CASE REPORTS

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Analyzing the morphology and intensity of occlusal contacts in implant-prosthetic restorations using T-Scan system

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Abstract

The dentists must have solid knowledge in occlusology in order to obtain predictable long-term results for the implant-prosthetic treatment. The aim of our study was to verify if, with methods and materials currently used in any dental office for occlusal equilibration, the dentist can successfully integrate the implant-prosthetic restoration in the habitual occlusion of the patient. Using the T-Scan II system, we analyzed occlusion of three mandibular class III Kennedy edentulous male patients, from a private practice in Bucharest (Romania), all missing the first mandibular molar and all wearing a metal-ceramic crown on implant. In all these cases, the occlusion of the crowns was adjusted using articulating paper and vinyl polysiloxane biting material. The analysis of occlusion with the T-Scan II system in those three cases showed that the crowns were successfully integrated in the habitual occlusion. This study proves that those traditional methods, which are most frequently used in practice, are good enough to adjust the morphology and intensity of the occlusal contacts, if they are correctly and conscientiously used.

Keywords: occlusion, implant-prosthetic restoration, articulating paper, biting vinyl polysiloxane, T-Scan.

Introduction

The surviving rate of the dental implants is correlated with the surgical technique, the osseointegration and the correct execution of the prosthetic restoration [1, 2]. The occlusion of this restoration must be done properly, so the forces that appear do not cause the breakdown of the osseointegration [3]. It has been recommended that the occlusal morphology should have a smooth shape with minimal cusp height and fossae depth [4]. Regarding the form of the occlusal surface, the idealized morphology, including tripodization of contacts, has been recommended by advocates of more advanced occlusal philosophies [5]. Some authors published a review about the history of the dental materials used for recording static and dynamic occlusal contacts and they have found about 17 methods used in prosthodontics [6]. For an accurate examination of occlusion in prosthodontic treatments, it is important to understand the patterns of tooth contact, the properties of the materials and the methods used to record these tooth contacts [7, 8]. The timing and force of occlusal contacts were measured by some researchers with the T-Scan system, and it has been reported that the center of the effort was located in the first molar region [9]. The invention of T-Scan device allows the recording of the occlusal contacts between the dental arches and represents a breakthrough for obtaining the correct occlusion of the implant-prosthetic restorations, but its costs are exceeding the budget of a simple dental practice. Therefore, there is a debate between some authors that argue that the use of the T-Scan system is the only reliable method to analyze the occlusal contacts, because the conventional methods are generating errors [10], and other authors which have shown that the intense marks obtained with the articulating paper stand for tighter occlusal contacts [11].

The aim of this *in vivo* study is to demonstrate, with the help of the T-Scan II system, that the articulating paper and the vinyl polysiloxane biting material usually used by the dentists for balancing implant-prosthetic crown's occlusion, are good enough for integrate it in the habitual occlusion of the patient.

Materials and Methods

In this study, we analyzed, using the T-Scan II system, the occlusions of three mandibular class III Kennedy edentulous male patients from a private practice in Bucharest (Romania), all missing the first mandibular molar and all being prosthetically rehabilitated with an implant and a metal-ceramic crown. In all cases, the implants were inserted in the first phase and the prosthetic treatment was made after a four months period of osseo-integration, in the second phase, by the same dentist. The occlusal morphology of the crowns and the intensity of the occlusal contacts were integrated in the habitual occlusion of the patient using the articulating paper and the vinyl polysiloxane biting material. In those three cases analyzed in our study, the dentist and the dental technician adapted the morphology of the implant-prosthetic restorations using only those two methods.

The habitual occlusion was verified and registered.

The chief complains of any of three patients were not related with TMJ (temporomandibular joint) problems. To verify if those methods (the use of the articulating paper and of the vinyl polysiloxane biting material) are accurate and if the prosthetic restoration was successfully integrated into the habitual occlusion of the patient, we have analyzed the occlusion of the restoration with the T-Scan II system, Tekscan Inc. (South Boston, MA, USA), in order to measure and to record the forces corresponding to the occlusal contacts.

