



The Effect of Using Ultra Suction System on Mandibular Complete Denture Retention

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ABSTRACT

Aim of the study: This study was carried out to evaluate the effect of using ultra suction system on mandibular complete denture retention and on the rate of growth of candida albicans. **Material and methods:** Ten completely edentulous patients participated in this study. Each patient received two dentures a conventional mandibular denture (**D1** denture) constructed using heat cured acrylic resin and an ultra suction retained denture (**D2** denture) which was constructed using heat cured acrylic resin with ultra suction system added to it. Patients were left to function with each denture set for a period one week, one month, three months respectively during which they were recalled to test denture retention and to make microbiological examination. Retention test was conducted using universal testing machine after pulling the denture from its geographic centre. The collected records were recorded, tabulated and statistically analyzed for each denture using the paired t test. **Results:** The mean retention value for (**D1** denture) were 3.66 ± 1.07 , 3.02 ± 0.82 , 4.07 ± 0.84 , 3.97 ± 0.99 at the baseline and after one week .one month ,three months respectively while for (**D2** denture) values were 8.01 ± 2.80 , 8.35 ± 2.53 , 8.72 ± 2.19 , 7.11 ± 1.70 at the baseline and after one week .one month ,three months respectively. Statistical analysis of these data revealed a significance increase in the retention after application of ultra suction system. The mean values for microbiology test were calculated using Chi square test at the base line and after three months of wearing dentures and after statically analyzing the results, it showed that statistically *non-significant* difference between *conventional (D1)* and *ultra-suction (D2)* denture ($P=0.1286>0.05$).

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INTRODUCTION

Almost one third of edentulous patients have complains with their complete dentures especially with regards to their lower one. The complaints include pain and discomfort which result from decreased stability and retention, this could be attributed to the small mandibular denture bearing area, unfavorable distribution of the occlusal forces resulting in an increased rate of bone resorption besides, the seal area in the mandibular denture which is not as readily located as in the maxillary denture and shows considerable movement during the ordinary functions of the mouth. From the patient's point of view, denture satisfaction appear to be primarily related to aesthetic, retention and function.⁽¹⁾

Recently, a variety of retentive aids have been introduced to improve denture retention, this includes the use of soft liners, denture adhesives, multiple suction cups, and implant supported over denture besides ultrasuction devices.

Denture retention was improved when using soft liners as it works by utilizing bilateral undercuts, and improving the fit of old dentures. As well as, they may act as shock absorbers between the occlusal surface of the denture and the underlying oral tissues and may give good level of distribution of functional load ⁽²⁾ however, as temperature changes under clinical conditions it was found that it may influence the bonding at liner – denture base resin interface, causing the loss of adhesion to the denture base. Besides, the tensile bond strength of silicone liners has been extensively examined and it has been concluded that, water reduces adhesion and causes liner degradation.⁽³⁾

Denture adhesives are efficient following initial placement, as they reduce the amount of lateral movements that occur while dentures are in contact with basal tissues, This benefit can mislead a patient into ignoring his or her need for professional help when dentures actually become ill-fitting, besides that these beneficial effects decrease over time as

a result of breakdown of the adhesives by the oral fluids. The viscosity gradually decreases as the adhesive becomes thinned and the retentive quality gets lost over time.⁽⁴⁾

It was found that the suction cup liner can be applied to both upper and lower dentures, with a maxillary denture containing up to 200 suction cups and the mandibular denture more than 150 ones. The suction cups system is highly useful for edentulous patients with irregular ridge morphology, flat ridges, poor healing, post-infection tissue healing and long-term denture wear.⁽⁵⁾ However on a study based on suction cups dentures, a case report showed that the negative pressure has a destructive effect of on the palatal tissues.^(6,7)

Dental implants was believed to increase retention of complete dentures and assist its support and stability, it is an effective treatment for a lot of edentulous patients. However, a lot of patients cannot undergo an implant surgery due to systemic factors, old age and cost factors in such cases.

