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THE EFFECT OF COMPUTER-GUIDED OCCLUSAL ADJUSTMENT VERSUS ARTICULATING PAPER ON IMPLANT RETAINED MANDIBULAR COMPLETE OVERDENTURE ON FORCE DISTRIBUTION

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ABSTRACT

Objective: This study evaluated the effect of computer-guided occlusal adjustment versus articulating paper on implant-retained mandibular complete overdenture on force distribution. **Subjects and Methods:** From the removable prosthodontics department clinic, Faculty of Dental Medicine (Boys, Cairo, Egypt), Al-Azhar University, ten completely edentulous patients were randomly selected. The patients were randomly divided into two groups. Group I received dentures adjusted by articulating paper, and group II received dentures adjusted by t-scan. Statistical analysis was done using a student t-test, while data distribution of normality was done using the Kolmogorov-Smirnov test. **Results:** There was a statistically significant difference between group I & group 2 in the anterior area at one week and three months intervals, while there was a statistically significant difference between group I and group 2 in the posterior regions at one week, three months, and six months. **Conclusion:** T-scan could be promisingly used for occlusal adjustment in complete dentures.

KEYWORDS: Implant-retained overdenture, T-scan, articulating paper, force distribution.

INTRODUCTION

Problems associated with complete dentures are apparent to every dentist. One of those problems is the resorption of the alveolar ridge and atrophy of the denture supporting areas, leading to ill-fitting dentures, lack of stability, and impaired masticatory efficiency [(1)].

In patients with extensive tooth loss, restoration of masticatory function and aesthetics is the primary concern for a prosthodontist [(2)].

Until not long ago, the only treatment alternative for complete edentulism was complete denture, which, most of the time, was unable to meet the patients' expectations, usually having poor stability and associating difficulties during mastication. Because of the reduction in masticatory function, the risk of cardiovascular diseases and gastrointestinal disorders may increase [(3)].

Phonetic and speech functions are also affected, particularly after the loss of anterior teeth, making edentulous patients less confident and limited to interacting with others [(4)].

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To overcome the above problems, implant-supported overdentures have been proposed during the last decades for restoring completely edentulous patients as an alternative and more effective treatment modality to the conventional complete removable denture. High long-term success rates and improved patients' quality of life were reported for implant-retained and -supported overdentures [5].

Occlusion is the most critical component of implant prosthodontics. 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. Therefore, the occlusion for the tissue-borne overdenture should include multiple bilateral, even contacts in centric relation and eccentric positions for proper force distribution[6].

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 marked area on the articulating paper is representative of how heavy the occlusal load is [7].

A t-scan computerized occlusal analysis system was introduced to avoid 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 [8].

The aim of this study was to evaluate the effect of computer-guided occlusal adjustment versus articulating paper on implant-retained mandibular complete overdenture on force distribution.

Patients and method:

The patient number was determined by a power test, according to Bhat and associates [9]. using SPSS version 18, when the power of the sample was 80% and the effect size at p.

The patients were divided into two groups. Each group contained five patients. Ethical approval was obtained from the 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 ten completely edentulous patients from the outpatient clinic of the 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 dentures with articulating paper adjustment received duplicated dentures with T-scan system adjustment and vice versa. Fig (1).

FIG (1) T- Scan device

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, and verification of esthetics, stability, retention, occlusion, high spots, and any sharp or overextension that could cause pain was 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 [10].

Two implant fixtures (Nucleoss, Menderes, Izmir, Turkey) with a length of 10 mm and a diameter of 3.7 mm were inserted in the inter canine region of the mandibular alveolar ridge. Depending on the occlusal adjustment method, patients were randomly divided into two groups. The study was completed in a crossover design.

Group I received dentures adjusted by articulating papers. Force distribution was measured at insertion, three months, and six months after insertion, they were replaced by dentures adjusted by t-scan, and measurements were repeated at the same periods.

Straight articulating paper was used of thickness 50μ and width 20 mm, where articulating paper marks were corrected to adjust high spots in centric and eccentric, both lateral and protrusive.

Group II received dentures adjusted by t-scan. Force distribution was measured at insertion, three months, and six months after insertion; then, they were replaced with dentures adjusted by articulating papers, and measurements were repeated at the same periods. This randomization was made to reduce the effect of prosthesis type and inherent bias on patient satisfaction. Fig (2).