For choosing the right size of the sensor, we have measured with a digital caliper the upper central incisor. For each patient, we used a new sensor and we have done several measurements with the same device. The sensor was applied to an autoclavable plastic fork-shaped device, which was then placed on the upper arch of the patient. Patients were instructed to bite firmly on the sensor, and the results could be visualized on a PC monitor. The image is adjusted by the system-operating program of T-Scan II, which has the ability to recognize the form and type of the teeth and also the missing teeth from the arches. In order to compensate the variations of the occlusal forces, which are different from patient to patient, the T-Scan II sensor was calibrated before each recording. For the same patient, we have maintained the same values for the sensor sensitivity in all the records we have made. The following occlusion parameters were evaluated in this *in vivo* study: the time from the first occlusal contact to maximum intercuspation (MIP), the distribution area of the left and right occlusal contacts (percentage) and the distribution area of the occlusal contacts when the mandible is conducted in propulsion (percentage). The software processed and restored data as 2D and 3D graphics.

Results

Patient B.S. came to the dental office with a class III Kennedy edentulous space (a missing 3.6). The habitual occlusion of the patient presented prezature contacts at the level of tooth 3.7 and 4.7; in maximum intercuspation (MIP), the forces are equilibrated: 49.2% in the left quadrant, respectively 50.8% in the right one. At the level of the implant-prosthetic restoration (3.6) was recorded the smallest percent of the masticatory force from the molar area (Figure 1). In propulsion, we have observed that the first contact appears at the level of tooth 2.7, and this contact it is maintained during the whole movement (Figure 2). During both MIP and propulsion, we have noticed that there were not any premature contacts and interferences on the implant-prosthetic restoration.

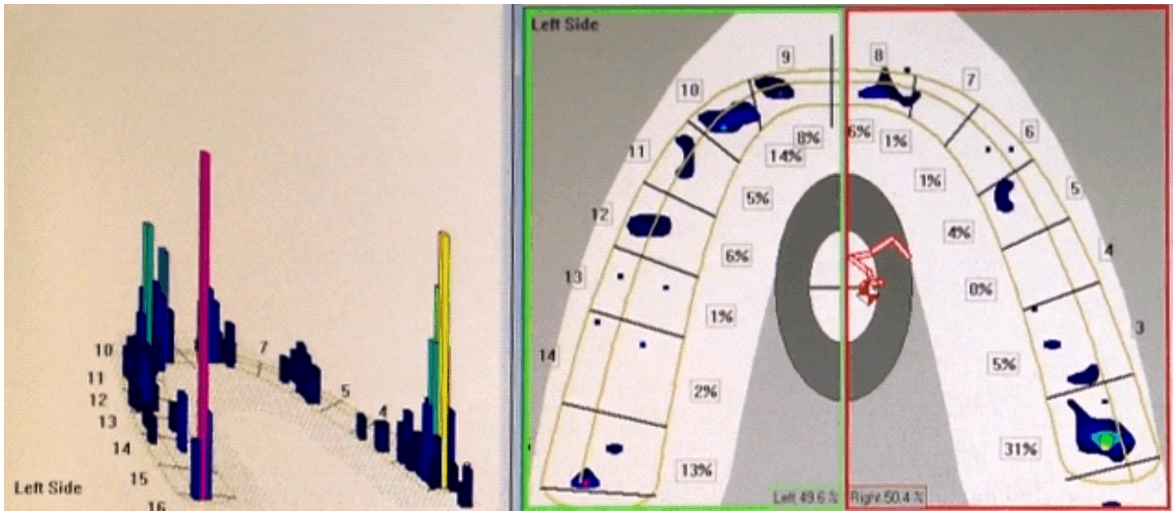

Figure 1 – ***Patient B.S.: the maximum intercuspation (3D and 2D display); at the level of the implant-prosthetic restoration (3.6) was recorded the smallest percent of the masticatory force from the molar area.***