An intermediate solution was introduced to solve the previous problems of stability and retention of conventional dental replacements. The ultra suction holds dentures in place using suction chamber and a mounted valve that comprises a tiny unidirectional device imbedded into the denture base. 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 dislodgement.⁽¹⁾

MATERIALS AND METHODS

Ten completely edentulous patients were selected from the Out Patient Clinic Prosthodontic Department, Faculty of Dental Medicine, Al- Azhar University. The patient's age range from 50-60 years and were apparently free from any oral or debilitating

systemic diseases. The residual alveolar ridges of maxilla and mandible were covered by health, firm and compressible mucosa and free from any signs of inflammation or ulceration. Patients were free from any temporomandibular joint TMJ disorders and all patients with angle's class I jaw relation. Patients with dry mouth, excessive salivation or thick saliva were excluded. Patients receiving drugs like corticosteroids or broad-spectrum antibiotics were excluded. Patients with smoking habits were excluded as this is a major predisposing factor for growing of candidal species.

I- Construction of Mandibular Dentures:

This set of dentures was constructed using the conventional method except the mandibular secondary impression was made using rubber base then it was poured in dental stone which was duplicated after hardening to obtain three master casts, on the first two master casts set **D1 and D2** dentures were processed, while the third cast was used in determining the geographic center of the dentures. Boxing was an essential step to preserve the depth and width of the borders which had to be reproduced.

Steps of conventional dentures was completed including jaw relation record block, Acrylic resin teeth of proper shade and size setup, waxed up trial denture bases denture was then processed using heat cured acrylic resin following the conventional procedure.

Steps of D2 Mandibular denture construction:

In this denture, a kit of ultra suction system was used which is consisting of: (**Fig. 1**)

Two ultra suction valves, two processing caps, a specially designed profiled bar (used to create suction chamber along the entire denture at the ridge level), service key and a spare diaphragm.

On the ridge, the location of the space bar was pencil designed making sure that it stopped about 1 cm short from the end of the denture.



Fig. (1) The ultra suction system kit components.

The bar was stabilized on the duplicate of the mandibular master cast using 2-3 drops of cyanoacrylate adhesive.

Adequate amount of separating medium was applied on the cast and the bar.

An acrylic resin mix was adapted on the cast to construct the trial denture base. Base plate wax was then used to form the occlusion rim. The mandibular occlusion block was used to record the centric occluding relation. The record was used to mount the lower cast on the articulator, where the upper finished denture was already mounted by means of the face bow index. After processing, the bar was removed carefully to avoid suction chamber wall damage. At the lingual aspect of the lower premolar-first molar area two cavities were prepared using a round bur (cavities located 1-1.5 mm above the highest point of the retention chamber) in which the valves were lodged.

The graded end of the key was used to guide the width and depth of the valve. A processed cap was placed in each valve to protect the body of the valve from being filled with acrylic resin, then the cap was fixed carefully with self cured acrylic. After polishing the processing cap was removed

Using a fissure bur a communication channel was created between the valve and the high point of the suction chamber. **Figure (2)**



Fig. (2) A communication channel created between the valve and the high point of the suction chamber using a fissure bur

Using a fissure 1 mm an obtuse angle was drilled guided by the transparency of the acrylic. An air source was used to make sure that the air channels are complete and unobstructed. A plastic diaphragm was placed in each valve and the perforated cover was closed with the provided key.

Then the geographic center of the lower denture was determined when both sets were finished, the denture was prepared for the retention test by pulling the denture from its geographic centre. Hence. It was essential to locate the centre for both sets of denture. this procedures was carried out on casts .

Preparing the denture for the retention test:

Modification in the denture was made as following:

Two small metal tubes (3 mm diameters) were placed a few millimeters underneath the premolars in mandibular dentures by self cure acrylic resin. The distance between the right tube and the geometric centre (point a) was almost the same distance as between the left tube and the geometric centre (point a). The exact distance was checked using an orthodontic wire.

