The effect of computer guided occlusal adjustment versus articulating paper on implant retained mandibular complete over denture on masticatory efficiency and patient's satisfaction

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Abstract

Objective: The aim of this study was to evaluate the effect of computer guided occlusal adjustment versus articulating paper on implant retained mandibular complete over denture on masticatory efficiency and patient's satisfaction **Patients and Methods**: From the removable prosthodontics department clinic, Faculty of Dental Medicine, (Boys, Cairo, Egypt), Al-Azhar University, 10 completely edentulous patients were randomly chosen. The patients were divided into two groups, Group I received dentures adjusted by articulating papers. Group II received dentures adjusted by t-scan. Statistical analysis was done using student t-test, the data distribution of normality was done by using the Kolmogorov Smirnov test. **Results**: It was found that group I recorded a significant increase in masticatory efficiency and patient satisfaction for 1 week after insertion and there was no significant difference between the two groups for 3& 6 months after insertion. **Conclusion**: T-scan could be used for occlusal adjustment in complete denture.

KEY WORDS: Implant-retained overdenture, T-scan, articulating paper, masticatory efficiency, patient satisfaction.

Introduction:

Complete edentulism is a clinical situation typical for the elderly people, defined by the total absence of one's own natural teeth, in one or both arches. While the loss of teeth there are a series of negative effects on the general, social and psychological status, frequently leading to a decrease in the quality of the individual's life, damage of the oral structure, disturbance of oral

functioning, decreased ability to chew, compromising facial aesthetic, a negative influence on self-perception and diminishing of social interactions.[1, 2]

Problems associated with complete dentures are apparent to every dentist. One of those problems which are the most important is resorption of the alveolar ridge and atrophy of the denture supporting areas leading to ill-fitting denture, lack of stability, and impaired masticatory efficiency.[3]

The masticatory function is often poor in the complete denture wearers. The masticatory force is 10% to 20% of that of healthy dentate subjects. Consequently, patients with dentures may have a diet deficient in fiber and vitamins.[4]

The mandibular implant-supported over denture is a treatment that has been proposed for edentulous patients as an alternative to removable or implant supported fixed full prostheses. Use of two implants placed in the inter-foraminal region have been considered the minimum number of implants required for implant supported overdenture.[5,6]

Occlusion is the most critical component of implant prosthodontic. When occlusal factors are not properly controlled, bone loss, fracture of the prosthesis or failure of the implant may occur. Thus, the occlusal performances of an overdenture are more similar to a fixed prosthesis than a conventional denture. So that, the occlusion for the tissue-borne overdenture should include multiple bilateral, even contacts in centric relation and eccentric positions for proper distribution of force.[7]

Articulating paper has been established as the most commonly used diagnostic tool to identify contact points between the maxillary and mandibular teeth. The size of the mark area on the articulating paper is representative of how heavy the occlusal load is.[8, 9]

T-scan computerized occlusal analysis system was introduced to avoid the subjectivity in the interpretation of the articulating paper markings. Kerstein, et al. consider the T-scan III system to be a highly accurate technique to study and analyze the occlusal and articulation relations.[10]

The aim of this study was to evaluate the effect of computer guided occlusal adjustment versus articulating paper on implant retained mandibular complete over denture on masticatory efficiency and patient's satisfaction.

Patients and method:

Patient number was selected by power test according to Bhat and associates. [11] Using SPSS version 18, when power of the sample was 80 % and effect size at p.

The patients were divided into two groups. Each group contained five patients. Ethical approval was obtained from Research Ethics Committee, Faculty of Dental medicine Al-Azhar University Under the No. (EC Ref No. 416/1951).

This randomized prospective crossover clinical study was carried out on a total of 10 completely edentulous patients from the out-patient's clinic of Removable Prosthodontics Department, Faculty of Dental Medicine (Boys), Al-Azhar University, (Cairo). They were selected with an age of 55-65 years, free from any systemic diseases that might affect implant placement. After clarification of the technique prior to study enrolment, informed consent was obtained from all participants.

Five patients received complete dentures retained by two implants and occlusal adjustment done by articulating paper, the other patients received complete dentures retained by two implants and occlusal adjustment was done by T-scan system. After six months, the patients who received denture with articulating paper adjustment received duplicated denture with T-scan system adjustment and vice versa.

An acrylic complete denture was constructed for each patient according to the conventional steps of complete denture construction with bilateral balanced occlusion. The denture was inserted into the patient's mouth, verification of esthetics, stability, retention, occlusion, high spots, and any sharp or overextension that could cause pain were checked, Post insertion instructions were given, follow up visits were secluded, and patients were instructed to wear the dentures till adaptation was acquired.

