COMPUTER ANALYSIS OF FUNCTIONAL PARAMETERS AND DENTAL OCCLUSION

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ABSTRACT

The paper presents the modern device and methodology for computer occlusal analysis. The method allows clinical and experimental studies directly on the patients measuring occlusal parameters in static positions and during dynamic of the mandible. The advantages compared to other methods of occlusal analysis on articulated dental casts consist in elimination of the deficiencies caused by the impossibility of isolating individual variables. T-Scan system is rapid and accurate in identifing the distribution of the tooth contacts; it shows great promise as a clinical diagnostic screening device for occlusion and for improving the occlusion after various dental treatments.

K**eywords**: occlusion, functional parameters, computer analysis, orthodontics

1. Introduction

Dental occlusion refers the act of closure of dental arches, depending on the relations of lower and upper teeth.

Occlusion has a functional role and is involved in different functions of the dentition: speaking, mastication, deglutition or esthetics.

"The key of dentistry", as it is called, occlusion is studied nowadays in universities all over the word under different names of disciplines: gnathology, occlusion, prosthetics or orthodontics [1].

Occlusion is not a fixed anatomical state, it suffers changes and adaptive remodeling during lifetime. Considering this, the study of occlusion is now directed towards studying the variability of normal occlusion that permits functional comfort, stability and esthetics[2].

In prosthodontics and orthodontics there is a special interest in determination of occlusal static and dynamic parameters, which should be correlated to the physiology of temporo-mandibular joints[2].

An important step in the study of biomechanics of occlusion was made when articulators were developed and used as individual simulators. These have the possibility to recreate the complex movements of the mandible in three spatial directions permitted by the condyles.

With all these, modern devices used in simulating condylar movements are unable to represent precisely the function of neuromuscular complex, so the best articulator is the stomatognathic system.

This paper presents the modern devices and methods for clinical and experimental computer analysis of occlusal parameters. This evaluation is made entirely on the patient, eliminating deficiencies resulted from the impossibility of isolating individual variables.

2. Materials and method

The method considered for the occlusal analysis was a computerized system, T-Scan III (Tekscan Corp) a device simple and easy to use for examination of occlusal contacts.

Fig. 1 - T-Scan Sensor: small and large[3]

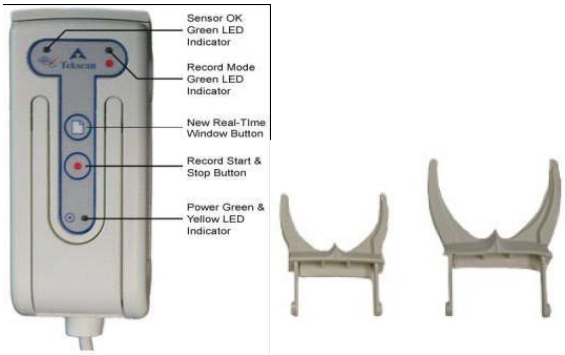

Fig. 2 - T-Scan handle and sensor support: small and large

The T-Scan III technology has application in all phases of dentistry in which occlusal diagnosis and treatment are involved, and remains the only practical quantitative method to analyze the occlusion.

The system is composed of a computer with a specific board and software capable of converting information recorded by the sensor to visual and numerical information on tooth contact. For the Tekscan system to function properly, computer system must meet or exceed specified system requirements.

The Tekscan USB handle does not require an additional interface card or parallel box in order to be connected to computer.

Most computers now come equipped with at least 2 USB connectors. These handles can be connected directly to computer via the handle's USB cable.

When inserted into computer, the computer's operating system will automatically detect and configure the hardware for use.

The *T-Scan III* sensor (Fig.1, and Fig.2) is an ultra-thin (.004", 0.1 mm), flexible printed circuit that detects your patient's occlusal forces.

These sensors are made up of 1370 active pressure sensing locations for the large sensor, and 1122 pressure sensing locations for the small sensor.

These sensing locations are referred to as 'sensing elements', or 'sensels'. The 'sensels' are arranged in rows and columns on the sensor.