Devices used for measuring retention:

Retention was measured by universal Testing Machine (Model LRX-Plus, Lloyd Instruments, Fareham, UK) with a load cell of 5 kN.

The retention device's system is able to storing up to 600 test results from a choice of 10 programmable test set-ups .

It is composed of:

Attachment part: consisted of two metallic arms perpendicular on each other. The vertical one can slide on the horizontal one through a metallic tube. **Chin rest:** It is composed of adjustable rigid metallic rest with a heavy weight base and a vertical arm to help firm support of the chin during measuring the retention besides **the Universal testing machine:** which is a device that allows applying an increasing vertical upward force on the denture.

The test was repeated five times to obtain 5 records, the mean of which was calculated.

Detection and isolation of Candida:

Samples were obtained by rubbing of the fitting surface of the mandibular complete denture for 30 seconds using sterile cotton tipped wooden swab for each patient and was inoculated immediately in sterile glass tube containing 2 ml of sabouraud dextrose broth and was transferred directly for microbiological examination within an hour.

Twenty (20) ml from each tube of sabouraud dextrose broth was plated on sabouraud dextrose agar. The plates were covered and then placed in an incubator for 48 hours at 37°C then the plates were examined under light microscope and then identification and count of *Candida albicans* was done by counting number of *Candida* colonies by counting colony forming units on SDA plates by an automated colony-counting device. *Candida's*

swabs were classified according to the number of colony forming unit to :

- a) Negative (CFU) = 0 – forming units.
- b) Carrier (CFU) < 400 colony – forming units.
- c) Positive (CFU) >400 colony – forming units.

If no colonies were reported after two days of such incubation, culture plates were left on the bench for further 72 hours and then examined again before being discarded as negative.

Samples were treated as previously and the data were collected and tabulated for statistical analysis.

RESULTS

Statistical analysis of the results including the means, mean differences, standard deviations, and T- value were calculated between the different measurements of the three recording methods.

Comparison between mean values of retention of the two mandibular dentures (**D1** and **D2**), showed a statistically significant increase in the retention after application of ultra suction system as revealed on **Table (1)** .On the other hand, studying the effect of time on the mean retention values obtained for both sets of dentures revealed a statistically significant increase in the retention by time **Table (2)**.

Table (1) Retention force results (Mean±SD) for **D1 denture** and **D2 denture** as function of investigation time

Variable		Denture							
		D1				D2			
		Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Investigation time	Baseline	3.66	1.07	2.16	5.66	8.01	2.80	5.42	13.09
	One week	3.02	0.82	1.80	3.81	8.35	2.53	5.88	12.93
	One month	4.07	0.84	2.80	5.42	8.72	2.19	5.65	15.09
	Three months	3.97	0.99	2.80	5.71	7.11	1.70	4.63	9.93

Md= Mean Difference

SDd= Standard deviation difference

Table (2) Comparison of the retention force results (Mean ± SD) as function of investigation time

Variable		Mean	±SD
Investigation time	Baseline	5.84 a	2.18
	One week	5.69 a	2.67
	One month	6.40 a	2.33
	Three months	5.54 a	1.57

Md= Mean Difference

SDd= Standard deviation difference

II – Results of Candida albicans growth:

Chi square test showed statistically **non-significant** difference between **conventional (D1)** and **ultra-suction (D2)** denture (P=0.1286 >0.05)

Table (3) Comparison of the Colony-forming unit's results scores (%) as function of denture type

Variable		Negative	Carrier	Positive	Statistics
Denture type	D1	7 (70%)	2(20%)	1(10%)	P value 0.1286 ns
	D2	6(60%)	(20%)2	2(20%)	

ns; non-significant (P>0.05)

*; significant (P<0.05)

DISCUSSION

According to *Kumar* ⁽⁸⁾, there are many factors that would complicate denture treatment process of an aged patients such as decreased neuromuscular coordination, reduced ability to sense where the mandible is in relation to the maxilla (oral awareness), and impaired ability to position the mandible or the tongue in desired locations.

