DIGITAL OCCLUSAL LOAD ANALYSIS AND EVALUATION OF ORAL HEALTH QUALITY OF LIFE OF MANDIBULAR COMPLETE DENTURE RETAINED BY ULTRA SUCTION SYSTEM

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ABSTRACT

Background: Occlusal unbalance is considered a major challenge for complete denture wearers. It could affect functional intra oral stability and decreases patient desires related to complete dentures as a definite treatment plan.

Materials and Methods: Twelve mandibular complete dentures had been divided into two groups according to retentive protocol into group (C) as a control group: who received conventional heat-cured acrylic resin mandibular complete dentures, group (U) as test group: who received conventional heat-cured acrylic resin mandibular complete dentures retained by ultra-suction device. T-Scan occlusal load analysis system was used to evaluate the balanced occlusion existence on the complete denture followed by OHIP questionnaire administration to the patients to evaluate patient satisfaction. Studying the effect of time over six months' follow-up for each group performed by paired t-test and comparison between group (C) and group (U) were performed using Independent t-test at the level of significance ≤ 0.05.

Results: Considering balanced occlusion of both groups, they showed a significant difference between both sides posteriorly before adjustments (46.5%, 39.9% and 45%, 37.7%) and an insignificant difference between both sides posteriorly after adjustments (38.3%, 41.6% and 49.6%,49.3%) after one month except for group (C) which showed a significant difference after six months (38.3%, 41.6% and 44.5%, 39.7%) posteriorly between both sides. Investigated domains showed a higher significant difference for group (C) about oral health's effect on the quality of life (42.8±11.69).

Conclusion: Ultra Suction retained mandibular complete dentures revealed better-balanced occlusion and patient satisfaction than ordinary mandibular complete dentures.

KEYWORDS: Digital, Suction, Denture, Satisfaction, Occlusion

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INTRODUCTION

Occlusal loads that might affect complete denture stability during function can be originated from uneven occlusal load distribution. [1]

Loss of balanced occlusion could affect the stability of both maxillary and mandibular complete dentures during function. Maintenance of complete denture occlusion conforming occlusal force distribution within the center of occlusal surfaces would enhance denture seating during a masticatory function on the edentulous tissue-bearing area. [2]

Despite the majority of patients showing significant acceptance with their conventional complete dentures, many drawbacks were exposed with their mandibular complete dentures. This could result from insignificant denture bearing area in addition to uneven occlusal load distribution resulting in accelerated bone resorption, declined stability and retention which in turn result in pain and patients' disapproval. [3]

It was found, in an in vivo study evaluating the T-SCAN system for analysis of occlusal loadings, that the system was not efficient enough in measuring them positively although it is reflected as a beneficial clinical instrument. The authors investigated multiple types of research on the occlusal relation during masticatory functions with T-SCAN II elucidating the relationship between occlusal load and occlusal loadings. [4]

To overcome many of the previously listed problems, suction systems incorporated into the fitting surface of dentures since their late presence in 1885. Their advanced routine in patients contraindicated to surgical consequences to enhance their denture bearing area had shown a successful, economic and conservative technique for enhancing denture stability. [5]

Ultra-Suction system that enhances mandibular denture retention using suction chamber and a mounted valve containing a tiny unidirectional device inserted into the denture base. As the patient occludes tightly, the confined air between the soft tissue and the intaglio surface of the denture is emitted through the device, through two air passages. The negative pressure gained under the denture tends to apply a pull and aids in securing the denture against the ridge. [6]

Previous studies, regarding oral health's effect on the quality of life, revealed multiple follow-up visits were included among pretreatment and monthly visits using the oral health impact profile in which (OHIP) change before and after treatment was obvious. The author mentioned that treatment planning should be based on objective factors including not only solid evidence for clinical performance but also patient satisfaction and OHRQoL. [7]

Quality of life values scored by (OHIP) questionnaire was minimal in case of completely edentulous conditions and using complete dentures as a prosthetic substitute. Low quality of life scores was revealed in six months articles investigating complete denture patients after denture delivery. During monthly investigations, denture retentive aiding protocols were followed during six months' follow-ups with the assumed questionnaire. Revealed data of this study showed an insignificant minor change in (OH-QoL) score which correlated with other studies. [8]

Objectives

This study was performed to compare between conventional and ultra-suction retained removable complete dentures regarding the effect on balanced occlusal load (measuring balanced occlusion and on quality of life).

