



COMPREHENSIVE ASSESSMENT OF TREATMENT SATISFACTION WITH COMPLETE DENTURES ARTICULATED WITH THE T-SCAN SYSTEM AND ARTICULATION PAPER

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ABSTRACT:

Background: Prosthetic treatment in case of complete edentulism has the task of restoring the lost chewing function, speech and breathing and preventing the appearance or deepening of the reduction changes of both the soft tissues and the bones in the maxillofacial region, as well as restoring the aesthetic appearance and improving the psyche of the patient

The **aim** of the present pilot study is to evaluate the satisfaction with treatment with complete dentures articulated with articulation paper and the T-SCAN system, which will serve as the basis for a large-scale cross-sectional study.

Material and methods: The study includes a sample of 20 completely edentulous patients. The sample consisted of 10 women and 10 men. The studied patients were randomly divided into two groups of 10 people each. The patients were interviewed post treatment [at 5 weeks], a validated questionnaire about oral health-related quality of life in edentulous people [OHIP-EDENT] was applied.

Results: The digital occlusal analysis provides more accurate information on the articulation of the prostheses, as it indicates the teeth with increased force in percentages and also the sequence of occurrence of the occlusal contacts. Analysis of occlusal contacts is subjective, and articulating them with this method carries error risks. When using the T-Scan system, patients are more satisfied than the treatment with total patients, as they feel the prostheses are much more comfortable and in much fewer visits.

Conclusion: This quantitative methodology can be used as the method of choice for control of occluso-articulation relationships in treatment with total dentures in any dental practice, if technically possible.

Keywords: T-SCAN system, articulation paper, occlusal-articulation relationships, complete denture,

INTRODUCTION

Complete edentulism is a very severe pathological condition of the masticatory apparatus, which is defined as the complete loss of permanent teeth and is very common worldwide in the elderly population between 65 and 74 years of age [1]. The absence of teeth inevitably leads to significant changes and disorders in the maxillofacial area, in the orofacial complex and in the whole organism. The changes are irreversible and constantly progressing and deepening [2]. That is why the condition of complete edentulism is an indication of urgent prosthetic treatment with complete dentures [3].

Prosthetic treatment in case of complete edentulism has the task of restoring the lost chewing function, speech and breathing and preventing the appearance or deepening of the reduction changes of both the soft tissues and the bones in the maxillofacial region, as well as restoring the aesthetic appearance and improving the psyche of the patient [4, 5]. Artificial teeth must be arranged in such a way as to create conditions for unhindered movements with a maximum number of contacting surfaces during the articulation cycles. On the one hand, the multiple contacts contribute to the universal or a universal pressing of the prostheses to the mucosa, and thus translations and rotations are avoided; on the other hand, they are a factor for the uniform distribution of chewing pressure over the entire surface of the prosthetic field [6]. To achieve ideal occlusion, it is necessary that all lateral teeth contact simultaneously and that the occlusal contacts are evenly distributed [7]. As a criterion for evaluating the complete prostheses and their functional suitability, the

need to create occlusal-articulation contacts ensuring bilaterally balanced occlusion is indicated [8]. Retention is a *conditio sine qua non* [a condition without which it cannot] for the stability of a complete denture.

Both qualitative and quantitative methods are used to record occlusal-articulation relationships [9, 10]. The most commonly used qualitative occlusal indicator is articulation paper [11]. Of the quantitative methods in practice, the most widespread is the T-SCAN system. The system is a precise method for assessing the consistency and strength of occlusal contacts [12, 13]. The T-SCAN system [Tekscan Inc., South Boston, MA, USA] can be used to perform computer-guided occlusal adjustment of complete dentures since one of the causes of destabilization of dentures during function is the incorrect distribution of occlusal contacts [14].

The **aim** of the present pilot study is to evaluate the satisfaction with treatment with complete dentures articulated with articulation paper and the T-SCAN system, which will serve as the basis for a large-scale cross-sectional study.

MATERIALS AND METHODS:

Study design

The study includes a sample of 20 completely edentulous patients who visited the Department of Prosthetic Dentistry at the Faculty of Dental Medicine Plovdiv-Bulgaria for treatment with complete dentures. A set of total upper and lower jaw dentures were made for each patient. The sample consisted of 10 women and 10 men with an average age of 67.25 ± 4.34 . The studied patients were randomly divided into two groups of 10 people each. The following inclusion criteria were established: edentulous in both jaws with no previous history of denture treatment and no significant medical history. Exclusion criteria were the presence of polyarthritis or other rheumatic diseases, xerostomia, severe oral manifestations of systematic diseases, and psychological or psychiatric conditions that could influence data collection.