Mandibular alveolar ridge height, bone quality and the type of bone were evaluated by the cone beam computerized tomography. Measurements were carried out in cross-sections from the most superior point of the crest of the ridge to the most inferior point of the mandible. [12]

Two implant fixtures (Nucleoss, Menderes, Izmir, Turkey) with a length of 10 mm, diameter of 3.7 mm were inserted in the inter canine region of the mandibular alveolar ridge.

Depending on occlusal correction method, patients were randomly divided into two groups. The study was completed in a crossover design.

Group I received dentures adjusted by articulating papers. Patient satisfaction and masticatory efficiency were measured at insertion, 3months and 6 months after insertion then they were replaced with dentures adjusted by t.scan method and measurements were repeated at the same periods.

Group II received dentures adjusted by t-scan. Patient satisfaction and masticatory efficiency were measured at insertion, 3months and 6 months after insertion then they were replaced by dentures adjusted by articulating papers method and measurements were repeated at the same periods.

This randomization was made to reduce the effect of prothesis type and inherent bias on patient satisfaction.

1) Masticatory efficiency measurement: [13]

Group I and group II were subjected to the masticatory efficiency test using Trident® (Mondelez International Inc, Turkey (chewing gums). Watermelon (pale red) and spearmint (light green) were used. Strips of 30 mm length were cut from both colors and manually struck together, Patients set upright and chewed both gums for 5, 10, 20, 30 and 50 chewing cycles, respectively.

Between each chewing sequence a pause of 2-3 seconds was respected. The chewing cycles were counted by the operator. This test measured the ratio of pixels corresponding to unmixed color sections of the chewing gum to the numbers of pixels in the image.

By assessing all samples, counting un mixed pixels, scanning the samples, copping the scanned images into images of fixed sizes, recording the number of selected pixels we could compute the ratio of the unmixed fraction (UF) using the following formula:

$$UF = \frac{(\text{Pixels green side a} + \text{Pixels green side b}) - 2 \times \text{Pixels of scale}}{2 \times \text{Pixels all}}$$

2) . Oral health related quality of life (OHRQoL):

The complete denture treatment addresses function by increasing the muscular forces and maximal bite force gradually to improve masticatory efficiency.[14] Thereby, quality of life is also promoted. The oral-health related quality of life (OHRQoL) is most widely used to measure the influence of dental care on overall wellbeing and social sphere.[15] It is comprised of 49 items divided into 7 subscales, and was designed by Adulyanon and Sheiham.[15]

Numerical data were explored for normality by checking the distribution of data and using the Statistical tests. Data showed normal (parametric) distribution. The Independent t-test was used to compare mean values between two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with SPSS Statistic version 18.

Results

a) Masticatory efficiency measurement

1. Results for 1 Week:

Table (1) shows the mean values of masticatory efficiency for the two groups after 1 week. A statistically significant difference was found between group 1 and group 2 as indicated by independent t-test as (p<0.05) for all results.

Table (1): Comparison of unmixed fraction between group 1 and group 2 for different chewing strokes at 1 week interval (T1).

Group / Cycle	Articulating paper	T-Scan	p Value	Significance
	Mean ± SD			
5 Cycles	0.616 ± 0.017	0.578 ± 0.039	0.0004	Significant
10 Cycles	0.612 ± 0.029	0.552 ± 0.056	0.0195	Significant
20 Cycles	0.608 ± 0.050	0.547 ± 0.005	0.0035	Significant
30 Cycles	0.598 ± 0.081	0.526 ± 0.019	0.0007	Significant
50 Cycles	0.563 ± 0.028	0.496 ± 0.023	0.0257	Significant

Paired t-test showed a statistically significant difference between the two groups for all cycles (p<0.05).

2.   Results for 3 months:

Table (2) shows the mean values of masticatory efficiency for the two groups after 3 months. A statistically nonsignificant difference was found between group 1 and group 2 as indicated by independent t-test as (p>0.05) for all results.

Table (2): Comparison of unmixed fraction between group 1 and group 2 for different chewing cycles at 3 months interval (T2).

Group / Cycle	Articulating paper	T-Scan	p Value	Significance
	Mean ± SD			
5 Cycles	0.577 ± 0.168	0.542 ± 0.219	0.653	Non-Significant
10 Cycles	0.549 ± 0.236	0.536 ± 0.278	0.911	Non-Significant
20 Cycles	0.524 ± 0.153	0.509 ± 0.199	0.852	Non-Significant
30 Cycles	0.516 ± 0.208	0.493 ± 0.225	0.793	Non-Significant
50 Cycles	0.486 ± 0.178	0.490 ± 0.101	0.960	Non-Significant

Paired t-test showed a statistically significant difference between the two groups for all cycles (p<0.05).