MATERIALS AND METHODS

The randomized clinical trial introduced within this study in which retentive appliance was used in lower complete dentures as test group and compared conventional lower dentures as a control

group. To study digital occlusal load analysis and patient satisfaction, the mandibular complete denture was constructed on a completely edentulous mandibular ridge following clinical trials protocol ID: **NCT04999579.**

Sample Size Calculation

According to this study [5], the minimally accepted sample size was 6 per group, when the response within each subject group was normally distributed with a standard deviation of 1.7, the true mean difference was 3.14 when the power was 80 % and type I error probability was 0.05. Independent t-test was performed by using PS Power software

The included patients were divided randomly according to the method of acrylic resin denture base retention into two groups through sealed envelopes having groups for interventions and comparator. Each patient enrolled in the trial picked a closed sealed opaque envelope having either the test or control group.

Group (C) (Control Group): Each patient within the control group received a conventional mandibular complete denture cured by heat-activated acrylic resin.

Group (U) (Test Group): Each patient within the test group received a mandibular complete denture cured by heat-activated acrylic resin retained by ***Ultra Suction device (iImpexbo - Impexbo SARL,***

Route de Lausanne 3, CH - 1041 Bottens).

After trial completion, practitioners were encouraged for recalling patients after six months of follow-up for occlusal load analysis appointments. During the recall visit, dentures were checked for their fit to the supporting tissue, followed by a general examination of the oral cavity. On this occasion, calculus deposits were removed from around the retention chamber and the air channels were thoroughly cleaned.

The valve covers were opened over a receptacle of water to avoid losing the components. The valves were cleaned and the diaphragms replaced, as shown in figure (1). Patients were instructed to clean their dentures and the valves daily. Patients who had manual dexterity were given the service key, together with spare diaphragms, and were instructed to perform routine maintenance in between the biannual visits. Cleaning the dentures after every meal under running water only. Not to use any type of denture cleansers, toothpaste, and solutions containing phenol. Also, denture adhesives should be avoided. Removing the prosthesis at night for tissue rest and immersing it in a cup of tap water.

Before employing a T-Scan occlusal analyzer to assess the occlusion on the complete denture, the complete denture was seated and checked for fitness, stability, pressure areas with pressure indicating paste, and border evaluation and extension. The peripheral seal should be evident so that the denture-maintained suction against maxillary and

Fig. (1) Mandibular Complete Denture retained by Ultra Suction Device

mandibular tissues. Upon completion of these fit and stability assessments, the occlusion could then be addressed.

T-Scan analyzes the order of the occlusal contacts while simultaneously measuring the changes in force percentages of the same contacts, from the moment the teeth begin contacting to maximum intercuspation. Therefore, it could assess the initial occlusal contact, the order that which all the occlusal contacts occur, and the amount of relative occlusal force loading at each contact. It enables us to assess the force changes, all during the process of contact evolutions, as shown in figure (2).

Computer-guided occlusal adjustments could then be employed to alter a poorly contacting tooth sequence into a contact sequence where multiple equal-intensity contacts occur simultaneously throughout the arches bilaterally. According to the data displayed on the 3D graph, teeth with premature contact were reduced and the process was repeated until nearly the contact between posterior teeth is equal in distribution and intensity and until the intensity of the biting force of both sides of the arch are nearly equal.

The Oral Health Impact Profile for Edentulous Patients (OHIP-EDENT) containing 19 questions were obtained from each of the seven conceptual domains of the OHIP (functional limitation, physical pain, psychologic discomfort, physical disability, psychologic disability, social disability, and handicap) as shown in table (1).