Patients were selected free from systemic diseases which could affect denture retention as parkinson's disease, hemiplegia or any abnormalities in the tempromandibular joint as they may result in prosthetic failure due to lack of neuromuscular control ⁽⁹⁾, they were also free from diabetes as diabetics have increased predisposition to oral diseases like Candidiasis which is associated with xerostomia. ⁽¹⁰⁾

Patients with xerostomia were all excluded as *Turner et al.* ⁽¹¹⁾ stated that saliva is critical for retention of removable prostheses as salivary wetting mechanics are necessary to create adhesion, cohesion and surface tension that ultimately lead to increased retention of prostheses. Saliva allows for the formation of a vacuum pressure on the seating of dentures and contributes significantly to denture retention and wearer's satisfaction with the prosthesis.

Zarb et al. ⁽¹²⁾ mentioned that "because of the nature of the inflammation, the soft tissue is not in their normal size as the inflammation from either trauma or diseases, changes the gross form of the mucosal surface". They added that, with distortion of the denture foundation tissues the denture may appear to have good retention and stability, but at the same time, it may not fit the true form of the oral structure. So, since this study is based on the mandibular denture, patients were selected with healthy firm mucoperiosteum, with well developed ridges, without any sign of inflammation or flabby tissues covering the edentulous ridge to prevent denture base movement over the rebound tissues which could affect denture base stability and

consequently give false records during testing the retentive quality of the denture. ⁽⁹⁾

All selected patients selected had no previous experience in complete denture wearing to exclude the role of muscles in denture retention as *Basker et al.* ⁽¹³⁾ concluded that, there is an active muscular fixation of denture especially during function. Also previous denture wearing may cause lesions of the oral mucosa that may represent an acute or chronic reaction to microbial dental plaque or a mechanical dental injury.

Since accuracy of impressions with repeated pours is of interest clinically, because duplicate models are sometimes desired. most of the studies carried out on rubber impression material showed that they were dimensionally accurate even up to one week. This is advantages because multiple casts can be poured in the same impression up to one week without concern for dimensional inaccuracy. ⁽¹⁾

These materials exhibit the least amount of distortion from loads imposed on the set materials. thus pouring the impression. removing the cast several times will not alter the dimensional stability of the impression, even though a fairly substantial force is needed each time the cast is removed from the impression ⁽¹⁴⁾

At the time of denture insertion, patients were instructed to remove the denture after every meal and rinse them under running water only without any mechanical or chemical means that might affect plaque accumulation and its microbial flora.

Three months later, samples were obtained from the patients and Before denture reinsertion in the patient's mouth, the dentures were mechanically cleaned from Candida using a soft tooth brush as firm bristles can damage the acrylic denture material, and the patients were instructed to rinse with chlorohexidine (chx) mouth wash once to remove any Candida attached in their mouth, as a result of wearing the denture, without affecting plaque accumulation and candidal growth ⁽¹⁵⁾

Retention was measured by a universal testing machine which is a standardized accurate device for measuring retention. A new attachment was made to help measurement of retention of complete denture in the patient mouth.⁽¹⁶⁾

The retention device is very sensitive as when device's sensitivity increases, this increases the device ability to read the smaller values of forces thus giving accurate records. The device has a very sensitive load cell (grade 0.5%) that can start measuring from the zero Newton of force (as the manufacturer claimed). The application of a vertical dislodging loading force was similar to the technique used in previous study by *Mohammed Ali*⁽¹⁷⁾.