3.Results for 6 months:

Table (3) shows the mean values of masticatory efficiency for the two groups after 1 week. A statistically nonsignificant difference was found between group 1 and group 2. as indicated by independent t-test as (p>0.05) for all results.

Table (3): Comparison of unmixed fraction between group 1 and group 2 for different chewing cycles at 6 months interval (T3).

Group / Cycle	Articulating paper	T-Scan	p Value	Significance
	Mean ± SD			
5 Cycles	0.524 ± 0.141	0.509 ±0.124	0.816	Non-Significant
10 Cycles	0.496 ± 0.197	0.481 ± 0.21	0.780	Non-Significant
20 Cycles	0.48 ± 0.146	0.477 ±0.113	0.951	Non-Significant
30 Cycles	0.469 ± 0.127	0.453 ± 0.156	0.818	Non-Significant
50 Cycles	0.446 ± 0.103	0.425 ± 0.188	0.771	Non-Significant

Paired t-test showed a statistically significant difference between the two groups for all cycles (p<0.05).

 b) **Patient Satisfaction:**

1. Patient satisfaction after 1 week:

Table (4): shows the mean values of patient satisfaction for the two groups after 1 week. A statistically significant difference was found between group 1 and group 2. as indicated by independent t-test as (p<0.05) for all results.

Table (4): Comparison of OHRQoL between group 1 and group 2 for different chewing strokes at 1 week interval (T1).

	Grouping	Mean	Std. Deviation	t-value	P-Value
Total	T-scan	3.13	0.50	7.822	<0.001*
	Articulating paper	2.44	0.52		
Function	T-scan	3	0.63	2.753	0.013*
	Articulating paper	2.2	0.60		
Physical Pain	T-scan	2.9	0.54	2.545	0.0202*
	Articulating paper	2.3	0.46		
Psycho-Discomfort	T-scan	3.1	0.54	2.884	0.0098*
	Articulating paper	2.4	0.49		
Physic-Disability	T-scan	3.2	0.40	3.279	0.0041*
	Articulating paper	2.5	0.50		
Psycho Disability	T-scan	3.3	0.46	4.629	0.0002*
	Articulating paper	2.3	0.46		
Social disability	T-scan	3.2	0.40	2.846	0.0107*
	Articulating paper	2.6	0.49		
Handicap	T-scan	3.2	0.40	2.121*	0.048*
	Articulating paper	2.8	0.4		

2. Patient satisfaction after 3 months:

Table (5): Comparison of OHRQoL between group 1 and group 2 for different chewing strokes at 3 months interval (T2). the difference between the two groups was non statistically significant for all variables as indicated by independent t-test as (p>0.05) for all results.

Table (5): Mean and Std. Deviation values of OHRQoL for the two involved groups after 3 months.

	Grouping	Mean	Std. Deviation	t-value	P-Value
Total	T-scan	3.54	0.48	2.536	0.0061*
	Articulating paper	3.29	0.24		
Function	T-scan	3.60	0.71	0.287	0.388 ns
	Articulating paper	3.50	0.5		
Physical Pain	T-scan	3.60	0.71	0.639	0.265 ns
	Articulating paper	3.40	0.27		
Psycho-Discomfort	T-scan	3.50	0.5	0.738	0.234 ns
	Articulating paper	3.30	0.23		
Physic-Disability	T-scan	3.50	0.50	1.632	0.0599 ns
	Articulating paper	3.10	0.10		
Psycho Disability	T-scan	3.70	0.46	1.524	0.0724 ns
	Articulating paper	3.30	0.23		
Social disability	T-scan	3.50	0.5	1.152	0.1321 ns
	Articulating paper	3.20	0.18		
Handicap	T-scan	3.40	0.27	0.948	0.1776 ns
	Articulating paper	3.20	0.22		

3. Patient satisfaction after 6 months:

Table (6): Comparison of OHRQoL between group 1 and group 2 for different chewing strokes at 6 months interval (T3). the difference between the two groups was nonstatistically significant for all variables as indicated by independent t-test as (p>0.05) for all results.

Table (6): Mean and Std. Deviation values of OHRQoL for the two involved groups after 6 months.