The questionnaire was left with the patients therefore it was translated into common Arabic language. The Arabic translation was validated through multiple stages to assure validity and reliability of the questionnaire. The original (OHIP-EDENT) questionnaire was forward-translated into common Arabic language and then content-validity assessed by expert panel; Expert (1) was the original translator, Expert (2) was a public health expert and Expert (3) was an expert in translation and development of questionnaire. Back-translated into English was assessed by single independent translator having English as mother tongue but no knowledge regarding questionnaire then pretesting of Arabic questionnaire was face-validated through various validation processes. [9]

The five categories of response for each item were never (= 0), hardly ever (= 1), occasionally (= 2), fairly often (= 3), and very often (= 4). The sum ranges from 0-76. Higher OHIP-EDENT summary scores indicate OHRQoL impairment.
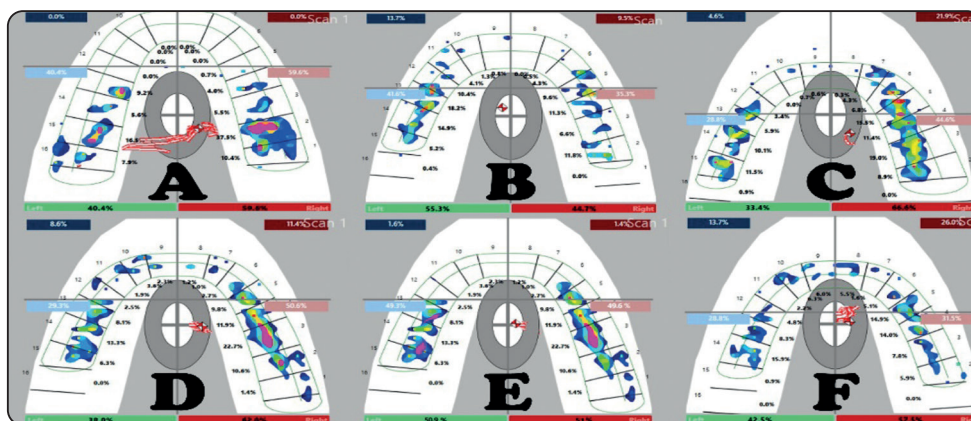

Fig. (2): Occlusal Load Analysis of Group (C) and Group (U) using T-scan A. Conventional Mandibular Complete Denture Before Occlusal Adjustment. B. Conventional Mandibular Complete Denture After Occlusal Adjustment. C. Conventional Mandibular Complete Denture After Six Months of Occlusal Adjustment. D. Ultra Suction retained Mandibular Complete Denture Before Occlusal Adjustment. E. Ultra Suction retained Mandibular Complete Denture After Occlusal Adjustment. F. Ultra Suction retained Mandibular Complete Denture After Six Months of Occlusal Adjustment.

TABLE (1): OHIP-EDENT Questionnaire

Functional limitation	Q1	Have you had difficulty chewing any foods?
	Q2	Have you had food catching in your dentures?
	Q3	Have you felt that your dentures have not been fitting property?
Physical pain	Q4	Have you had painful aching in your mouth?
	Q5	Have you found it uncomfortable to eat any foods because of problems with your dentures?
	Q6	Have you had core spots in your mouth?
	Q7	Have you had uncomfertable dentures?
Psychological discomfort	Q8	Have you been worried by dental problems?
	Q9	Have you been self-conscious because of your dentures?
Physical disability	Q10	Have you had to avoid eating some foods because of problems with your dentures?
	Q11	Have you been unable to eat with your dentures because of problems with them?
	Q12	Have you had to interrupt meals because of problems with your dentures?
Psychological disability	Q13	Have you been upset because of problems with your dentures?
	Q14	Have you been a bit embarrassed because of problems with your dentures?
Social disability	Q15	Have you avoided going out because of problems with your dentures?
	Q16	Have you been less tolerant of your spouse or family because of problems with you." dentures?
	Q17	Have you been a bit irritable with other people because of problems with your dentures?
Handicap	Q18	Have you been unable to enjoy other people's company as much because of problems with your dentures?
	Q19	Have you felt that life, in general, was less satisfying because of problems with your dentures?