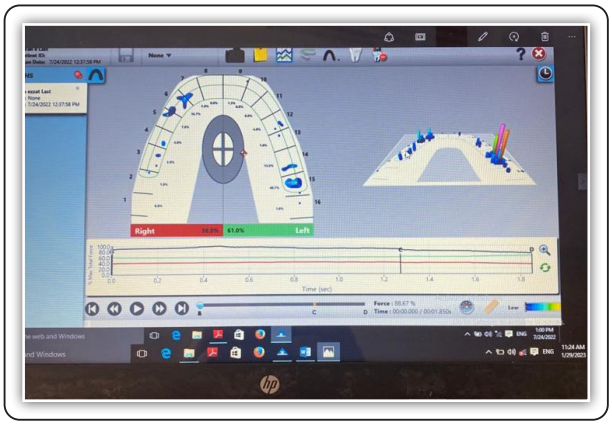

FIG (2) Force distribution measurement

The proper T-Scan Sensor support and proper size of pressure sensors were chosen and guided by the T-Scan support into the handpiece. The Graph and Graph Zoom windows contain color-coded "traces" representing the forces applied on each tooth, the magnitude of forces applied, the distribution of the forces along the arch and teeth under heavy contact, and premature contact inside each of the colored boxes in the 2-D Movie window.

According to the data displayed on the 3D graph, teeth with premature contact were reduced. The process was repeated until the contact between posterior teeth was equal in distribution and intensity and until the intensity of the biting force on both sides of the arch was nearly equal.

Finally, the mean values were calculated from the three recordings & the data was saved for statistical analysis.

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 the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistic version 18.

RESULTS

Force distribution results:

As shown in Table (1) , as regards force distribution in the anterior area, there was a statistically significant difference between group I & group 2 representing mean force distribution (14.368 ± 3.788 Vs 10.789 ± 1.685) at the time of insertion (T1).

The difference between the posterior right articulating paper & T-scan was statistically non-significant (36.654±5.986 Vs 48.365±4.808). In contrast, the difference between the posterior left articulating paper & T-scan was statistically significant (45.598±1.994 Vs 46.897±6.381) at the time of insertion (T1).

TABLE (1) Comparison between group 1(Articulating paper) and group 2 (T-Scan) as regards force distribution in anterior and posterior areas at the time of insertion (T1).

Group	Anterior Area	Posterior Right	Posterior left
		Mean ± SD	
Articulating paper	14.368±3.788	36.654±5.986	45.598±1.994
T-Scan	10.789±1.685	48.365±4.808	46.897±6.381
P value	0.018 (Significant)	0.193 (Non-significant)	0.006 (Significant)

P>0.05: non-significant P<0.05: significant

P<0.01: highly significant

P<0.001: very highly significant

As shown in Table 2, at the anterior teeth, there is a statistically significant difference between group I & group 2 representing mean force distribution (13.981±3.890 Vs 12.364±2.404) at 3-month intervals (T2).

The difference between posterior right articulating paper & T-scan was statistically significant (40.598±9.161Vs 50.351±11.269). In contrast, the difference between posterior left articulating paper & T-scan was statistically significant (41.121±8.324 Vs. 51.987±4.951) at three-month intervals (T2).

TABLE (2) Comparison between group 1 (Articulating paper) and group 2 (T-Scan) as regard to force distribution in posterior areas at 3-month intervals (T2).

Group	Anterior Area	Posterior Right	Posterior left
		Mean ± SD	
Articulating paper	13.981±3.890	40.598±9.161	41.121±8.324
T-Scan	12.364±2.404	50.351±11.269	51.987±4.951
p Value	0.186 (Significant)	0.041 (Significant)	0.001 (Significant)

As shown in Table 3, at the anterior area, there is a statistically non-significant difference between group I & group 2 representing mean force distribution (14.371±4.933 Vs. 13.912±2.287) at six-month intervals (T3).

The difference between posterior right articulating paper & T-scan was statistically significant (44.602 ± 10.152 Vs 53.140 ± 13.674), while the difference between posterior left articulating paper & T-scan was statistically significant (42.169±13.366 Vs 54.107±14.785) at 6 months interval (T3).

TABLE (3) Comparison between group 1(Articulating paper) and group 2 (T-Scan) as regard to force distribution in posterior areas at six-month intervals (T3).

Group	Anterior Area	Posterior Right	Posterior left
		Mean ± SD	
Articulating paper	14.371±4.933	44.602±10.152	42.169±13.366
T-Scan	13.912±2.287	53.140±13.674	54.107±14.785
p Value	0.763 Non-Significant	0.043 (Significant)	0.056 (Non significant)

DISCUSSION

CBCT was used in this study due to its ability to visualize the bone in coronal and sagittal sections. The morphology of the alveolar ridge and the height of the alveolar bone can be accurately displayed, showing the buccolingual thickness and the mesiodistal width. The absence of magnification and distortion encountered in panoramic x-ray, even digital ones, is a critical feature [11].