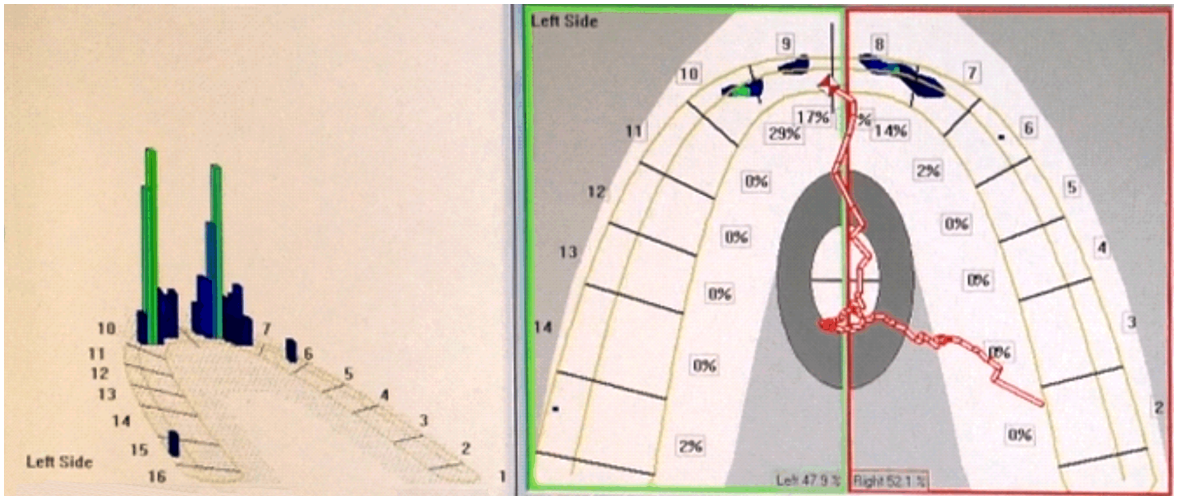

Figure 2 – ***Patient B.S.: the maximum propulsion (3D and 2D display); there are no premature contacts on the implant-prosthetic restoration (3.6).***

The second patient, R.L., came to the dental office with a class III Kennedy edentulous space (a missing 4.6). Using the T-Scan II system we observed that, from the first contacts that appeared on the teeth 3.7 and 4.4 until the MIP was reached, there was not any contact at the level of the implant-prosthetic restoration; the forces measured were 55.6% in the second quadrant, respectively 44.4% in the first one, when the patient closed the mouth in MIP. At the level of the implant-prosthetic restoration (4.6) was recorded the smallest percent of the masticatory force from the whole molar area (Figure 3). After the first contact is made, the mandible deflects (interference) from the right side to the left side and the occlusal forces are bigger in the first quadrant; in propulsion the first contact appears at the level of tooth 3.7, being maintained during the whole movement. During the mandibular movements (propulsion), we have noticed that there was no contact on the implant-prosthetic restoration (Figure 4).

Patient V.V. came to the dental office with a class III Kennedy edentulous space (a missing 3.6). The patient's habitual occlusion presents, from the centric relation to the MIP, a first dental contact on the teeth 3.5 and 4.7; in MIP, the forces are 36.9% on the left side, respectively 63.1% in the right side. At the level of the implant-prosthetic restoration (3.6) was recorded the smallest percent of the masticatory force from the whole molar area (Figure 5). In propulsion, the dental contacts exists at the level of teeth 3.7 and 4.7 (interference), and they are maintained until the moment when the anterior teeth make contacts; the measured forces are bigger on the left side (63.1%) and there are no premature contacts on the implant-prosthetic restoration (3.6) (Figure 6).

Discussion

The dentists are very interested in the correlation between the patient's habitual occlusion and the related biomechanical elements of it [12]. Some authors claimed that the attempts to measure bite forces is an inaccurate science and that often the dentists have to make and assume complicated decision based on such subjective appreciation [13]. The unequal distribution of the occlusal forces on teeth that are not making simultaneous contacts is resulting in occlusal trauma. It can appear either on the intact teeth because of the incorrect occlusal contacts, or on the incorrect overcontoured restorations that determine a bite raising [14].