The *T-Scan III* software offers features that allow the user to: Record the patient's occlusal contact data; View the patient's tooth contacts and associate them with specific teeth; Analyze the data, with the force and time relationships of the contacts displayed as color contour images, showing: Instant Intercuspidal Position; Center of Force; Center of Force Trajectory; More advanced features, such as:

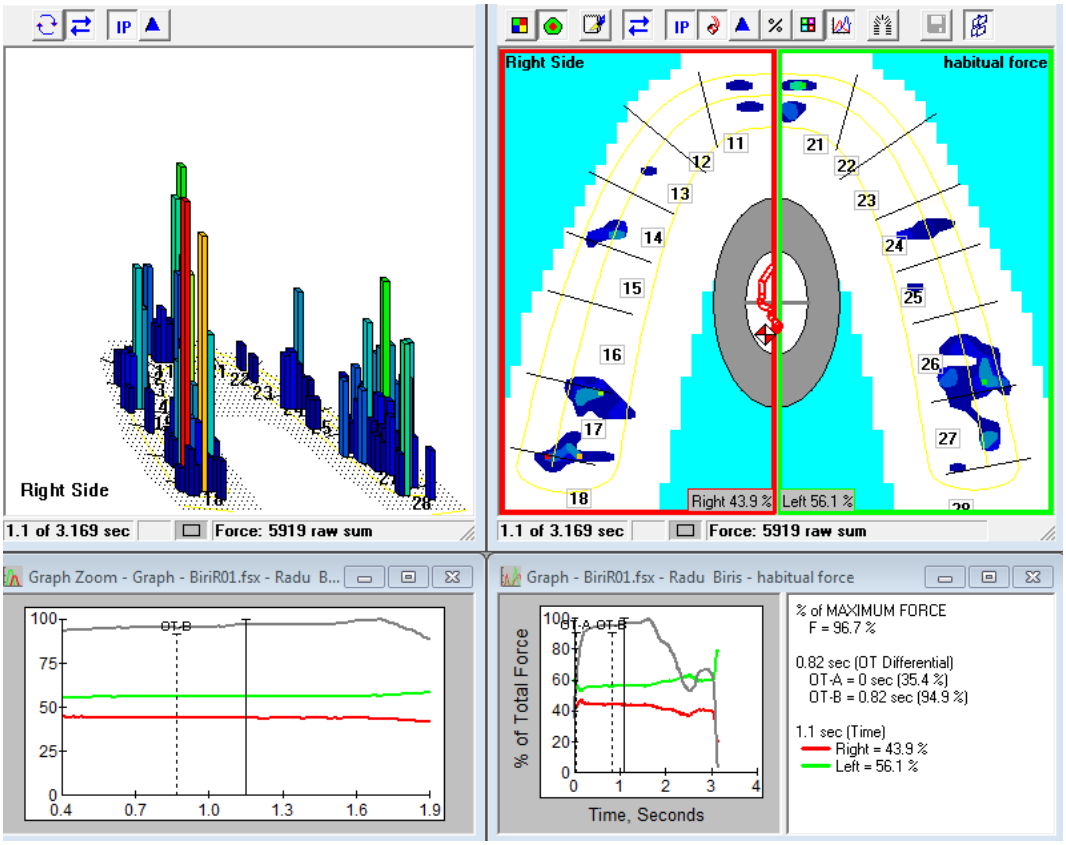

Fig. 3 - Example of a computer analysis

Max, Delta, Graph, Graph Zoom and 3-D Columns, Manage patient records and movie files through the use of an intuitive database. The *T-Scan III* software is compatible with Microsoft (MS) Windows 2000/XP/Vista/7.

The recording is taken by placing the sensor in the patient's mouth, with the sensor support pointer between the two central incisors and keeping the scanning handle as parallel to the occlusal plane as possible.

Having the patient bite down normally on the sensor, the first tooth contact will cause the system to begin recording. While recording is in progress, the Real-time Status Bar shows the frame count progress.