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 interforaminal region [12].

Placement of the dental implant inter foraminal region exhibits a high success rate and also reduces the risk of postoperative complications except for implant placement in the midline area of the lower jaw, care should be taken to avoid injury of lingual foramen contents that may cause morbidity of patient [13].

The same implant size was used as a variation in the length or the diameter of the implant, which may affect the biomechanics of the dental implant and may affect its result [14].

The use of articulation paper is the most used method to determine excessive force in differing occlusal contacts. Patients occlude upon strips of articulation paper that leave behind various ink markings on the tooth surface. No scientific evidence that shows articulation paper mark size, or mark appearance characteristics can accurately describe varying occlusal loads exists [15].

Afrashtehfar and Qadeer[16] reported that the computerized occlusal analysis system provides quantifiable force and time variance in a real-time window from the initial tooth contact to the maximum intercuspation, therefore providing valuable information. Bozhkova[17] 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 occlusal parameters were analyzed digitally using a computerized method viz. T-Scan III. It is considered as suitable, precise and reliable for occlusal analysis. The T-Scan III system proved to be beneficial as it is a rapid and accurate system in identifying the distribution of loads, regions of excessive force, uneven force concentration and occlusal force summation, which would not be possible with the conventional way of occlusal assessment like articulating paper [18].

The results of our study agreed with Ibraheem EM et al., who used T-scan analysis for evaluating the percentage of force distribution and determination of unseen premature contacts that could not be accurately detected using articulating paper due to mucosal resiliency. They concluded that using digital occlusal analysis (T-scan) and proper denture relining significantly improved the force distribution in initially ill-fitting complete dentures and further enhanced denture retention/stability, ensuring simultaneous occlusal contacts [19].

The results also agreed with Metwally et al., who concluded that occlusal force percentage was significantly decreased in the anterior area of the dentures in both studied groups after occlusal adjustment.

Metwally et al., presumed that the percentage of force distribution was not balanced on the anterior,

right & left sides of the dentures even after occlusal adjustment with laboratory remounting & intra-oral articulating paper techniques in tested groups. After T-scan digital occlusion analysis and adjustment of occlusion; the percentage of occlusal force was significantly decreased in anterior areas. This may be explained by the value of T-scan analysis in evaluating of force distribution & determination on unseen premature contacts that couldn't be detected by articulating paper due to mucosal resiliency [20].

Reddy S et al., said that the marked area with articulating paper increased nonlinearly with increasing load and there was a false-positive result. The characteristics of the paper mark appearance did not describe the amount of occlusal load present on a given tooth. The contact marking obtained using T-Scan for an applied occlusal load indicated that the marked area increased with an increase in the load and provided more predictable results of actual load content within the occlusal contact.

The size of an articulating paper mark may not be a reliable predictor of the actual load content within the occlusal contact, whereas a T-Scan provides more predictable results of the actual load content within the occlusal contact [21].

A study conducted by Kerstein and Qadeer[22] , concluded that there were false-positive results with the articulating paper.

Majithia I et al., granted that Computerized occlusal analysis provides accurate information when performing selective occlusal grinding of the cusps because the scanning not only analyses the tooth with premature contacts but also specifically indicates the slopes of the cusps that have to be subjected for grinding.

Also, they concluded that computerized occlusal analysis is not very technique-sensitive and the procedure can be performed easily to obtain accurate results as compared to the articulating paper because the thickness of the sensors is standardized, whereas the articulating paper thickness varies from one company to other.

Because of misinterpretation of readings, T Scan III sensors are synthetic and resistant to salivary wetting thus maintaining the accuracy of the recordings [23].

CONCLUSION

Within the limitation of this study, the T-scan could be used for occlusal adjustment of complete dentures.