Accuracy of Articulation:

In the first group, control of the occluso-articulation relationships was done using the T-Scan Novus Digital Occlusal Analysis System [T-Scan™ v9.1 Software, Tekscan, Norwood, MA, USA, 2018]. The system consists of a handle, a 100 µm thick sensor and a sensor holder [Figure 1.]. The obtained results were visualized and analyzed using software version 9.1.

Fig. 1. T-Scan Novus Digital Occlusal Analysis System



In the second group, a conventional technique with Bausch articulating paper 100 µ [PROGRESS 100 Microns Articulating Paper with Progressive Color Transfer, Bausch Articulating Papers, Inc., USA, 1998] was used for articulating the total patients [Figure 2]. This 100-micron paper is impregnated with hydrophilic waxes and pharmaceutical oils. This unique combination with the bonding agent Transculase® enhances the detection of high spots on hard to locate surfaces, such as highly polished metals or ceramics. Its hydrophilic properties make it advantageous for use on moist occlusal surfaces – a highly desirable attribute. On the occlusal surface of teeth, many marks of different sizes and intensities of the coloring are obtained. Analysis of occlusal contact strength is subjective.

Fig. 2. Articulation paper 100 µ



Functionality:

Assess the overall functionality of the prostheses in terms of speech, chewing efficiency, and other relevant activities. They use standardized criteria: stability during function, absence of premature contacts, distribution of forces, patient comfort.

Patient Satisfaction:

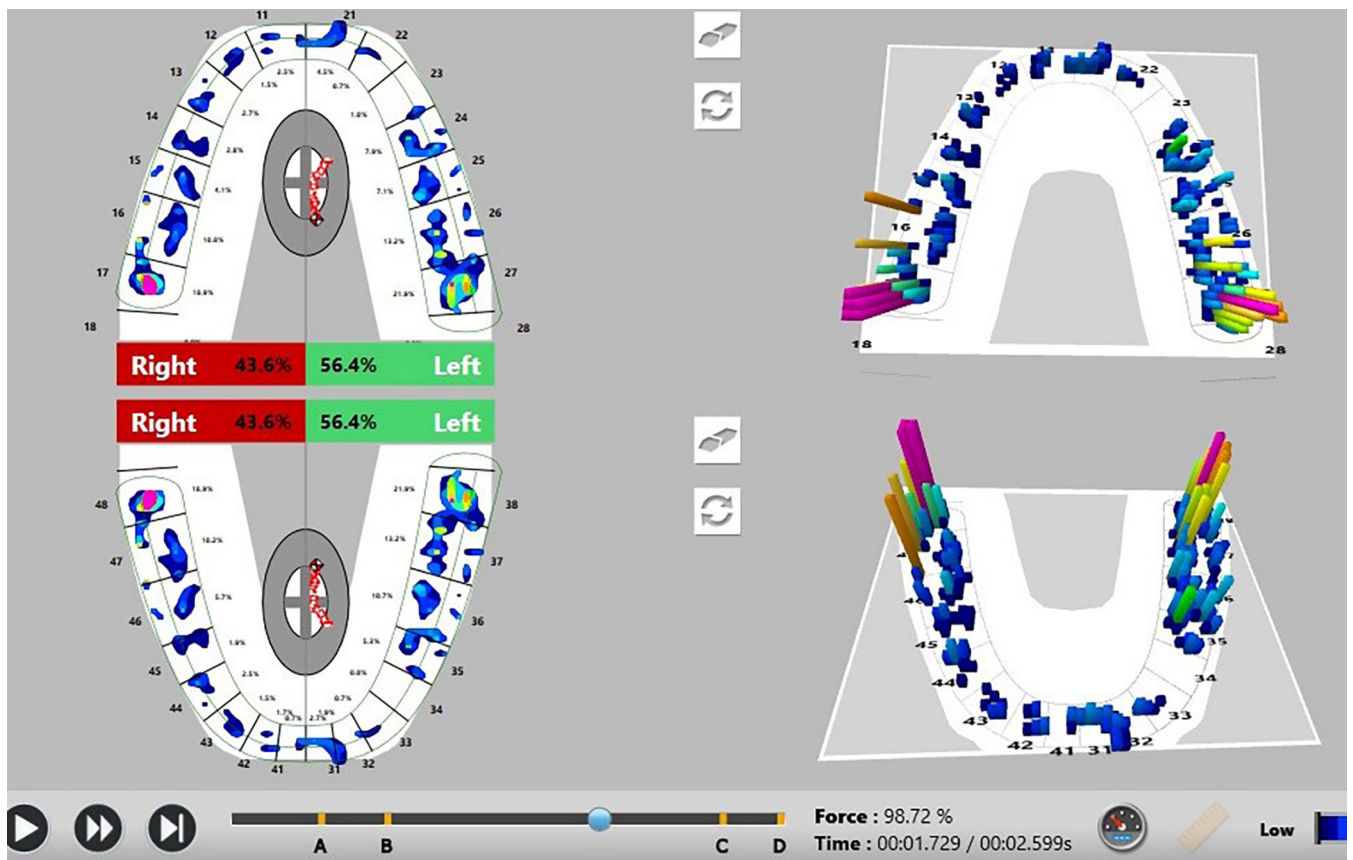
The patients were interviewed post treatment [at 5 weeks], a validated questionnaire about oral health-related quality of life in edentulous people [OHIP-EDENT] was applied. The OHIP-EDENT [Oral Health Impact Profile for Edentulous Adults] is a tool used to measure the impact of oral health on the quality of life for edentulous individuals, particularly those with complete dentures. The questionnaire assesses various aspects, such as functional limitations, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. Score each response based on the OHIP-EDENT scoring system. The scores typically range from 0 to 4 [0 = never, 4 = very often]. Sum the scores for each patient to get a total OHIP-EDENT score. Each session of the interview was ~15 min and was conducted in the clinical area by a single interviewer at both visits to minimize the vari-