By default, the first contact on the sensor will trigger the recording, and 20 frames that lead up to that trigger event are automatically included at the beginning of the movie. This assures that if there is any light contact leading up to the contact that triggers the movie, it will be included in the recording. By using the Triggering option, the operator needs to be careful not to allow anything to press on the sensor before the intended event occurs, as this may cause premature recording.

Each sensel can be seen as an individual square on the computer screen by selecting the 2-D display mode or as a bar in 3-D mode.

The output of each sensel is divided into 256 increments, and displayed as a value (raw sum) in the range of 0 to 255 by the software [3].

The analytical software displays, such as "Center of Force (COF)" and "Center of Force Trajectory," provide in-depth understanding of the overall balance of the occlusion, which cuts to the heart of occlusal analysis [3].

Center of Force analysis allows the dentist to examine easily the total effect of restorative dentistry on the patient's maximum closure and excursions.

Initial records were taken on patients before initiating orthodontic therapy. The patients were referred to the orthodontic department by other dentists for orthodontic treatment. T-Scan III 5.0

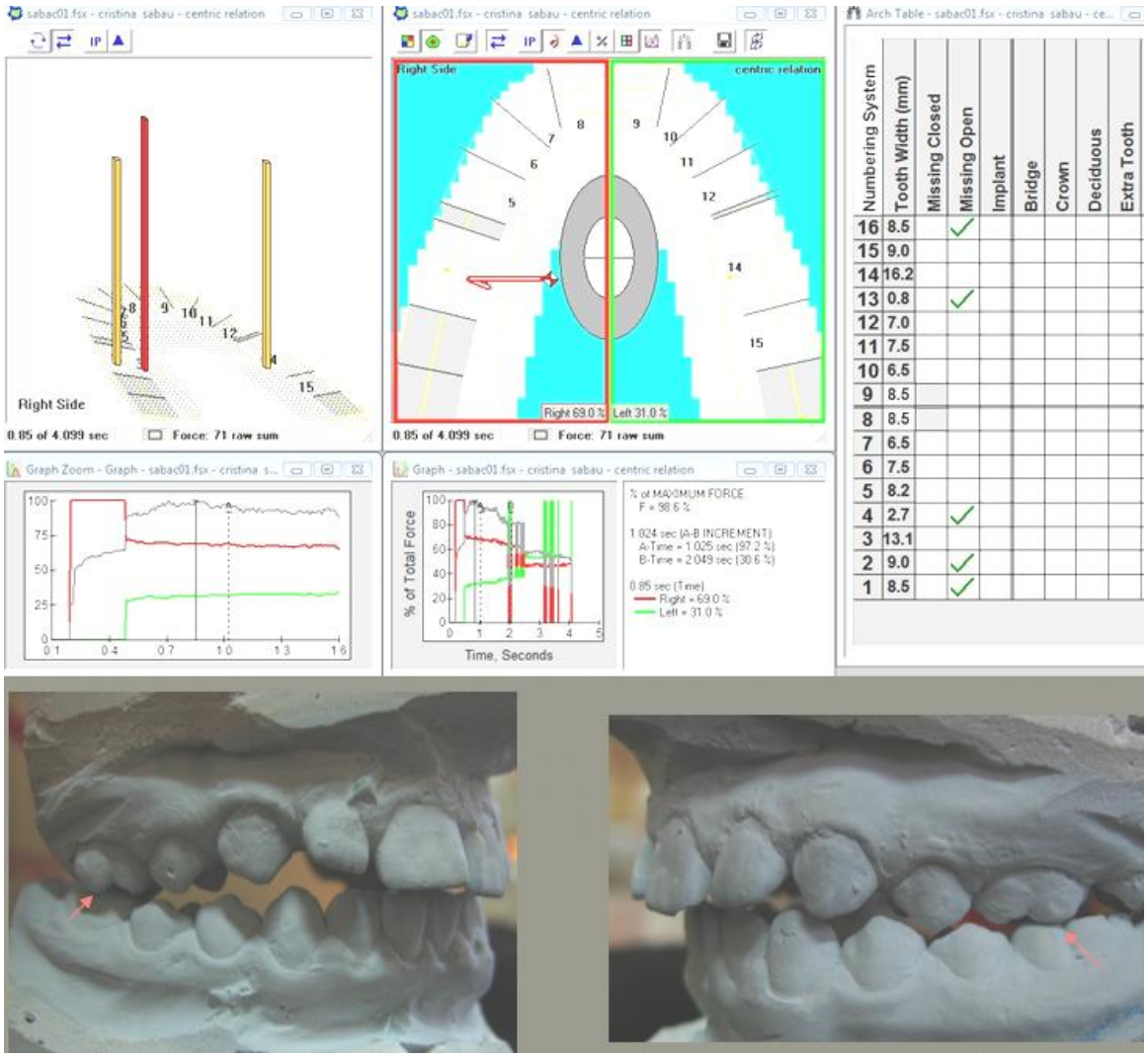

Fig. 4 - Example of a computer analysis. Remark the occlusal contacts on the chart correspondent to the red arrows on the casts

system was used to record occlusal contacts in maximal intercuspal position. Data collected were analyzed with the computer software integrated in the system.

3. Results and discussions

The occlusal records of two patients are presented. Preliminary data resulted from occlusal analysis enables occlusal contacts graphical representation and also force quantification and distribution along dental arches and on each tooth.

Figure 3 presents a case of initial recording on a patient with normal arches excepting an ectopically positioned upper left cuspid. The four windows show different aspect of occlusal examination. The upper right box is a 3D chart of occlusal contacts intensities on every tooth of the dental arch.

The height and color of the bar is related to the pressure of the contact. The upper left window show the distribution of contacts on the arch, also quantified on the left and right sides. For this patients there is a good distribution for the two sides, 43,9% on the right and 56,1% on the left.

The center of force is placed in the white ellipse, meaning that the vectors of force meet in the central point of the arch, showing a favorable situation.