Techniques available for the isolation of *Candida* within the oral cavity include the use of a smear, a plain swab, an imprint culture, collection of whole saliva, the concentrated oral rinse, and mucosal biopsy. Each method has particular advantages and disadvantages and the choice of sampling technique is primarily governed by the nature of the lesion to be investigated where an accessible and defined lesion is evident, a direct sampling approach such as the use of a swab or an imprint is often preferred as this will provide information of the organisms present at the lesion itself. In cases where there are no obvious lesions or in instances where the lesion is difficult to access, an indirect sample based on culturing saliva specimens or an oral rinse is more acceptable.⁽¹⁸⁾

Swabbing technique was employed in this study for isolation of the yeast *Candida albicans* as simple and efficient method for oral yeast isolation.⁽¹⁹⁾

The swabs were taken from the fitting surface of the denture under some precautions that could affect the *Candida albicans* count. As mentioned previously, the tissue surface of the denture is considered an irregular surface as it usually shows micropits and micro porosities that harbor microorganisms that are difficult to remove by mechanical methods⁽²⁰⁾.

Swabs were placed immediately in tubes of fresh sabouroud dextrose broth and transferred to the laboratory within one hour as the swabs should be sent to the laboratory in a standard transport medium.⁽²¹⁾

It is important that patients perceive their dentures as retentive during function and as esthetically agreeable in order to meet the psychodynamics required by the patient.⁽⁸⁾

The results of this study showed a superiority of the retention of the ultra suction mandibular complete denture than that of the conventional complete denture as re//tention tests revealed higher retention values with the ultrasuction system. This is attributed to the fact that the ultrasuction system work on a simple principle – suction. Once the denture was in place in tight occlusion the gingival tissues penetrated the suction chamber expelling the air and forming a tight seal.⁽¹⁾

For suction to be effective a proper seal was obtained at the borders for the vacuum to be sustained. Sealing the entire border of the denture is an essential requirement, as complete sealing of the entire border will result in a stable and retentive mandibular denture. While obtaining a seal on an upper denture is often straightforward, the mandibular denture requires proper extension of the borders to cover the maximum surface area possible. The result was a better fit to the tissues and an improved resistance to dislodging forces⁽¹²⁾.

Mony Paz, the system inventor, explained 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 dislodgement. Thus, the increase in the retention of **D2** dentures could be mainly attributed to the atmospheric pressure effect

that has been long time ago documented in dental literature. 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 ridge. This point is suggested for further investigations to evaluate long-term effect of the system on the health of the tissues throughout future researches.⁽¹⁾

At denture delivery, there was a statistically insignificant difference between the retention forces mean values of of the two groups, because the denture needs a period of time about one week to allow its settlement and adaptability to the underlying tissues to produce sufficient retention.

After one week from denture insertion ,the ultra suction mandibular complete denture showed statistically significant higher retention mean values than conventional acrylic resin, this may be attributed to the property of atmospheric pressure which acts to resist the dislodging forces applied to the dentures if the dentures have an effective seal around their borders, and as there is intimate contact between ultra suction complete denture and the supporting structures, the retention was higher in the ultra suction complete denture than that of conventional denture. This was accepted by *Murray and Darvel*⁽²²⁾ who stated that the retention due to atmospheric pressure is directly proportional to the area covered by the denture base and to the intimate peripheral seal as well as the posterior palatal seal.

Regarding candida albicans laboratory test, The results of this study have shown that there was a statistically insignificant change in the Candida albicans count after using ultrasuction system .The increase in the number of colonies in some patients after using the ultrasuction system may be due to the increase of temperature as there is a direct relation between the degree of denture retention and the increase of temperature below the denture. The better the retention, the higher the temperature and the less washing effect of saliva.

It can be said that ultrasuction system represents an intermediate solution between implant and conventional denture as ultra suction denture is more affordable than implant and more effective than the conventional denture.

CONCLUSION

Within the limitation of this study it was concluded that, Ultra Suction system increases the retention of mandibular complete dentures and if patient follows the proper denture cleaning instructions, no growth of Candida albicans species is going to occur.

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