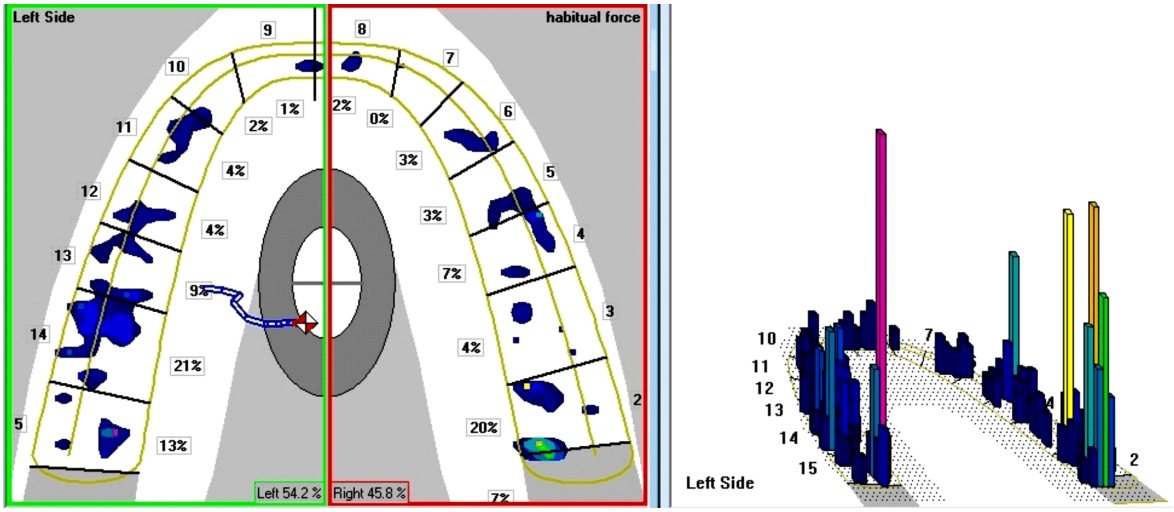

Figure 3 – ***Patient R.L.: the maximum intercuspation (2D and 3D display); at the level of the implant-prosthetic restoration (4.6) was recorded the smallest percent of the masticatory force from the molar area.***

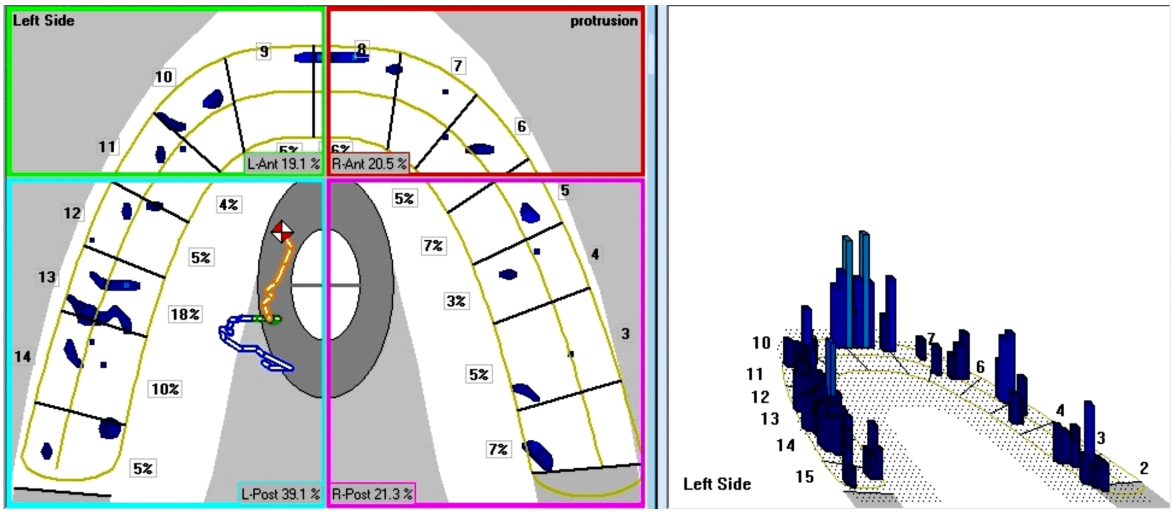

Figure 4 – ***Patient R.L.: propulsion (2D and 3D display); there is no contact on the implant-prosthetic restoration (4.6).***