The lower windows present data that can be used to calculate different parameters of the occlusion, such as maximal force, occlusion time, disclosure time.

The second case is a female patient with a complex malloclusion: open bite 16-24, mandibular retrognathia, bilateral cross-bite, agenesis of 15,25.

The intercuspal position show only 3 contact points that correspond to the red arrows marked on the plaster casts. The clinical evaluation could not offer the information about the intensity of these contacts.

Figure 4 show that the right side of the patient is dominant, with the center of force evidently displaced to the right.

The center of effort for tooth contacts anteroposteriorly should be located in the region of the first molar and be symmetrical bilaterally[4,5]. In this case is located eccentric to the right side and the molars are the only teeth that contact.

Occlusal analysis marked out in the first patient even and in the second other uneven distribution of occlusal contacts. Further study will correlate occlusal analysis results with electromyographic data, clinical and other paraclinical parameters.

4. Conclusions

T-Scan is a high technology instrument that helps the dentist detect in a very precise way functional and parafunctional occlusal contacts.

Unlike articulating paper which is leave color marking on every tooth contact the sensor is able to determine the timing and sequence of contacts.

This is helpful in considering and eliminating the premature contacts and interferences.

This method permits quantify the forces and their distribution, in every mandibular position with the teeth of contact.

Center of force can be easily visualized on the chart created by the analysis software, and in every frame COF track can be followed and the degree of balanced occlusion assessed.

Articulating paper labeling is an inadequate indicator of perceived occlusal contact time simultaneity as it renders no occlusal contact force or time sequencing [6]. T-Scan measures the intensity and timing of every contact, and also builds easy to interpret graphics.

Computerized occlusal analysis is becoming a very good tool available to clinicians with which to understand functional and parafunctional forces of occlusal contact, contact timing sequences, and occlusal surface interface pressures.

The T-Scan III technology has application in dentistry in which occlusal diagnosis and treatment are involved, and remains the only practical quantitative method to analyze the occlusion.

T-Scan system is rapid and accurate in identifying the distribution of the tooth contacts; it shows great promise as a clinical diagnostic screening device for occlusion, guiding dental treatment to obtain measurable bilateral occlusal contact simultaneity.

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