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Overview of The Common Methods for Registration of Occlusal Contact.

Vesna Korunoska-Stevkovska[1]*, Jelena Jovanovska[2], Elena Radevska Razmovski[3], Aneta Mijoska[4], Emilija Bajraktarova Valjakova[5], Natasha Stavreva[6], Blagoja Dastevski[7], and Biljana Evrosimovska[8]

*[1,4,5,6,7] Faculty for Dental Medicine, Department for prosthodontics, University Ss' Ciryl and Methodius, Macedonia- Skopje
[2]Dental office " Raspeana mladost" Skopje, Macedonia
[3]Dental office "Dentalina duo" Skopje, Macedonia
[8]Faculty for Dental Medicine, Department for oral surgery, University Ss' Ciryl and Methodius, Macedonia- Skopje"

ABSTRACT

Registration of the occlusion and inter occlusal relationship between upper and lower jaw is very important in everyday dental practice, especially in prosthodontic. Occlusion presents "static" relationship between the incising or occlusal surfaces of the maxillary or mandibular teeth or tooth analogues. It presents one of the most controversial subjects in dentistry. Clinicians use various occlusal indicators to analyze occlusal contacts. The methods for occlusal contacts registration can be divided in two types as: qualitative and quantitative. Articulating paper is still most often used in everyday dental practice in the process of occlusion registration and balancing. Another common material for occlusal registration are dental waxes, and most often pink wax. Very often dentists use flexible materials like addition silicones - vinyl polysiloxane VPS (putties and pastes), injectable or hand mixed, but with their use it is very hard to find the exact position of the casts. Another method for occlusal registration is dual arch impression taken with dual arch tray, which offer the ability to simultaneously take a working model, opposing model and bite registration. T-Scan III System is a dental device used to analyze relative occlusal force that is recorded intraorally by a pressure-mapping sensor. The purpose of the paper is to evaluate different methods used for assessing occlusion and inter occlusal relationship, from very beginning till modern computer technology use. T Scan III is a reliable tool to detect early contacts and can be effectively used to check occlusal balances. It can be used in full mouth rehabilitation cases very effectively

Keywords: occlusion, articulation paper, wax, T scan

Corresponding author

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INTRODUCTION

Registration of the occlusion and inter occlusal relationship between upper and lower jaw is very important in everyday dental practice, especially in prosthodontic. Occlussion presents "static" relationship between the incising or occlusal surfaces of the maxillary or mandibular teeth or tooth analogues. It presents one of the most controversial subjects in dentistry.

For an accurate examination of the 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 [1]. For years, dental occlusion had been largely a matter of guess work for dentists. Articulation paper marks, waxes, pressure indicator paste, etc. were the only tools available to access and balance the bite force [2]. Occlusal contacts occur when the maxillary and the mandibular dentition touch each other [3]. Normal occlusal and articulation relations between the jaws ensure equal distribution of occlusal forces during mastication [4]. Teeth contacts can be classified as: cuspid protected occlusion, group function occlusion and full balanced occlusion. The occlusion should be balanced and as stress free as possible [5].

The knowledge about occlusion is critical to good clinical practice in dentistry. All disciplines of dentistry require that the clinicians assess the articulation of the teeth and prosthesis with respect to simultaneous contacts, biting time and biting force [6]. Occlusion for the prosthodontist is commonly understood as having the tempromandibular joint (TMJ) in its most orthopedically stable position as defined by centric relation (CR), the masticatory muscles in functional harmony, the teeth intercuspating simultaneously with equal intensity in CR, and anterior guidance in harmony with the envelope of function.

Faulty occlusion is one of the most common causes of bruxism that further leads to damage of the teeth and muscle and temporomandibular joint pain [7]. The occlusal forces that are applied to an implant prosthesis can be a potentially destructive factor in longevity of any implant prosthesis. Poorly directed and non-uniform occlusal loading will torque a prosthesis and apply stresses that may ultimately result in prosthetic failures [8].

Therefore, assessment of the occlusion is crucial to remedy these occlusal issues. Clinicians use various occlusal indicators to analyze occlusal contacts. The purpose of the paper is to evaluate different methods used for assessing occlusion and inter occlusal relationship, from very beginning till modern computer technology use.

MATERIALS AND METHODS

There are many different materials used for recording occlusal contacts, such as: alginate impression material, mylar paper strip, polyether rubber impression bites, silicon putty, typewriter ribbon, transparent acetate sheets, wax, wax articulation paper, silk stripes, foils, black silicon, high spot indicator, occlusal sprays, photo occlusion, occlusal sonography, pressure sensitive films etc [9].