Statistical Analysis

Statistical analysis of the given data was performed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). and Graph Pad Prism. Data revealed as means and standard deviations for each output of occlusal load analysis and OHIP-EDENT questionnaire score over six months' follow-up periods. Studying the effect of time over six months' follow-up for each group performed by paired t-test and comparison between group (C) and group (U) were performed using Independent t-test at the level of significance < 0.05.

RESULTS

Occlusal load analysis using T-scan system before occlusal adjustment was considered as baseline data following (1:1 allocation ratio) with no significant bias in each group regarding concealment of allocation.

Baseline characteristics regarding gender and age of participants were revealed in table (2). For gender distribution among both groups, males and females were counted as (66.66%) and (33.33%) respectively for both groups. While for age range, (45-49) (50-54) and (55-60) years old were counted as (40%), (50%) and (10%) respectively for both groups. Performing Chi square test for significance evaluation between proportions, it was revealed insignificant difference between both groups as P-value > 0.05.

Regarding group (C), occlusal load analysis between both sides anteriorly showed insignificant difference before adjustment, after adjustment, and after six months, as investigated in table (3) and figure (3). Posteriorly, occlusal load analysis between both sides revealed a significant difference before adjustment and after six months while revealed insignificant difference after adjustment, as investigated in table (3) and shown in figure (3).

Regarding group (U), occlusal load analysis between both sides anteriorly showed insignificant difference before adjustment, after adjustment, and after six months, as investigated in table (3) and figure (3). Posteriorly, occlusal load analysis between both sides showed a significant difference before adjustment and insignificant difference after adjustment and after six months, as investigated in table (3) and shown in figure (3).

After calculation of percentage change before occlusal adjustment and after six months of occlusal adjustment, the overall percentage of change of right and left sides for anterior and posterior occlusal load revealed a significant difference between group (C) and group (U), investigated in table (4) and shown in figure (4).

Analysis of oral health effect on the quality of life, studied domains revealed a significant difference between group (C) and group (U) as the group (U) showed lower scores than group (C), as investigated in table (5) and shown in figure (5).

TABLE (2): Baseline Characteristics of Group (C) and Group (U):

		Group (C)	Group (U)	P-value
Gender	**Male**	66.66%	66.66%	**1.00 (ns)**
	Female	33.33%	33.33%	**1.00 (ns)**
Age	**45-49 Years Old**	40.00%	40.00%	**1.00 (ns)**
	50-54 Years Old	50.00%	50.00%	**1.00 (ns)**
	55-60 Years Old	10.00%	10.00%	**1.00 (ns)**

Ns; Insignificant Difference

TABLE (3): Comparative Values of Effect of time on Occlusal Load Analysis in Group (C) and Group (U):

			Before Adjustment (M±SD)	After Adjustment (M±SD)	After Six Months (M±SD)
Group (C)	**Anterior**	**Rt.**	14 %±4.21	9.5 %±5.62	11.5 %±3.86
		Lt.	15.5 %±4.54	13 %±4.38	12 %±4.34
		P-value	**0.5661(ns)**	**0.2566(ns)**	**0.8372(ns)**
	Posterior	**Rt.**	46.5 %±2.8	38.3 %±3.18	44.5 %±3.98
		Lt.	39.9 %±3.74	41.6 %±4.92	39.7 %±2.37
		P-value	**0.0061***	**0.1977(ns)**	**0.0295***
Group (U)	**Anterior**	**Rt.**	11.5 %±3.86	2.51%±0.57	6 %±2.87
		Lt.	12 %±4.34	1.94 %±0.68	9 %±2.29
		P-value	**0.8372(ns)**	**0.1467(ns)**	**0.0732(ns)**
	Posterior	**Rt.**	45 %±2.17	49.6 %±6.33	40 %±1.36
		Lt.	37.7 %±3.49	49.3 %±5.73	38.8 %±1.27
		P-value	**0.0014***	**0.9331(ns)**	**0.1453(ns)**