ability. Written informed consent was obtained from the patients, and they were assured that the research worker was not involved in their treatment and that their participation would not influence the outcome or cost of their treatment.

RESULTS:

During the study of occlusion, the T-Scan Novus system registers the sequence, force and time of occurrence of occlusal contacts, which are stored in an individual file in the form of a film. The digital occlusal examination system software visualizes the registered contact 2D and 3D graphic images of the upper and lower dentition, respectively. The recorded occlusal contacts are colored in different colors, indicating the strength of each contact. The strongest contacts are colored in red, and the weakest in blue. The examination shows an individually calculated dental arch for each patient and the percentage distribution of forces in the area of each tooth. The software automatically calculates the distribution of occlusal forces in the right and left halves of the dentition, respectively. The recorded quantitative data enable an accurate quantitative analysis of the occluso-articulation relationships [Figure 3].

Fig. 3. 2D and 3D images of the registered occlusal contacts.



Achieving evenly distributed occlusal contacts is achieved using 100 μ thick articulating paper [Figure 4]. The registered occlusal contacts are visualized as marks of varying size and shape. The assessment of strength is subjective and is determined by the size and intensity of the staining.

Fig. 4. Registered occlusal contacts with articulation paper.



The null hypothesis was partially accepted. Data about OHIP-EDENT were similar for both groups of patients digital T-Scan articulation and conventional articulated dentures. However, digital dentures showed better results in comfort, retention, and satisfaction. In addition, fewer follow-up sessions were needed for dentures articulated with the T-Scan system.

OHIP-EDENT score for both dentures was 4 [Table 1], indicating a low impact of oral health on quality of life. These values are in accordance with clinical studies about oral health-related quality of life in denture wearers [15]. Since this evaluation was conducted after the adjustment of the denture ase and a certain period of adaptation to denture wear, the pain was reported in both situations [16, 17]. Furthermore, since both dentures were removable and supported by mucosa, the evaluation of OHIP-EDENT domains [functional limitation, psychological discomfort, psychological disability, social disability and handicap] were similar [18].

Table 1. OHIP-EDENT scores for complete dentures.

Variables	Digital denture Mean	Conventional denture Mean
Functional limitation	0	2
Pain	1	2
Psychological discomfort	0	0
Physical disability	2	2
Psychological disability	0	0
Social disability	0	0
Handicap	0	0
Total OHIP	3	6

DISCUSSION:

Many methods and materials have been used to determine premature occlusal contacts and articulation blocks in clinical practice [11]. The accuracy of the occlusal indicators used is essential to create occlusal harmony, which is the ultimate goal of dental treatment. The analysis of the occlusal-articulation relationships and the corrections that are necessary depend on the exact markings of the occlusal contacts [19]. With qualitative methods, it is only possible to determine the localization of the occlusal contacts, and the sequence and strength of the contacts cannot be assessed. In practice, dentists very often evaluate the strength of occlusal contacts according to the intensity of staining and the size of the marks obtained. This widespread perception has been proven to be wrong and can lead to errors in the articulation of prosthetic structures [20, 21].

Some of the quality indicators are thick and have relatively little flexibility, which can lead to a higher number of false marks. The resulting markings with this type of indicators are also easily washed off by saliva [22, 23]. All this gives the possibility of errors in the articulation of the entire prostheses, which will prevent the achievement of a balanced occlusion.