The methods for occlusal contacts registration can be divided in two types as: qualitative and quantitative. The qualitative methods can determine only the localization, while quantitative methods also validate the sequence and the density of the contacts [10]. None of these dental materials has any scientifically proven capability to measure occlusal forces or sequence contact timing. Additionally, they all necessitate the clinician to "subjectively interpret" their occlusal representations [11,12].

Articulating paper is still most often used in everyday dental practice in the process of occlusion registration and balancing. The paper is produced in different colors (red/blue/black/green/orange), thickness (25-350 microns) and configurations. Red paper can be used in highly polished metal surfaces, while blue is for ceramic surfaces. The ink from the paper leaves positive contact marks on the tooth and prosthetic devices surfaces, but the precision of this method is questionable (fig.1). Most articulating papers are made for dry surfaces, and are not suitable for prosthetic devices, but some are added special bonding agents in the ink, and the manufacturer recommend them for wet and polished surfaces [13]. Adjustments must be very careful, in order not to affect vertical dimension and jaw support.

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Figure 1: Articulating paper in different color and shape

Another common material for occlusal registration are dental waxes, and most often pink wax. The wax rim is softened in hot water, or under flame, shaped according occlusal arches and put in patient's mouth onto the lower teeth arch. The patients close the mouth in central position, the wax is chilled with water and removed from the mouth. The problem occurs due to thermoplastic features and dimensional instability of the material, so it can be easily deformed when taking out of the mouth, or in the laboratory, if it is pressed firm when the casts are set. Sometimes wax can also interfere the path of closure of the jaws [14, 15, 16].

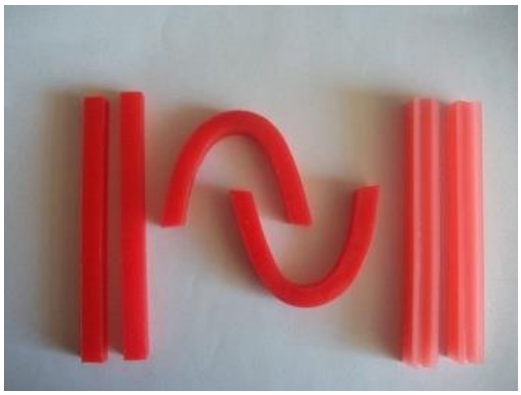

Figure 2: Pink wax for occlusal registration

Very often dentists use flexible materials like addition silicones - vinyl polysiloxane VPS (putties and pastes), injectable or hand mixed, but with their use it is very hard to find the exact position of the casts. It is because of spring back when the material is compressed, which allow a wide range of possible locations. Shrinkage during the polymerization process and distortion occurs if the material is removed from the mouth before it reached its complete set [17] Fig 3.

Figure 3: Vinyl Polysiloxane for occlusal registration

No matter which material is chosen we must understand that they all must meet some requirements like: easy preparing and handling, fast setting, flexibility and consistency, ability to wet the teeth etc.

Another method for occlusal registration is dual arch impression taken with dual arch tray, which offer the ability to simultaneously take a working model, opposing model and bite registration (fig.4). Bite registration provided by dual arch impressions provides superior maximum intercuspal relationships over full arch models, if done correctly [18, 19].

Figure 4: Dual arch impression trays

However, none of the described qualitative methods and materials are not completely accurate and satisfying. Most of them use the density and darkness of the colored mark which is not precise criterion for evaluation.

Quantitative methods use different devices to determine occlusal relationships, with certain differentiation of the sequence and density of the contacts. Photo occlusion and T Scan are some of the methods most often used in the practice.

First T Scan model was presented in 1987, and ever since manufacturer improved it till the last third generation. Improvements were made in the system's accuracy, sensitivity and reproducibility [20]. The T-Scan III System is a dental device used to analyze relative occlusal force that is recorded intraorally by a pressure-mapping sensor. The recorded force data is stored on a hard drive, and can be played back for data analysis in a time-based dynamic video. It consists of a piezoelectric foil sensor, a sensor handle, both hardware and software for recording, analyzing and viewing the data. The T-scan identifies the time magnitude and the distribution of the occlusal contacts (Fig. 5).