M; Mean, SD; Standard Deviation, P; Probability Level
Ns; Insignificant Difference indicating Existence of Balanced Occlusion
*significant Difference indicating Absence of Balanced Occlusion

TABLE (4): Comparative Values of Occlusal Load Analysis Change between Group (C) and Group (U):

		Group (C)		Group (U)		P-value
		M %	SD	M %	SD	
Percentage of Change	Anterior	20.22	5.59	36.41	10.07	0.0063*
	Posterior	2.40	0.66	7.01	1.94	0.0003*

M %; Mean Percentage, SD; Standard Deviation, P; Probability Level
*significant Difference indicating Absence of Balanced Occlusion

TABLE (5): Evaluation of OHIP-EDENT Questionnaire Score in Group (C) and Group (U) after Six Months:

	Group (C) (M±SD)	Group (U) (M±SD)	P-value
Functional Limitation	9.6±2.08	6.4±1.2	0.0085*
Physical Pain	9±1.95	6.1±1.15	0.0105*
Psychological Discomfort	5.7±1.23	2.7±0.51	0.0003*
Physical Disability	8.2±1.77	5.3±1.01	0.0059*
Psychological Disability	4.5±0.97	1.8±0.34	<0.0001*
Social Disability	3.1±0.67	1.6±0.35	0.0007*
Handicap	2.7±0.58	1.4±0.26	0.0005*
Overall OHIP-EDENT	42.8±11.69	25.5±6.97	0.011*

M; Mean, SD; Standard Deviation, P; Probability Level *significant Difference
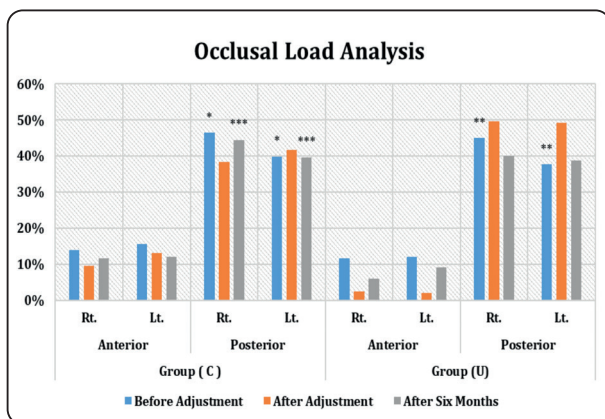

Fig. (3): Bar chart revealing significant difference of the same symbols on top bars (Absence of Balanced Occlusion)
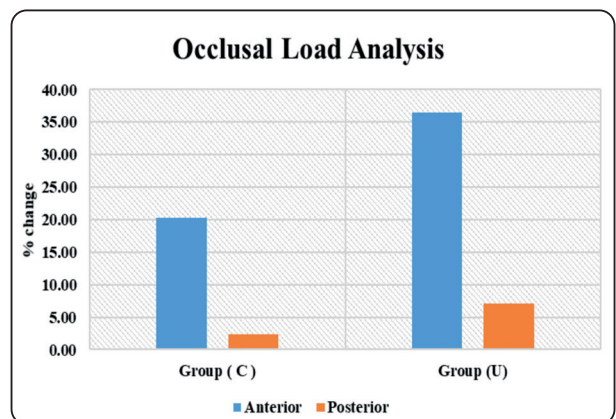

Fig. (4): Bar Chart revealing Significant Difference of Occlusal Load Analysis Change between Group (C) and Group (U)
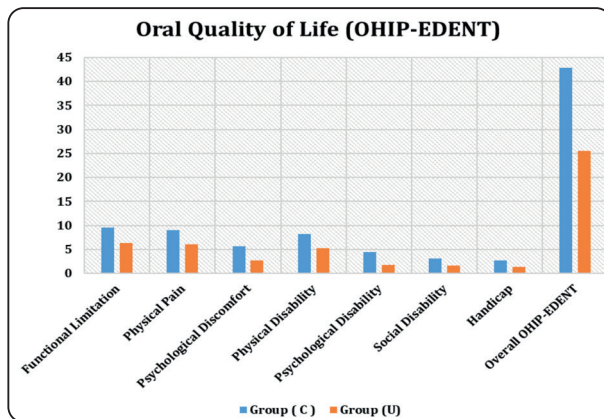
Fig. (5): Bar Chart revealing Significant Difference of OHIP-EDENT Questionnaire Score between Group (C) and Group (U) after Six Months