Quantitative methods for evaluating occlusal relationships can determine the sequence and frequency of contacts, which is recorded in real time [24]. The effectiveness of the T-Scan system has been evaluated in many studies that confirm its use also as an alternative to conventional occlusal analysis [25, 26, 27]. These studies also prove our opinion that the T-scan system is a good alternative to the conventional method for studying occluso-articulation relationships. Studies show how the digital occlusion analysis system has improved over the years, although some limitations remain in its use [28, 29].

There are a number of studies in the literature that assess comfort, retention, esthetics, mastication, phonetics and wearing comfort using the Oral Health-Related Quality of Life in Edentulous People [OHIP-EDENT] questionnaire [18, 30, 31]. The analysis of the results obtained from the questionnaire shows that the patients whose occlusal adjustment was performed with the T-Scan system are more satisfied with the final result of the treatment with full dentures. In our opinion, this is due to the more accurate and rapid achievement of balanced occlusal relationships using the digital analysis system. The obtained quantitative parameters provide a more accurate assessment of occlusion compared to the conventional method. This statement of ours is confirmed by a number of other authors [32, 33].

A careful check of the occlusion should be made when handing over the complete dentures, as it is an effective factor in the correct distribution of masticatory pressure on the denture base, in the stability of the denture and last but not least in the comfort and satisfaction of the patient [34].

The success of treatment with total dentures is based on the patient's opinion, mainly considering the sta-

bility of the dentures, wearing comfort, speech, eating ability and aesthetics [35]. A specific instrument is used in the literature to assess all clinical changes and quality of life of edentulous OHIP-EDENT patients after prosthetic treatment [36]. Harmonious occlusal relationships, in addition to providing more excellent retention and stability of dentures, have been shown to help break down food more easily and improve masticatory efficiency, resulting in patient comfort with new dentures [37, 38].

There are many studies in the literature showing that good treatment with complete dentures significantly improves the quality of life of totally edentulous patients. It has been proven that, in addition to the restoration of impaired functions and aesthetics, the social status of patients is also improved [39-43].

Additionally, comparing the T-Scan system with traditional articulation paper can help identify the strengths and weaknesses of each method in achieving optimal treatment outcomes.

Comparison of the benefits and drawbacks of using the T-Scan system and articulation paper regarding time, cost, accuracy, and patient satisfaction (table 2).

Table 2. Comparison of the benefits and drawbacks of using the T-Scan system and articulation paper

Indicators for comparison	T-Scan	Articulation paper
Time	The research and analysis takes place in minutes	The research and analysis takes place in minutes
Cost	The system is expensive	One of the cheapest indicators on the market
Accuracy	Better exactly	Less accuracy
Patient satisfaction	More satisfied	Less satisfied

Research Limitations:

Several limitations need to be highlighted in the present pilot study. The sample size consisted of only 20 people who had full dentures made. Since interpreting the occlusal contacts obtained with articulation paper is subjective, it was performed by a single dentist. In order to avoid the shortcomings of the paper, it is recommended that the registration of the occlusal contacts be performed on dried surfaces. Saliva does not affect the registration of occlusal contacts in the T-scan examination. In order to ensure greater reliability of the obtained results, the same clinician performed the studies of occluso-articulation relationships in both groups of patients.

CONCLUSION:

Within the limitations of the study, the following conclusions and recommendations can be drawn.

1. The digital study of occlusal-articulation relationships is a more expensive method compared to the conventional articulating method.
2. The digital occlusal analysis provides more accurate information on the articulation of the prostheses, as it indicates the teeth with increased force in percentages and also the sequence of occurrence of the occlusal contacts. Analysis of occlusal contacts is subjective and articulating with this method carries risks of error.
3. Articulating paper markings can be contaminated

by the saliva and hence can cause misinterpretation of readings, whereas, in the T-Scan system, the sensors are synthetic and are not affected by saliva.

4. When using the T-Scan system, patients are more satisfied than the treatment with total patients, as they feel the prostheses are much more comfortable and in much fewer visits.

5. As a disadvantage of the T-Scan system, we can point out that the occlusal contacts are not marked intraorally in any way.

Recommendations:

1. We recommend that the two methods be used in combination whenever possible in order to achieve the most accurate examination of the occlusion.

2. The T-scan system facilitates the process of occlusal adjustment of complete dentures, resulting in better treatment satisfaction for edentulous patients.

3. This quantitative methodology can be used as the method of choice for control of occluso-articulation relationships in treatment with total dentures in any dental practice, if technically possible.

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