the results

The recorded mean values were tabulated and statistically analyzed using SPSS 16.0® (Statistical

Package for Scientific Studies) for Windows. Paired t-test was used to compare between the mean retention values obtained for each set of dentures at the different follow up visits and to compare the retention values of both denture sets. Results were considered significant at $p \leq 0.05$.

RESULTS

I- Clinical observations

All patients were satisfied with both sets of dentures. However, they explained that the retention was surely enhanced with the ultrasuction system. Their main complaint of this system seemed to be related to the difficult cleansability of the orifices. By examination it was found that three out of seven patients showed slight hyperplasia of the ridge mucosa after four weeks of inserting set II dentures.

II- Statistical findings

The comparison between the mean retention values of set I and II dentures revealed a statistically significant increase ($p \leq 0.05$) in the retention after the application of the ultrasuction system at all follow up visits (0, 1, 2, 4 weeks) (*Tab. 1*). On the other hand, studying the effect of time on the mean retention values obtained for both sets of dentures (I and II) revealed a statistically significant increase in the retention by time ($p \leq 0.05$) (*Tab. 2*).

® SPSS, Inc., Chicago, IL, USA.

TABLE (1) The effect of the ultrasuction device on the retention of the mandibular denture at time of denture insertion 1, 2 and 4 weeks later

Testing time	Set I			Set II			P-value
	Mean (gram)	SE	SD	Mean (gram)	SE	SD	
Baseline	157.96	11.24	29.75	187.80	10.78	28.52	<0.001*
1 week	165.57	11.04	29.21	196.17	11.03	29.18	<0.001*
2 weeks	170.77	11.20	29.64	201.51	10.89	28.82	<0.001*
4 weeks	175.26	10.97	29.03	206.93	10.80	28.56	<0.001*

* Significant at $P \leq 0.05$

TABLE (2) The changes in retention by time in set I and II dentures

Testing interval	Set I		Set II		P-value
	Mean difference (gram)	SD	Mean difference (gram)	SD	
0-1 week	-7.6	1.5	-8.4	1.8	<0.001*
0-2 weeks	-12.8	1.3	-13.7	1.5	<0.001*
0-4 weeks	-17.3	4	-19.1	1	<0.001*

* Significant at $P \leq 0.05$

DISCUSSION

It is well known that maxillary dentures are retained by interfacial surface tension, good denture base adaptation, border seal and other important physical, mechanical and psychological factors. The same applies for mandibular dentures, but the smaller supporting surface area and the pronounced musculature in the lower jaw, reduce the retentive capacity of these dentures, causing their displace-

ment³. Although the multi-suction cup lined denture, resurrected by Dr. Jermyn in 1963, offered a successful, economic and noninvasive way for enhancing denture retention, they sometimes stand helpless in overcoming problems of reduced supporting surface area as in mandibular dentures. In these situations ultrasuction denture appear to offer a better solution. Their retentive capacity in comparison to conventional mandibular dentures has been positively demonstrated in this study not only

via the patients' comments, but also via the retention test, which showed a significant improvement in the denture retention after the application of the ultrasuction system. Mony Paz, the system inventor, explains that once the patient bites firmly, the valves incorporated in the system allows for expelling the air from beneath the denture base and the gingival tissues penetrate the suction chamber. Simultaneously, the diaphragm prevents the reintroduction of the expelled air. The pressure difference, that is, the lower pressure beneath the denture, exerts a pull and seals off the alveolar ridge periphery, creating better fit and high resistance to denture dislodgement¹². Thus, the increase in the retention of set II dentures could be mainly attributed to the atmospheric pressure effect that has been long time ago documented in dental literature^{25,26}. This effect seems to be only active, if the denture has an effective seal around its border. Unfortunately, the negative pressure effect created by the valves of the system results in hyperplasia of the tissues covering the ridge¹⁹. The system is, therefore, never intended to make up for under-extended or inaccurate impressions. a condition that requires further investigations to evaluate biological long term effect of the system on the health of the tissues.

Statistical analysis also revealed a time dependant increase in the denture retention for both sets, namely set I and II. This could be attributed to the adaptability of the oral mucosa to the new denture regardless of the differences between both sets. Murray and Darvell²⁷ pointed out that muscle control and patient's tolerance often has an amazing influence on the denture retention, because of the adaptability of the oral mucosa and the muscles of the lips, tongue and cheeks as well as patient's tolerance.

CONCLUSIONS

The ultrasuction system increases the retention of mandibular complete dentures. However, further long term prospective clinical studies are recommended to investigate the biological effect of the system on the supporting tissues.

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