	Grouping	Mean	Std. Deviation	t-value	P-Value
Total	T-scan	2.94	0.9	1.330	0.0927 ns
	Articulating paper	2.74	0.69		
Function	T-scan	3.50	0.94	0.496	0.3127 ns
	Articulating paper	3.30	0.68		
Physical Pain	T-scan	3.20	1.29	0.428	0.3366 ns
	Articulating paper	3.00	0.89		
Psycho-Discomfort	T-scan	2.90	0.54	0.572	0.2871 ns
	Articulating paper	2.70	0.68		
Physic-Disability	T-scan	2.70	0.68	0.582	0.2836 ns
	Articulating paper	2.50	0.5		
Psycho Disability	T-scan	2.90	0.77	0.526	0.3025 ns
	Articulating paper	2.70	0.68		
Social disability	T-scan	2.70	0.68	0.534	0.2997 ns
	Articulating paper	2.50	0.72		
Handicap	T-scan	2.70	1.34	0.465	0.3235 ns
	Articulating paper	2.50	0.5		

Discussion:

The most common implant design being used today is the screw shaped or threaded cylindrical implant over the other implants geometry because the threaded design engages bone well and ability to achieve good primary stability and its taper design which requires less space in the apical region which is better for placement in narrow anatomic areas and to avoid interference with the labial concavities.[16]

The implant-retained overdenture for the mandible is a highly successful prosthetic treatment because of its relative simplicity, minimal invasiveness, economy improve retention, stability, better function, and overall satisfaction for the patients.[17]

A two-implant overdenture provides an excellent alternative to a conventional complete denture. This recommendation is supported by comparative prospective studies of patients with two or four implants in the edentulous mandible. These studies concluded that there were no significant differences in survival rates, clinical outcomes, masticatory performance and patient satisfaction for mandibular overdentures supported by two or four implants in the inter foraminal region.[18]

Ball attachments are among the simplest of all stud attachments widely used because of their low-cost, ease of handling, minimal chairside time requirements and their possible applications with both root and implant-supported prostheses.[19] Many authors agree that for un splinted implants, the most common attachment used is the ball attachment. This attachment system is a practical, effective, and relatively low-cost prosthetic concept.[20]

The method used in evaluating chewing efficiency in this study (using two-colored chewing gums) was more practical and had several advantages including; no special equipment and enabled assessment of the bolus formation and the degree of blending of the two-colored specimen proved was able to detect changes in dental state.[21]

 Measuring the oral health-related quality of life (OHRQoL) is essential for epidemiological and clinical studies for health improvement and diseases prevention.[22]

Articulating papers are the most frequently used qualitative indicators to locate the occlusal contacts intraorally; their basic constituents are a coloring agent and a bonding agent between the two layers of the film. [23]

 Bozhkova[24] reported that the T-Scan system provides a very accurate way of determining and evaluating the time sequence and force magnitude of occlusal contacts by converting qualitative data into quantitative parameters and displaying them digitally. The system is a useful clinical method that eliminates a biased, subjective evaluation of the occlusal and articulating relations on the part of an operator, which is in accordance with the results of our study.

The results of masticatory test for 1 week showed that a statistically significant difference between the two groups for all cycles ($p<0.05$).

The results agreed with Zayed who concluded that occlusal adjustment using T-scan III enhanced the performance of muscles of mastication leading to better masticatory efficiency.[25]

Another study also concluded that the establishment of multilocal autonomous stabilizing contacts will influence chewing efficiency.[26]

However, the results for 3 months and 6 months showed nonsignificant difference between two groups. This could be attributed to the wear of the teeth that eliminated pre mature contacts.

Bilhan H etal., persumed that the advanced wear of the artificial teeth prevents premature contact, and thus did not elicit any complaints. Additionally patients' TMJ and musculature may have adapted to the faultily acquired centric occlusion through remodeling.[27]

Patient satisfaction

In relation to patient satisfaction the results at the time of insertion showed that the "articulating paper group" recorded a total mean OHRQoL value of (2.44) and the "T scan group" recorded a total mean OHRQoL value of (3.13). The difference between the two groups was statistically significant, as indicated by the unpaired t-test (p<0.001).

Also at 3 months It was found and the "articulating paper group" recorded a total mean OHRQoL value of (3.29) that and the "T scan group" recorded a total mean OHRQoL value of (3.54). The difference between the two groups was statistically significant, as indicated by the unpaired t-test (p=0.0061).

The results agreed with Maruo et al. who concluded that patient satisfaction is directly affected by the denture stability; which is mainly influenced by presence of balanced occlusal contacts. Most commonly, at the time of insertion and post-insertion recall visits, complete denture occlusion is adjusted using articulating paper till reaching acceptable simultaneous occlusal contacts. However, this procedure is not accurately reliable for the study of occlusal forces distribution as the accurate analysis that combines time resolution and forces distribution within patient occlusion is not applicable when traditional methods of occlusal assessment.[28]

Metwally etal. said that patient satisfaction is directly affected by the denture stability; which is influenced by presence of balanced occlusal contacts adjusted with T- scan analysis.[29]

Bana and his coworkers assumed that masticatory efficiency was highly correlated with all subscales of OHIP after treatment. [30]

Conclusion: T-scan could be used for occlusal adjustment in complete denture.

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