Figure 5: T Scan III

The T-scan system consists of a thin flexible sensor inserted into an autoclavable sensor handle that is plugged into the USB port of a personal computer. The sensors can be used repeatedly for a single patient, and they are made up of 1370 active pressure sensing locations (1122 pressure sensing locations for small sensors). Eighty-five microns thick, it encloses a double layer of Mylar, a special ink. A force applied to each of these cells modifies the electric conductivity of the Mylar. The program records and analyzes the differentials of applied voltage, and gives relative values of the force and duration of occlusal contacts, with a time precision of 10 ms [21,22]. The T-SCAN system provides the only accurate way to determine and evaluate the time sequence and force of occlusal contacts by converting the qualitative data into quantitative and displaying them digitally [23,

24]. The other significant usage of the T-scan system is analyzing tooth contacts in order to improve TMD and removing the causes of disorders. The computerized occlusal analysis system has ability to provide quantifiable force and time variance in a real-time window from the initial tooth contact into maximum intercuspation. The T-Scan III system can be employed with complete removable denture prostheses to perform computer-guided occlusal force-finishing corrective adjustments that measurably improve the installed prosthetic occlusal balance.

DISCUSSION

Knowledge about occlusion is critical to good clinical practice in dentistry. All disciplines of dentistry require that the clinicians assess the articulation of the teeth/prosthesis with respect to simultaneous contacts, biting time and biting force. There are 138 possible contacts in the dentition with normal occlusion. 90% of the total units actually make exact contact in dentitions with normal occlusion [25]. Balanced occlusion is a favored occlusal design in setting of artificial teeth in conventional complete dentures which preserves edentulous ridge and influence the stability of dentures. Influence of balanced occlusion in complete dentures on the decrease in the reduction of an edentulous ridge [26].

According to Dawson there are 5 criteria for accuracy of an interocclusal bite record: the bite record must not cause any movement of teeth or displacement of soft tissue, it must be possible to verify the accuracy of the interocclusal record in the mouth, the bite record must fit the dental casts as accurately as it fits the mouth, it must be possible to verify the accuracy of the bite record on the dental casts, the bite record must not distort during the storage or transportation to the dental laboratory [27].

A wide variety of materials have been used, with varying degrees of success depending upon how closely they match the above, including wax, zinc oxide-eugenol paste, acrylic resin and polymers. Plaster and reversible hydrocolloids have also been recommended but are rarely used these days. Articulating papers are used to detect high spots, the width, thickness and dye type of the articulating paper helps it to leave a mark. High spots can be detected easily as dark marks and contacts as light marks. The disadvantages of articulating papers have been that they can be affected by saliva, are thick and have a relatively inflexible base material. All of these factors can lead to greater number of pseudo contact markings. It is recommended that the recording materials have to be used only once, and that the teeth have to be dry during occlusal analysis.

The ultimate advantage of a computerised occlusal analysis is that it can detect the amount of force as well as location of the highest intensity contacts of a single tooth which is very specific. T Scan III is a reliable tool to detect early contacts and can be effectively used to check occlusal balances. It can be used in full mouth rehabilitation cases very effectively [28].

Computerized occlusal analysis is becoming the principal tool available to clinicians able to understand functional and parafunctional forces of occlusal contact, contact timing sequences, and occlusal surface interface pressures, which arise as teeth mill against each other during mandibular movements. Computerized occlusal analyses can be used to guide the operator as to which tooth contact locations require appropriate occlusal adjustments [29,30].

Differences between subjective balance occlusion and measurements reported with T-scan III were analyzed in study with 54 participants divided into three groups: the I study group were participants with fixed dentures with prosthetic ceramic restorations. In the II study group were symptomatic participants with TMD. In the third control group were healthy participants with full arch dentition that completed a subjective questionnaire that documented the absence of jaw pain, joint noise, locking and subjects without a history of TMD. For attributive data were used percentage of the structure. Differences in $P < 0.05$ were considered significant. After distributing attributive data of occlusal balance subjectively reported and compared with measurements analysed with electronic system T-scan III were found significant difference $P < 0.001$ in all three groups. It was concluded that there were statistically significant differences of balanced occlusion in all three groups. Also it was concluded that subjective data are not exact with measurements reported with electronic device T-scan III.[31]

The T-Scan system detects the occlusal contacts, and the occlusal surfaces are obtained using an intraoral scanner. Once the alignment between the 3-dimensional occlusal surface and the T-Scan registration

is carried out, the resulting contacts are projected onto the patient's occlusal surfaces; in this way, occlusal forces are obtained over time. The results obtained with this procedure demonstrate the feasibility of integrating different tools and software and the full integration of this procedure into a dental digital workflow [32].

T-scan can see the static and dynamic quality of inter-arch contacts in real time in a form that can be preserved in a record for comparison at any future date.The T-scan III's precision, which can be quantified in milliseconds and square millimeters, has won recognition as a reliable and reproducible research tool [33].