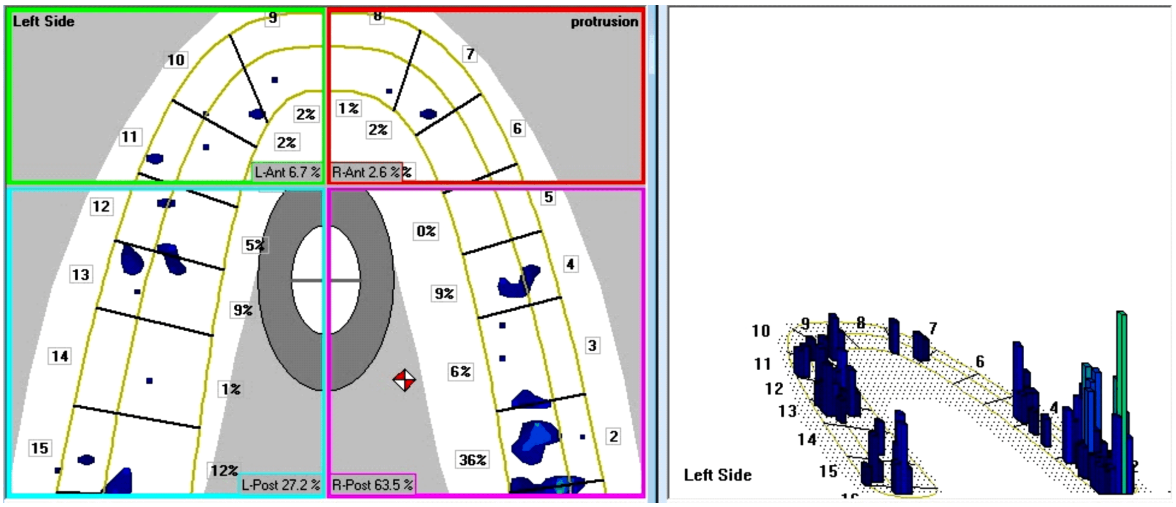

Figure 5 – ***Patient V.V.: the maximum intercuspation (2D and 3D display); at the level of the implant-prosthetic restoration (3.6) was recorded the smallest percent of the masticatory force from the molar area.***

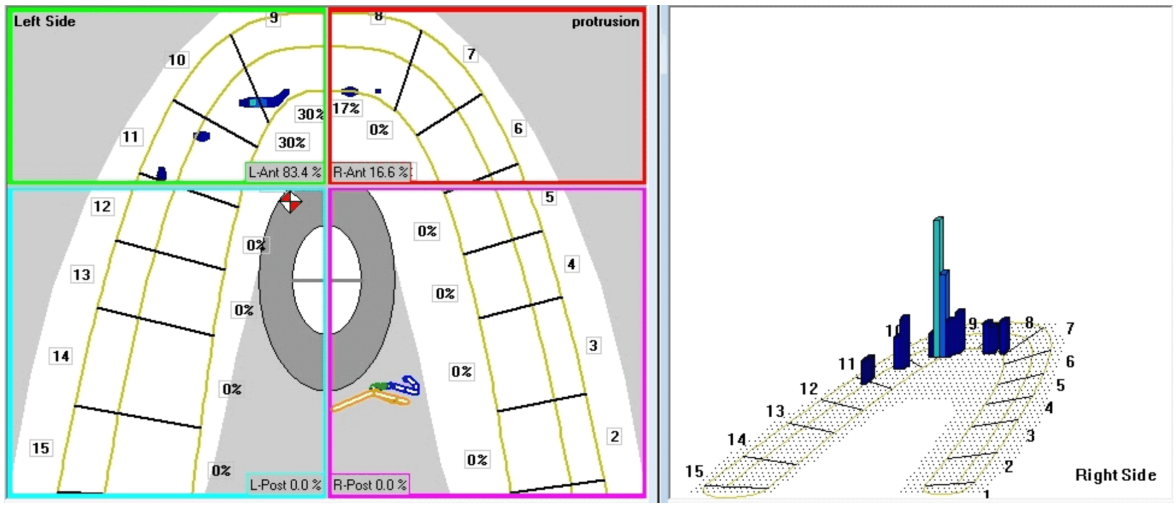

Figure 6 – ***Patient V.V.: the maximum propulsion (2D and 3D display); there are no premature contacts on the implant-prosthetic restoration (3.6).***