DISCUSSION

Occlusal overloading and premature contacts have been introduced as the principal factor for loss of balanced occlusion [10] Digital diagnostic monitoring and occlusal overloading is a key basis of occlusal unbalance. [11]

The outcomes of anterior teeth loading in the group (C) and group (U) had listed that the percentage of loading was not applied significantly (P-value >0.05) on both sides anteriorly of the dentures even after occlusal adjustment with remounting and occlusal adjustments even after six months. [12]

This is due to the time elapsed on the occlusal pathway from eccentric to the centric mandibular position being minimal (1-3 seconds). The primary incisal contact from eccentric to the centric mandibular position at (0.2 seconds) when force loading was at a peak of (100%). At (0.46 seconds) completed incisal contact in the anterior segment when both sides of the posterior area of the mandible were closed. [13]

In posterior teeth occlusal load analysis, there was a statistically significant difference in the occlusal force equilibration between both sides in both groups (P-value<0.05). This revealed that the conventional occlusal adjustment trials maybe not

have preceded to maintain bilateral occlusal balance in the complete denture. After occlusal adjustment, both sides of posterior areas of the dentures had revealed comparable occlusal force equilibration with an insignificant difference. [14]

After occlusal modification in group (C) and group (U), there's a uniform dental contact, which results in improved denture stability, higher control of mastication, and enhanced efficiency as introduced in previous articles. [15]

Authors reported that balanced occlusion improves the adaptation at early loading after fitting new conventional complete dentures [16]. In other articles, some reported that after insertion of new dentures, balanced occlusion was no longer evident due to acrylic tooth wear and changes in bony underlying tissues [17]. So, more investigations were needed to assess these findings in the longer term after the insertion of the prosthesis.

While in group (U), the retentive ability in comparison to conventional mandibular dentures had been completely verified in this study through patients` questionnaire practice which showed a significant enhancement in the denture retention after the application of the Ultra Suction system. [18]

Mony Paz, the system creator, clarifies that once the patient occludes tightly, the valves combined in the system permit ejecting the air from the undersurface of the denture base, and the soft tissues penetrate the suction chamber. Simultaneously, the diaphragm prevents the return of the expelled air. The pressure change applies a pull and seals off the denture bearing area borders, generating better fit and increased resistance to denture dislodgement. [5]

In group (C), more intensive pressures of artificial teeth at the working side will compromise supporting tissues and will be a factor for intensive resorption of edentulous ridge influencing residual ridge resorption. [19]

While in group (U), increased stability and its related balanced occlusion could be due to denture

retention enhancement and stability using the denture suction appliances. It provided a viable option to improve denture retention when the patient was unable to use other treatment methods. These suction appliances grip the oral tissue, providing an increased surface area for improved retention, stability, and an improved suction force for resistance. [5]

Available articles report that physically retained dentures significantly enhance the oral health effect on the quality of life for edentulous patients concerning ordinary removable complete dentures. Functional and psychosocial disability practiced by the denture wearer disturbs the need for denture retaining rehabilitation. For geriatric edentulous individuals, the common health and economical status are of importance while choosing physically retained over conventional dentures. [20,21]

CONCLUSION

Group (U) revealed significant improvement of occlusal load distribution (Occlusal Balance) among six months follow-up investigations while for the group (C), there was a transient improvement in balanced occlusion before and after occlusal adjustments but there was an insignificant setback of imbalance after six months. For effect on the quality of life, group (U) revealed significant improvement among six months' follow-up investigations.

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