T-Scan III occlusal analysis system was used to measure the occlusal force distribution and the time character of normal occlusion at intercuspal position, protrusive position, and lateral excursive position. The conclusion was that at intercuspal position the region from first premolar to second molar teeth were the occlusal force centers, and the second molar has the most force concentrated in the area at the protrusion position. The lateral occlusal pattern is multi-format [34].

The occluding movement in 30 healthy people from mandibular postural position to intercuspal position was recorded by T-Scan II system. The distribution of occlusal force, the center of force, the percentage of intercuspal position occlusal force in Max force and the occlusion time was analyzed by T-Scan II system and SAS 9.0 software package. The results showed that there was no significant difference between the occlusal force of the two sides under the intercuspal position mode(P=0.3242). The average percentage of intercuspal position occlusal force in Max force was 96.89%. The confidence interval (CI) was 90.88%-100%. The average occlusion time was (0.2015 ± 0.0861)s. There was no correlation between the occlusion time and the percentage of intercuspal position occlusal force in Max force [35].

Several studies have demonstrated that the prevalence of temporomandibular (TMDs) in tinnitus patients ranges from 7% to 95%, and is reported in the literature that idiopathic tinnitus patients should be referred to a dentist to determine whether or not the Tinnitus is associated with TMD. The clinical role of the COT analysis in the ICP using theThe T-scan III system could be useful to decide a possible and verify the effects of specially designed occlusal devices that recently have been proven to reduce the entity of tinnitus [36,37].

The most important usage of the T-scan system is in analyzing and registration of occlusal contacts in patients with implant-prosthetic restorations. Occlusal management with the T-Scan system is a potentially important aid in force and contact time management of occlusal stress on implant prostheses. Use of traditional clinical methods of checking the occlusion are qualitative. Excessive force due to incomplete equilibration may compromise an implant, lack of occlusion, perhaps due to excessive equilibration, may result in the implant prosthesis being no more than a nonfunctioning space maintainer. When occlusal forces are well managed, the implant prosthesis can become a long-term functioning component in the patient's occlusal scheme [38].

In order to develop an appropriate occlusion, occlusal contacts should be measured in terms of both force and duration of contact time during which the force is exerted. Articulating paper or foils used as standard clinical procedure for occlusal check do not provide enough objective and percise informations, nor indicate contact force and time of the contact. A device such as the T-Scan III system is a valuable tool for occlucal adjustments and for establishing the desired occlusion pattern to avoid excessive loading and complications with implants and restorations, especially in complex implant cases or full mouth rehabilitation [39].

T-Scan III Computerized Occlusal Analysis System as method for evaluating occlusal contacts and balance in FPD should overcome limitation of other descriptive tools (articulating paper, wax) and should minimize the mistakes from incorrect occlusal contacts. Computerized method reduces the subjective interpretation of occlusal analysis data and provides accurate registration of static and dynamic occlusal information [22].

The new product of the Tekscan is bioEMG -T-Scan Integration Module: The T-Scan/BioEMG Integration software synchronizes the clinical data of T-Scan with the electromyographic data of BioResearch's EMG unit. Together, they give a complete view of your patient's bite. BioEMG measures

muscular functions of the head and neck while the T-Scan shows occlusal contact timing and force distribution of teeth.

Occlusal splint, a well-established form of therapy, has been reported by many authors to have a beneficial effect on caraniomandibular disorders [40]. The articulating paper used to adjust the occlusal appliance is incapable of measuring timing sequebce, occlusal force and pressure. The only way to precisely measure occlusal forces and time is the T-Scan III. The concept of neuromuscular dentistry is one of great topicality. The integrated T-Scan III - BioEMG system as part of this approach has been proved useful in monitoring the oral rehabilitation treatment. The use of these computer-assisted diagnostic systems put the treatment on scientific bases and thus the rehabilitation is an evidence-based one.

CONCLUSION

In the restorative process, accurate bite records have long been a concern of dental technicians. The use of a more rigid material, which has been trimmed properly for use in quadrant dentistry, will aid the dental technicians in the mounting process and fabrication of any restoration. Given enough occlusal and axial reduction, a skilled dental technician can produce extremely aesthetic restorations that require minimal adjustment. This will not only preserve the artistry incorporated into the new work, but will also decrease the time needed for delivery while increasing patient satisfaction and confidence in the dentist and team.

Within the scope of this systematic review, there is evidence to support that T-Scan system is rapid and accurate in identifying the distribution of the tooth contacts and it shows great promise as a clinical diagnostic screening device for occlusion and for improving the occlusion after various dental treatments. Additional clinical studies are required to advance the indication filed of this system. Importance of using digital occlusal T-Scan analysis in orthodontics deserves further investigation

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