Some authors claim that the interocclusal tactile sensibility of natural teeth of 0.02 mm is in a similar range to the reported accuracy of the habitual intercuspation. Thus, ideally, no occlusal adjustments should be necessary when inserting restorative work made to occlude in habitual intercuspation [15, 16]. The conducted studies demonstrated that both dental and periodontal tissues can be harmed by occlusal trauma and these effects appear both on the natural teeth and on the dental implants. They are caused by consecutive overloading appeared during mandible's movements or by excessive masticatory forces [17, 18]. The exact analysis of the occlusion is essential for current clinical treatments as: the diagnosis of various intra- or extra-oral anomalies, the construction of the prosthetic and implant-prosthetic restorations or the removing of the orthodontic appliances [19]. In our study, we attempted to verify if the usual methods used in the dental offices to calibrate the occlusal contacts of the prosthetic restorations are succeeding to accomplish the objectives of a balanced occlusion, correctly integrated in the habitual occlusion of the patient. For this purpose, we used the T-Scan system as an objective method of appreciation of the prosthetic results, from the occlusion point of view.

The distribution of the occlusal contacts can be analyzed, conventionally, using the marks leaved by the articulating paper. Some researchers have concluded that this method is an accurate way of determining the "map" of the occlusal contacts, based on the force applied, and that the marks similar in size are indicating a uniform intensity resulting from maximum intercuspation forces [20]. Other authors sustain that none of the conventional methods used to analyze the dental occlusion determined the ideal characteristics that the dentists expected to observe as a results of this analysis [21]. They are claiming that there is no scientific correlation between the landmarks leaved by the articulating paper on the surface of the teeth, the quantity of the force or the contact period between the teeth, and this indicates that this method of occlusion analysis is not precise. Other researchers have concluded that neither the biting wax nor the articulating paper or the indentations made in the biting vinyl polysiloxane material do not allow the exact reproduction of the occlusal contacts [22–25] and therefore, in daily practice, the dentists probably interpret incorrect the marks made by the articulating paper [26]. In our study, we have demonstrated that, using these classic methods, we can integrate the implant-prosthetic restoration in the habitual occlusion of the patients. The results that were

obtained after analyzing the occlusions of our patients with the T-Scan II system showed that the dentists are capable of correctly interpreting the occlusal contacts map obtained using the articulating paper and the vinyl polysiloxane biting material.

In a 2007 study was stated that the absence of a periodontal ligament around implants determine an inability to absorb occlusal forces; the implant failure has often been associated with excessive occlusal forces acting on implant prostheses. This study concluded that the T-Scan system enables the clinician to measure occlusal forces before the implant insertion so that aberrant forces can be corrected and these results can be used to load implants sequentially to preserve balanced occlusal forces [27]. The T-Scan II system is a rapid and accurate system in identifying the distribution of the tooth contacts, and it can determine the high points, premature contacts, the regions of excessive loads and the uneven force's concentration; the articulating paper can determine only the position, number and the relative force of the occlusal contacts [28, 29]. The findings of our study are in accordance with the findings of other studies that previously attempted to correlate occlusal force to paper mark size and/or biting material and the T-Scan II system.

Conclusions

This *in vivo* study demonstrated, with the help of the T-Scan II system, that the articulating paper and the vinyl polysiloxane biting material used by the dentist for balancing implant-prosthetic crown's occlusion were good enough for integrate it in the habitual occlusion of the patient. It has been shown that these traditional methods, which are currently used in the dental offices, can help the dentist to correctly design the occlusion, if they are correctly and conscientiously used.

Conflict of interests

The authors declare that they have no conflict of interests.

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