REFERENCE

1. Elkafrawy MG, Abd Elfatah FA, Talep FA. Comparative evaluation of two different implant lengths for implant-assisted complete mandibular overdenture. Tanta Dental Journal. 2016; 1;13(3):139-46.
2. Hazari P, Bhoyar A, Mishra SK, Yadav NS, Mahajan H. A comparison of masticatory performance and efficiency of complete dentures made with high impact and flexible resins: a pilot study. Journal of clinical and diagnostic research: 2015;9(6):29-34
3. Udhayaraja P, Ariga P, Jain AR. Retention and stability of overdentures with ball, bar, or magnet attachments: A systematic review. Drug Invent. 2018;1;10:723-7.
4. Emami E, de Souza RF, Kabawat M, Feine JS. The impact of edentulism on oral and general health. International journal of dentistry. 2013; 8;2013.
5. Gargari M, Prete V, Pujia A, Ceruso F. Full-arch maxillary rehabilitation fixed on six implants. Oral & implantology. 2013;6:1-4.
6. Gross M. Occlusion in implant dentistry. A review of the literature of prosthetic determinants and current concepts. Australian dental journal. 2008;53:60-8.
7. Qadeer S, Yang L, Sarinnaphakorn L, Kerstein. Comparison of closure occlusal force parameters in post-orthodontic and non-orthodontic subjects using T-Scan® III DMD occlusal analysis. The Journal of Craniomandibular & Sleep Practice. 2016;34(6):395-401.
8. Kerstein RB, Thumati P, Padmaja SJ. Force finishing and centering to balance a removable complete denture prosthesis using the T-Scan III computerized occlusal analysis system. The Journal of Indian Prosthodontic Society. 2013;13:184-8.

9. Bhat S, Chowdhary R, Mahoorkar S. Comparison of masticatory efficiency, patient satisfaction for single, two, and three implants supported overdenture in the same patient: A pilot study. The Journal of the Indian Prosthodontic Society. 2016; 16(2):182-186

10. Liang X, Kim Y, Cho I. Residual bone height measured by panoramic radiography in older edentulous Korean patients. The journal of advanced prosthodontics. 2014; 6(1):53-59.

11. Resnik R, Kircos L. Diagnostic Imaging and Techniques In: Contemporary Implant Dentistry,(Misch CE). Mosby Elsevier, St. Louis, Missouri; 2008.

12. Dantas ID, Souza MB, Morais MH, Carreiro AD, Barbosa GA. Success and survival rates of mandibular overdentures supported by two or four implants: a systematic review. Brazilian oral research. 2014;28:74-80.

13. Pal KS, Sarapur S, Gaikwad A, Ali Z. Combination Syndrome: A Review of Classification and Treatment Modalities. Joint Research and Development. 2015;4(1):11-7.

14. Ghadiri M, Shafiei N, Salekdeh SH, Mottaghi P, Mirzaie T. Investigation of the dental implant geometry effect on stress distribution at dental implant–bone interface. Journal of the Brazilian Society of Mechanical Sciences and Engineering. 2016;38:335-43.

15. Carey JP, Craig M, Kerstein RB, Radke J. Determining a relationship between applied occlusal load and articulating paper mark area. The Open Dentistry Journal. 2007;1:1.

16. Afrashtehfar KI, Qadeer S. Computerized occlusal analysis as an alternative occlusal indicator. CRANIO®. 2016; 2;34(1):52-7.

17. Bozhkova TP. The T-SCAN system in evaluating occlusal contacts. Folia medica. 2016;1;58(2):122-130

18. Dias RA, Rodrigues MJ, Messias AL, Guerra FA, Manfredini D. Comparison between conventional and computerised methods in the assessment of an occlusal scheme. Journal of Oral Rehabilitation. 2020;47(2):221-8.

19. Ibraheem EM, ElGabry HS. Effect of mandibular complete dentures relining on occlusal force distribution using T-scan system. Bulletin of the National Research Centre. 2021;45(1):1-7.

20. Metwally AF. Comparison Of Patient Satisfaction & Occlusal Force Distribution pattern In CAD/CAM and conventional Complete Dentures Using The T-Scan III Computerized Occlusal Analysis System.(RCT). Egyptian Dental Journal. 2019; 1;65:2641-9.

21. Reddy S, Kumar PS, Grandhi VV. Relationship between the applied occlusal load and the size of markings produced due to occlusal contact using dental articulating paper and T-Scan: comparative study. JMIR Biomedical Engineering. 2018;3(1):11347-57

22. Qadeer S, Kerstein R, Kim RJ, Huh JB, Shin SW. Relationship between articulation paper mark size and percentage of force measured with computerized occlusal analysis. The Journal of Advanced Prosthodontics. 2012;1;4(1):7-12.

23. Majithia IP, Arora V, Kumar SA, Saxena V, Mittal M. Comparison of articulating paper markings and T Scan III recordings to evaluate occlusal force in normal and rehabilitated maxillofacial trauma patients. Medical journal armed forces India. 2015 ; 1;71:382-8.